$\eta(1440)$

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

See also the mini-review under non-$q\overline{q}$ candidates. (See the index for the page number.)

THE $\eta(1440)$, $f_1(1420)$, AND $f_1(1510)$

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The first observation of $\eta(1440)$ was made in $p\overline{p}$ annihilation at rest into $\eta(1440)\pi^+\pi^-$, $\eta(1440) \to K\overline{K}\pi$ (BAILLON 67). This state was reported to decay through $a_0(980)\pi$ and $K^*(892)\overline{K}$, with roughly equal contributions. The $\eta(1440)$ was also observed in radiative $J/\psi(1S)$ decay to $K\overline{K}\pi$ (SCHARRE 80, EDWARDS 82E, AUGUSTIN 90). There is now evidence for the existence of two pseudoscalars in the $\eta(1440)$ region, which we call η_L and η_H. The η_L around 1410 MeV decays mainly through $a_0(980)\pi$ (or direct $K\overline{K}\pi$). The η_H around 1475 MeV decays mainly to $K^*(892)\overline{K}$.

The simultaneous observation of two pseudoscalars is reported in three production mechanisms: π^-p (RATH 89); radiative $J/\psi(1S)$ decay (BAI 90C, AUGUSTIN 92); $\overline{p}p$ annihilation at rest (BERTIN 95,97, CICALO 99). All of them give values for the masses, widths, and decay modes in reasonable agreement. However, AUGUSTIN 92 finds η_L above η_H.

In $J/\psi(1S)$ radiative decay, the $\eta(1440)$ decays into $K\overline{K}\pi$ through $a_0(980)\pi$, and hence, a signal is also expected in the $\eta\pi\pi$ mass spectrum. This was indeed observed by MARK III in $\eta\pi^+\pi^-$ (BOLTON 92B), which report a mass of 1400 MeV, in line with the existence of the η_L decaying to $a_0(980)\pi$. This state is also observed in $\overline{p}p$ annihilation at rest into $\eta\pi^+\pi^-\pi^0\pi^0$, where it decays into $\eta\pi\pi$ (AMSLER 95F). The intermediate $a_0(980)\pi$ accounts for roughly half of the $\eta\pi\pi$ signal, in agreement with MARK III (BOLTON 92B) and DM2 (AUGUSTIN 90).

One of these two pseudoscalars could be the first radial excitation of the η', with the $\eta(1295)$ being the first radial excitation of the η. Ideal mixing, suggested by the $\eta(1295)$ and $\pi(1300)$ mass degeneracy, would then imply that the second isoscalar in the nonet is mainly $s\overline{s}$, and hence couples to $K^*\overline{K}$, in agreement with the η_H. Also its width matches the expected width for the radially excited $s\overline{s}$ state (CLOSE 97, BARNES 97).

An investigation of the $K\overline{K}\pi$ and $\eta\pi\pi$ channels in $\gamma\gamma$ collisions was performed (ACCIARRI 01G) . Their analysis leads to an η_H signal in $K\overline{K}\pi$, but η_L is not observed in $\eta\pi\pi$. Since gluonium production is presumably suppressed in $\gamma\gamma$ collisions, the ACCIARRI 01G results suggest that η_L has a large gluonic content (see also CLOSE 97B). The gluonium interpretation is, however, not favored by lattice gauge theories, which predict the 0^{-+} state above 2 GeV (BALI 93).

Let us now deal with 1^{++} isoscalars (see also our article in the previous issue of this *Review*). The $f_1(1420)$, decaying to $K^*\overline{K}$, was first reported in $\pi^- p$ reactions at 4 GeV/c (DIONISI 80). However, later analyses found that the 1400–1500 MeV region was far more complex (CHUNG 85, REEVES 86, BIRMAN 88). A reanalysis of the MARK III data in radiative $J/\psi(1S)$ decay to $K\overline{K}\pi$ (BAI 90C) shows the $f_1(1420)$, decaying into $K^*\overline{K}$. Also, a $C = +1$ state is observed in tagged $\gamma\gamma$ collisions (*e.g.*, BEHREND 89).

In $\pi^- p \to \eta\pi\pi n$ charge-exchange reactions at 8–9 GeV/c, the $\eta\pi\pi$ mass spectrum is dominated by $\eta(1440)$, and $\eta(1295)$ (ANDO 86, FUKUI 91C), and at 100 GeV/c ALDE 97B report $\eta(1295)$ and $\eta(1440)$ decaying to $\eta\pi^0\pi^0$ with a weak $f_1(1285)$ signal and no evidence for $f_1(1420)$.

Axial (1^{++}) mesons are not observed in $\overline{p}p$ annihilation at rest in liquid hydrogen, which proceeds dominantly through S-wave annihilation. However, in gaseous hydrogen, P-wave annihilation is enhanced, and indeed, BERTIN 97 report $f_1(1420)$ decaying to $K^*\overline{K}$.

The $f_1(1420)$, decaying into $K\overline{K}\pi$, is also seen in pp central production, together with $f_1(1285)$. The latter decays via $a_0(980)\pi$ and the former only via $K^*\overline{K}$, while $\eta(1440)$ is absent (ARMSTRONG 89, BARBERIS 97C). The $K_S K_S \pi^0$ decay mode of $f_1(1420)$ establishes unambiguously C=+1. On the other hand, there is no evidence for any state decaying to $\eta\pi\pi$ around 1400 MeV, and hence, the $\eta\pi\pi$ mode of $f_1(1420)$ must be suppressed (ARMSTRONG 91B).

We now turn to the experimental evidence for $f_1(1510)$. Two states, $f_1(1420)$ and $f_1(1510)$, decaying to $K^*\overline{K}$, compete for the $s\overline{s}$ assignment in the 1^{++} nonet. The $f_1(1510)$ was seen in $K^- p \rightarrow \Lambda K\overline{K}\pi$ at 4 GeV/c (GAVILLET 82) and at 11 GeV/c (ASTON 88C). Evidence is also reported in $\pi^- p$ at 8 GeV/c, based on the phase motion of the 1^{++} $K^*\overline{K}$ wave (BIRMAN 88).

The absence of $f_1(1420)$ in $K^- p$ (ASTON 88C) argues against $f_1(1420)$ being the $s\overline{s}$ member of the 1^{++} nonet. However, $f_1(1420)$ was reported in $K^- p$, but not in $\pi^- p$ (BITYUKOV 84), while two experiments do not observe $f_1(1510)$ in $K^- p$ (BITYUKOV 84, KING 91). It is also not seen in radiative $J/\psi(1S)$ decay (BAI 90C, AUGUSTIN 92), central collisions (BARBERIS 97C), nor in $\gamma\gamma$ collisions (AIHARA 88C), although, surprisingly for an $s\overline{s}$ state, a signal is reported in 4π decays (BAUER 93B). These facts leads to the conclusion that $f_1(1510)$ is not well established (CLOSE 97D).

Assigning the $f_1(1420)$ to the 1^{++} nonet, one finds a nonet mixing angle of $\sim 50^\circ$ (CLOSE 97D). However, arguments favoring $f_1(1420)$ being a hybrid $q\overline{q}g$ meson or a four-quark state were put forward by ISHIDA 89 and by CALDWELL 90, respectively, while LONGACRE 90 argued for a molecular state formed by the π orbiting in a P-wave around an S-wave $K\overline{K}$ state.

Summarizing, there is rather convincing evidence for $f_1(1420)$ decaying to $K^*\overline{K}$, and for two pseudoscalars in the $\eta(1440)$ region, η_L and η_H, decaying to $a_0(980)\pi$ and $K^*\overline{K}$, respectively. The $f_1(1510)$ is not well established.

References

References may be found at the end of the $\eta(1440)$, $f_1(1420)$, and $f_1(1510)$ Listings.

$\eta(1440)$ MASS

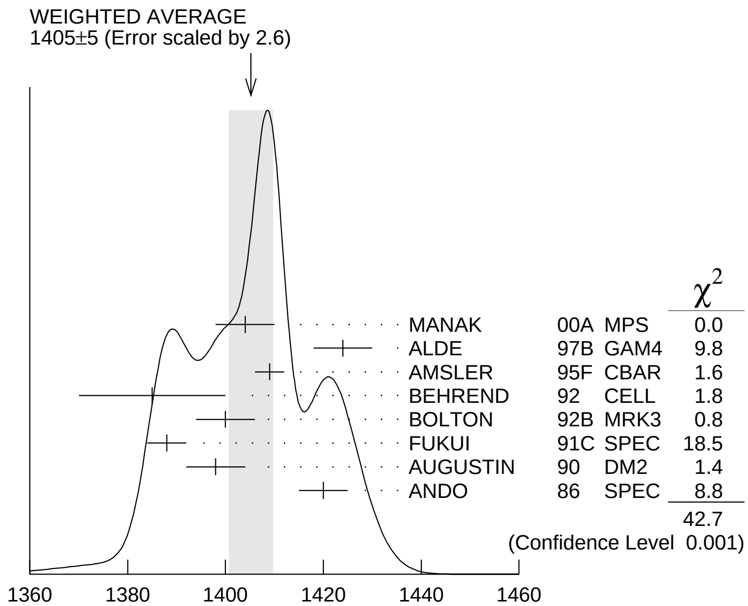
VALUE (MeV)	*DOCUMENT ID*
1400 - 1470 OUR ESTIMATE	Contains possibly two overlapping pseudoscalars.

$\eta\pi\pi$ MODE

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1405± 5 OUR AVERAGE		Error includes scale factor of 2.6. See the ideogram below.			
1404± 6	9082	MANAK	00A	MPS	18 $\pi^- p \to \eta\pi^+\pi^- n$
1424± 6	2200	ALDE	97B	GAM4	100 $\pi^- p \to \eta\pi^0\pi^0 n$
1409± 3		AMSLER	95F	CBAR	0 $\overline{p}p \to \pi^+\pi^-\pi^0\pi^0\eta$
1385±15		[1] BEHREND	92	CELL	$J/\psi \to \gamma\eta\pi^+\pi^-$
1400± 6		[1] BOLTON	92B	MRK3	$J/\psi \to \gamma\eta\pi^+\pi^-$
1388± 4		FUKUI	91C	SPEC	8.95 $\pi^- p \to \eta\pi^+\pi^- n$
1398± 6	261	[2] AUGUSTIN	90	DM2	$J/\psi \to \gamma\eta\pi^+\pi^-$
1420± 5		ANDO	86	SPEC	8 $\pi^- p \to \eta\pi^+\pi^- n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1385± 7		BAI	99	BES	$J/\psi \to \gamma\pi^+\pi^-$

[1] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.

[2] Best fit with a single Breit Wigner.



$\eta(1440)$ mass, $\eta\pi\pi$ mode (MeV)

$\pi\pi\gamma$ MODE

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1401±18	[3,4] AUGUSTIN	90	DM2	$J/\psi \to \pi^+\pi^-\gamma\gamma$
1432± 8	[4] COFFMAN	90	MRK3	$J/\psi \to \pi^+\pi^- 2\gamma$

[3] Best fit with a single Breit Wigner.
[4] This peak in the $\gamma\rho$ channel may not be related to the $\eta(1440)$.

4π MODE

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1420±20		BUGG	95	MRK3	$J/\psi \to \gamma\pi^+\pi^-\pi^+\pi^-$
1489±12	3270	[5] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

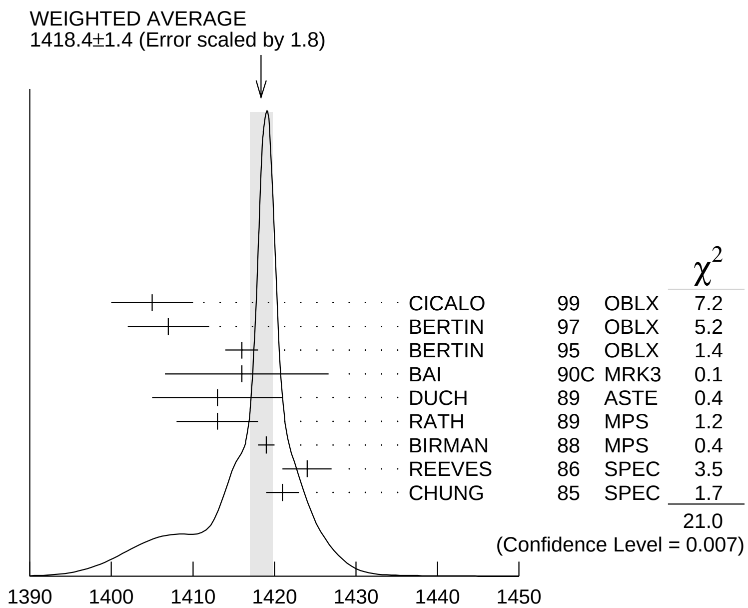
[5] Estimated by us from various fits.

$K\overline{K}\pi$ MODE ($a_0(980)\pi$ dominant)

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1418.4±1.4 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.				
1405 ±5		[6] CICALO	99	OBLX	$0\ \overline{p}p \to K^\pm K^0_S \pi^\mp\pi^+\pi^-$
1407 ±5		[6] BERTIN	97	OBLX	$0\ \overline{p}p \to K^\pm (K^0)\pi^\mp\pi^+\pi^-$
1416 ±2		[6] BERTIN	95	OBLX	$0\ \overline{p}p \to K\overline{K}\pi\pi\pi$
1416 ±8 $^{+7}_{-5}$	700	[7] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm\pi^\mp$

1413 ±8	500	DUCH	89	ASTE	$\overline{p}p \to \pi^+\pi^- K^\pm \pi^\mp K^0$
1413 ±5		[7] RATH	89	MPS	21.4 $\pi^- p \to n K^0_S K^0_S \pi^0$
1419 ±1	8800	BIRMAN	88	MPS	8 $\pi^- p \to K^+ \overline{K}^0 \pi^- n$
1424 ±3	620	REEVES	86	SPEC	6.6 $p\overline{p} \to K\overline{K}\pi X$
1421 ±2		CHUNG	85	SPEC	8 $\pi^- p \to K\overline{K}\pi n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1459 ±5		[8] AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$

[6] Decaying into $(K\overline{K})_S\pi$, $(K\pi)_S\overline{K}$, and $a_0(980)\pi$.
[7] From fit to the $a_0(980)\pi$ 0^{-+} partial wave. Cannot rule out a $a_0(980)\pi$ 1^{++} partial wave.
[8] Excluded from averaging because averaging would be meaningless.



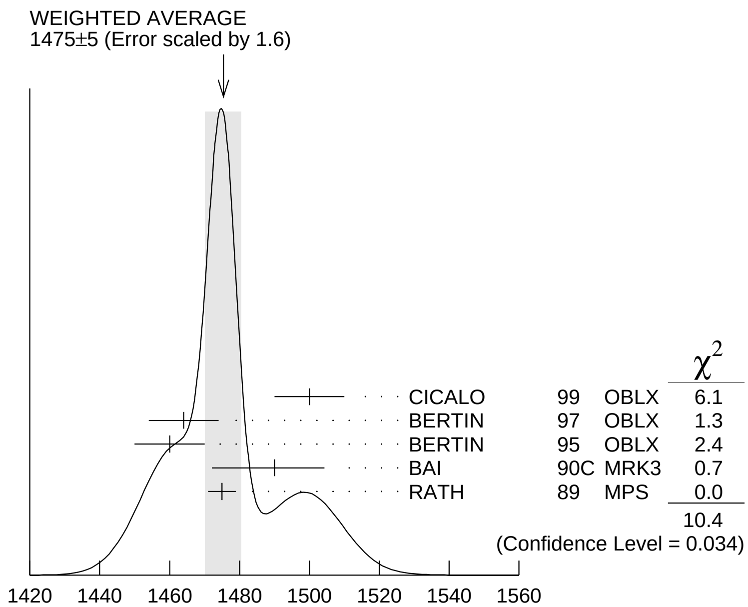
$\eta(1440)$ mass, $K\overline{K}\pi$ mode ($a_0(980)\,\pi$ dominant) (MeV)

$K\overline{K}\pi$ MODE ($K^*(892)$ K dominant)

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1475± 5 OUR AVERAGE	Error includes scale factor of 1.6. See the ideogram below.				
1500±10		CICALO	99	OBLX	0 $\overline{p}p \to K^\pm K^0_S \pi^\mp \pi^+ \pi^-$
1464±10		BERTIN	97	OBLX	0 $\overline{p}p \to K^\pm (K^0) \pi^\mp \pi^+ \pi^-$
1460±10		BERTIN	95	OBLX	0 $\overline{p}p \to K\overline{K}\pi\pi\pi$
$1490^{+14}_{-8}{}^{+3}_{-16}$	1100	BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
1475± 4		RATH	89	MPS	21.4 $\pi^- p \to n K^0_S K^0_S \pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					

1442±10	410	BAI	98C	BES	$J/\psi \to \gamma K^+ K^- \pi^0$
1421±14		[9] AUGUSTIN	92	DM2	$J/\psi \to \gamma K \overline{K} \pi$

[9] Excluded from averaging because averaging would be meaningless.



$\eta(1440)$ mass, $K\overline{K}\pi$ mode ($K^*(892)$ K dominant) (MeV)

$K\overline{K}\pi$ MODE (unresolved)

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1445± 8	693	AUGUSTIN	90	DM2	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
1433± 8	296	AUGUSTIN	90	DM2	$J/\psi \to \gamma K^+ K^- \pi^0$
1453± 7	170	RATH	89	MPS	21.4 $\pi^- p \to K^0_S K^0_S \pi^0 n$
1440^{+20}_{-15}	174	EDWARDS	82E	CBAL	$J/\psi \to \gamma K^+ K^- \pi^0$
1440^{+10}_{-15}		SCHARRE	80	MRK2	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
1425± 7	800	[10] BAILLON	67	HBC	$0\ \overline{p} p \to K\overline{K}\pi\pi\pi$

[10] From best fit of 0^{-+} partial wave , 50% $K^*(892)K$, 50% $a_0(980)\pi$.

$\eta(1440)$ WIDTH

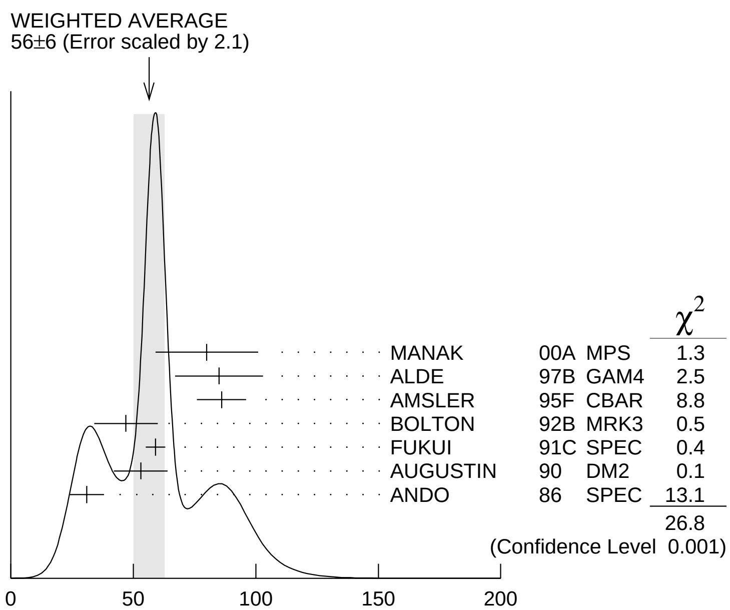
VALUE (MeV)	DOCUMENT ID
50 - 80 OUR ESTIMATE	Contains possibly two overlapping pseudoscalars.

$\eta\pi\pi$ MODE

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
56± 6 OUR AVERAGE		Error includes scale factor of 2.1. See the ideogram below.			
80±21	9082	MANAK	00A	MPS	18 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
85±18	2200	ALDE	97B	GAM4	100 $\pi^- p \rightarrow \eta\pi^0\pi^0 n$
86±10		AMSLER	95F	CBAR	0 $\overline{p}p \rightarrow \pi^+\pi^-\pi^0\pi^0\eta$
47±13		[11] BOLTON	92B	MRK3	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$
59± 4		FUKUI	91C	SPEC	8.95 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
53±11		[12] AUGUSTIN	90	DM2	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$
31± 7		ANDO	86	SPEC	8 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
∼ 50		[12] BEHREND	92	CELL	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$

[11] From fit to the $a_0(980)\pi$ 0^{-+} partial wave.

[12] From $\eta\pi^+\pi^-$ mass distribution - mainly $a_0(980)\pi$ - no spin–parity determination available.



$\eta(1440)$ width $\eta\pi\pi$ mode (MeV)

$\pi\pi\gamma$ MODE

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •				
174 ± 44	AUGUSTIN	90	DM2	$J/\psi \rightarrow \pi^+\pi^-\gamma\gamma$
90 ± 26	[13] COFFMAN	90	MRK3	$J/\psi \rightarrow \pi^+\pi^- 2\gamma$

[13] This peak in the $\gamma\rho$ channel may not be related to the $\eta(1440)$.

4π MODE

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
160 ± 30		BUGG	95	MRK3	$J/\psi \rightarrow \gamma\pi^+\pi^-\pi^+\pi^-$
144 ± 13	3270	[14] BISELLO	89B	DM2	$J/\psi \rightarrow 4\pi\gamma$

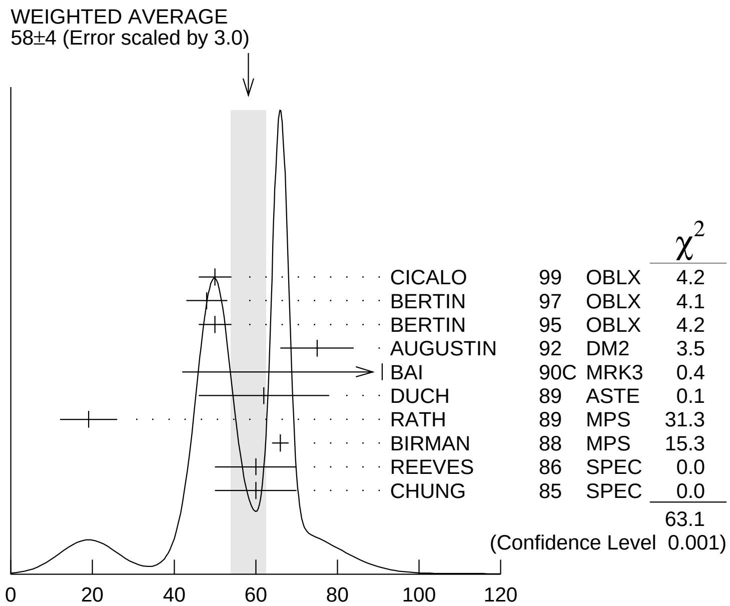
[14] Estimated by us from various fits.

$K\overline{K}\pi$ MODE ($a_0(980)\,\pi$ dominant)

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
58± 4 OUR AVERAGE	Error includes scale factor of 3.0. See the ideogram below.				
$50\pm\ 4$		CICALO	99	OBLX	$0\ \overline{p}p \rightarrow K^\pm K^0_S \pi^\mp\pi^+\pi^-$
$48\pm\ 5$		[15] BERTIN	97	OBLX	$0.0\ \overline{p}p \rightarrow K^\pm (K^0)\pi^\mp\pi^+\pi^-$
$50\pm\ 4$		[15] BERTIN	95	OBLX	$0\ \overline{p}p \rightarrow K\overline{K}\pi\pi\pi$
$75\pm\ 9$		AUGUSTIN	92	DM2	$J/\psi \rightarrow \gamma K\overline{K}\pi$
$91^{+67}_{-31}{}^{+15}_{-38}$		[16] BAI	90C	MRK3	$J/\psi \rightarrow \gamma K^0_S K^\pm\pi^\mp$
62 ± 16	500	DUCH	89	ASTE	$\overline{p}p \rightarrow K\overline{K}\pi\pi\pi$
$19\pm\ 7$		[16] RATH	89	MPS	$21.4\ \pi^- p \rightarrow n K^0_S K^0_S \pi^0$
$66\pm\ 2$	8800	BIRMAN	88	MPS	$8\ \pi^- p \rightarrow K^+\overline{K}^0\pi^- n$
60 ± 10	620	REEVES	86	SPEC	$6.6\ p\overline{p} \rightarrow KK\pi X$
60 ± 10		CHUNG	85	SPEC	$8\ \pi^- p \rightarrow K\overline{K}\pi n$

[15] Decaying into $(K\overline{K})_S\pi$, $(K\pi)_S\overline{K}$, and $a_0(980)\pi$.

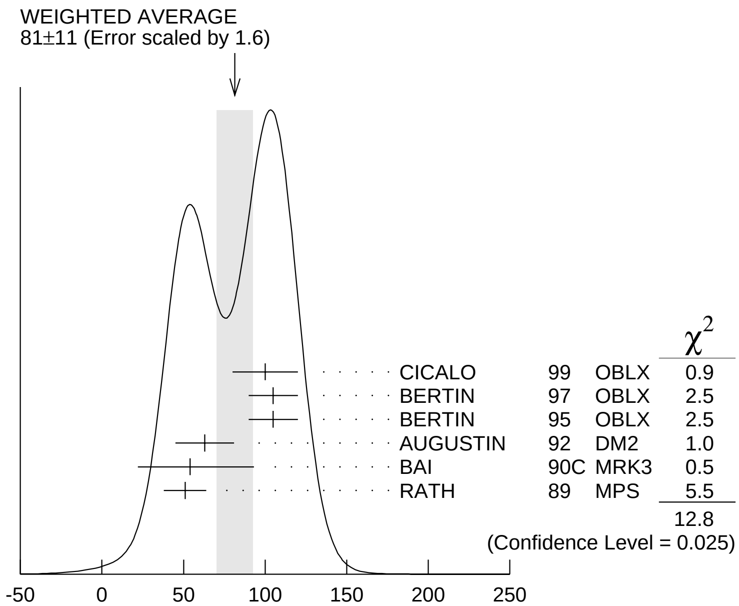
[16] From fit to the $a_0(980)\pi\ 0^{-+}$ partial wave , but $a_0(980)\pi\ 1^{++}$ cannot be excluded.



$\eta(1440)$ width $K\overline{K}\pi$ mode ($a_0(980)\,\pi$ dominant)

$K\overline{K}\pi$ MODE ($K^*(892)\,K$ dominant)

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
81±11 OUR AVERAGE	Error includes scale factor of 1.6. See the ideogram below.			
100±20	CICALO	99	OBLX	0 $\overline{p}p \to K^{\pm}K^0_S\pi^{\mp}\pi^+\pi^-$
105±15	BERTIN	97	OBLX	0.0 $\overline{p}p \to K^{\pm}(K^0)\pi^{\mp}\pi^+\pi^-$
105±15	BERTIN	95	OBLX	0 $\overline{p}p \to K\overline{K}\pi\pi\pi$
63±18	AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
$54^{+37}_{-21}{}^{+13}_{-24}$	BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^{\pm}\pi^{\mp}$
51±13	RATH	89	MPS	21.4 $\pi^- p \to nK^0_S K^0_S \pi^0$



$\eta(1440)$ width $K\overline{K}\pi$ mode ($K^*(892)$ K dominant)

$K\overline{K}\pi$ MODE (unresolved)

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
93±14	296	AUGUSTIN	90	DM2	$J/\psi \to \gamma K^+ K^- \pi^0$
105±10	693	AUGUSTIN	90	DM2	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
100±11	170	RATH	89	MPS	21.4 $\pi^- p \to K^0_S K^0_S \pi^0 n$
55^{+20}_{-30}	174	EDWARDS	82E	CBAL	$J/\psi \to \gamma K^+ K^- \pi^0$
50^{+30}_{-20}		SCHARRE	80	MRK2	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
80±10	800	[17] BAILLON	67	HBC	0.0 $\overline{p}p \to K\overline{K}\pi\pi\pi$

[17] From best fit to 0^{-+} partial wave , 50% $K^*(892)K$, 50% $a_0(980)\pi$.

$\eta(1440)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$K\overline{K}\pi$	seen
Γ_2	$K\overline{K}^*(892)+$ c.c.	seen
Γ_3	$\eta\pi\pi$	seen
Γ_4	$a_0(980)\pi$	seen

Γ_5	$\eta(\pi\pi)_{S\text{-wave}}$	seen
Γ_6	$f_0(980)\eta$	seen
Γ_7	4π	seen
Γ_8	$\gamma\gamma$	
Γ_9	$\rho^0\gamma$	

$\eta(1440)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(\text{total})$

$\Gamma(K\overline{K}\pi) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_1\Gamma_8/\Gamma$

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
0.212±0.050±0.023		[18] ACCIARRI	01G	L3	183–202 $e^+e^- \rightarrow e^+e^- K^0_S K^\pm \pi^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<1.2	95	BEHREND	89	CELL	$\gamma\gamma \rightarrow K^0_S K^\pm \pi^\mp$
<1.6	95	AIHARA	86D	TPC	$e^+e^- \rightarrow e^+e^- K^0_S K^\pm \pi^\mp$
<2.2	95	ALTHOFF	85B	TASS	$e^+e^- \rightarrow e^+e^- K\overline{K}\pi$
<8.0	95	JENNI	83	MRK2	$e^+e^- \rightarrow e^+e^- K\overline{K}\pi$

$\Gamma(\eta\pi\pi) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_3\Gamma_8/\Gamma$

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
<0.095	95	ACCIARRI	01G	L3	183–202 $e^+e^- \rightarrow e^+e^- \eta\pi^+\pi^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.3		ANTREASYAN	87	CBAL	$e^+e^- \rightarrow e^+e^- \eta\pi\pi$

$\Gamma(\rho^0\gamma) \times \Gamma(\gamma\gamma)/\Gamma_{total}$ — $\Gamma_9\Gamma_8/\Gamma$

VALUE (keV)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<1.5	95	ALTHOFF	84E	TASS	$e^+e^- \rightarrow e^+e^- \pi^+\pi^-\gamma$

[18] Signal and mass compatible with $K^* K$ decay of high mass $\eta(1440)$ state.

$\eta(1440)$ BRANCHING RATIOS

$\Gamma(\eta\pi\pi)/\Gamma(K\overline{K}\pi)$ — Γ_3/Γ_1

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.5	90	EDWARDS	83B	CBAL	$J/\psi \rightarrow \eta\pi\pi\gamma$
<1.1	90	SCHARRE	80	MRK2	$J/\psi \rightarrow \eta\pi\pi\gamma$
<1.5	95	FOSTER	68B	HBC	0.0 $\overline{p}p$

$\Gamma(a_0(980)\pi)/\Gamma(K\overline{K}\pi)$ — Γ_4/Γ_1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
~ 0.15		[20] BERTIN	95	OBLX	0 $\overline{p}p \rightarrow K\overline{K}\pi\pi\pi$
~ 0.8	500	[20] DUCH	89	ASTE	$\overline{p}p \rightarrow \pi^+\pi^- K^\pm \pi^\mp K^0$
~ 0.75		[20] REEVES	86	SPEC	6.6 $p\overline{p} \rightarrow KK\pi X$

$\Gamma\big(a_0(980)\pi\big)/\Gamma\big(\eta\pi\pi\big)$ Γ_4/Γ_3

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.29±0.10		ABELE	98E	CBAR	0 $p\overline{p} \to \eta\pi^0\pi^0\pi^0$
0.19±0.04	2200	[21] ALDE	97B	GAM4	100 $\pi^- p \to \eta\pi^0\pi^0 n$
0.56±0.04±0.03		[21] AMSLER	95F	CBAR	0 $\overline{p}p \to \pi^+\pi^-\pi^0\pi^0\eta$

$\Gamma\big(a_0(980)\pi\big)/\Gamma\big(\eta(\pi\pi)_{S\text{-wave}}\big)$ Γ_4/Γ_5

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.91±0.12		ANISOVICH	01	SPEC	0.0 $\overline{p}p \to \eta\pi^+\pi^-\pi^+\pi^-$
0.15±0.04	9082	MANAK	00A	MPS	18 $\pi^- p \to \eta\pi^+\pi^- n$
0.70±0.12±0.20		[22] BAI	99	BES	$J/\psi \to \gamma\eta\pi^+\pi^-$

$\Gamma\big(K\overline{K}^*(892)+\text{c.c.}\big)/\Gamma\big(K\overline{K}\pi\big)$ Γ_2/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.50±0.10	BAILLON	67	HBC	0.0 $\overline{p}p \to K\overline{K}\pi\pi\pi$

$\Gamma\big(K\overline{K}^*(892)+\text{c.c.}\big)/\big[\Gamma\big(K\overline{K}^*(892)+\text{c.c.}\big)+\Gamma\big(a_0(980)\pi\big)\big]$ $\Gamma_2/(\Gamma_2+\Gamma_4)$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.25	90	EDWARDS	82E	CBAL	$J/\psi \to K^+K^-\pi^0\gamma$

$\Gamma\big(\rho^0\gamma\big)/\Gamma\big(K\overline{K}\pi\big)$ Γ_9/Γ_1

VALUE	DOCUMENT ID		TECN	COMMENT
0.0152±0.0038	[23] COFFMAN	90	MRK3	$J/\psi \to \gamma\gamma\pi^+\pi^-$

$\Gamma\big(\eta(\pi\pi)_{S\text{-wave}}\big)/\Gamma\big(\eta\pi\pi\big)$ Γ_5/Γ_3

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.81±0.04	2200	ALDE	97B	GAM4	100 $\pi^- p \to \eta\pi^0\pi^0 n$

$\Gamma\big(a_0(980)\pi\big)/\Gamma\big(\eta(\pi\pi)_{S\text{-wave}}\big)$ Γ_4/Γ_5

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.32±0.07	[19] ANISOVICH	99I	SPEC	0.9–1.2 $\overline{p}p \to \eta 3\pi^0$

[19] Using preliminary Crystal Barrel data.
[20] Assuming that the $a_0(980)$ decays only into $K\overline{K}$.
[21] Assuming that the $a_0(980)$ decays only into $\eta\pi$.
[22] Assuming that the $a_0(980)$ decays only into $\eta\pi$.
[23] Using B($J/\psi \to \gamma\eta(1440) \to \gamma K\overline{K}\pi$)=$4.2\times10^{-3}$ and B($J/\psi \to \gamma\eta(1440) \to \gamma\gamma\rho^0$)=$6.4\times10^{-5}$ and assuming that the $\gamma\rho^0$ signal does not come from the $f_1(1420)$.

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BAI	98C	PL B440 217	J.Z. Bai *et al.*	(BES Collab.)
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