$\eta(1440)$

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

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 π^-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 $K^-p \to \Lambda K\overline{K}\pi$ at 4 GeV/c (GAVILLET 82) and at 11 GeV/c (ASTON 88C). Evidence is also reported in π^-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 π^-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

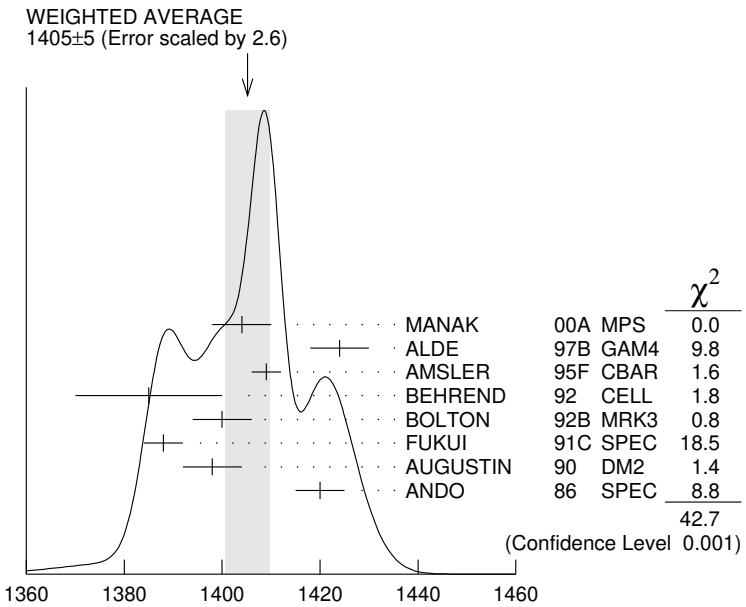
VALUE (MeV)	*DOCUMENT ID*
1400 – 1470 OUR ESTIMATE	Contains possibly two overlapping pseudoscalars.

$\eta\pi\pi$ 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 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
1424± 6	2200	ALDE	97B	GAM4	100 $\pi^- p \rightarrow \eta\pi^0\pi^0 n$
1409± 3		AMSLER	95F	CBAR	0 $\overline{p}p \rightarrow \pi^+\pi^-\pi^0\pi^0\eta$
1385±15		[1] BEHREND	92	CELL	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$
1400± 6		[1] BOLTON	92B	MRK3	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$
1388± 4		FUKUI	91C	SPEC	8.95 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
1398± 6	261	[2] AUGUSTIN	90	DM2	$J/\psi \rightarrow \gamma\eta\pi^+\pi^-$
1420± 5		ANDO	86	SPEC	8 $\pi^- p \rightarrow \eta\pi^+\pi^- n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1385± 7		BAI	99	BES	$J/\psi \rightarrow \gamma\pi^+\pi^-$

[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)

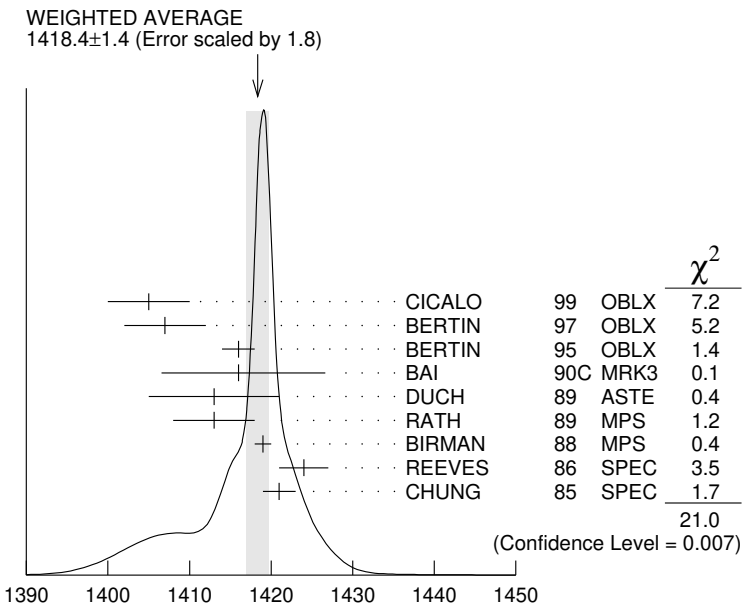
VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1418.4±1.4 OUR AVERAGE		Error includes scale factor of 1.8. See the ideogram below.			
1405 ±5		[6] CICALO	99	OBLX	$0\,\overline{p}p \to K^\pm K^0_S \pi^\mp \pi^+ \pi^-$
1407 ±5		[6] BERTIN	97	OBLX	$0\,\overline{p}p \to K^\pm (K^0) \pi^\mp \pi^+ \pi^-$
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	$\overline{p}p \rightarrow$ $\pi^+\pi^- K^\pm \pi^\mp K^0$
1413 ±5		[7] RATH	89	MPS	21.4 $\pi^- p \rightarrow$ $n K^0_S K^0_S \pi^0$
1419 ±1	8800	BIRMAN	88	MPS	8 $\pi^- p \rightarrow K^+ \overline{K}^0 \pi^- n$
1424 ±3	620	REEVES	86	SPEC	6.6 $p\overline{p} \rightarrow K\overline{K}\pi X$
1421 ±2		CHUNG	85	SPEC	8 $\pi^- p \rightarrow K\overline{K}\pi n$

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

1459 ±5	[8] AUGUSTIN	92	DM2	$J/\psi \rightarrow \gamma K\overline{K}\pi$

[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 ($a_0(980)$ π dominant) (MeV)

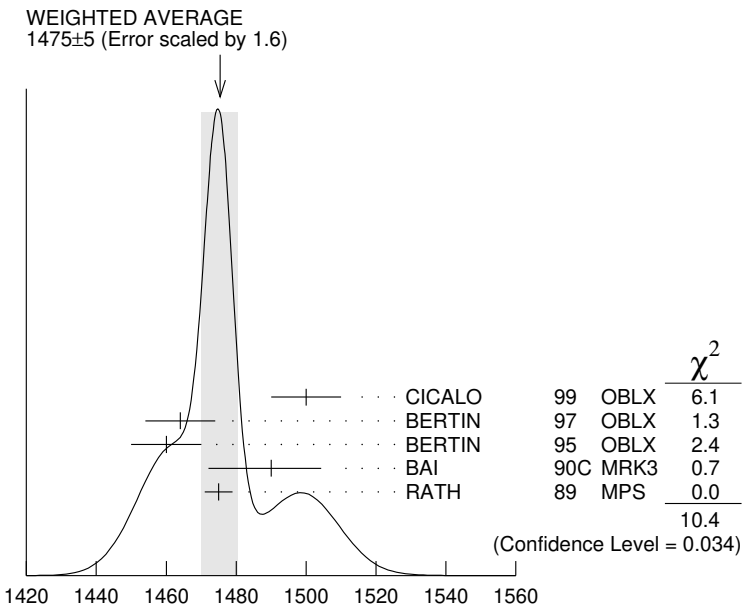
$K\overline{K}\pi$ MODE ($K^*(892)$ K dominant)

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 $\overline{p}p \rightarrow$ $K^\pm K^0_S \pi^\mp \pi^+ \pi^-$
1464±10		BERTIN	97 OBLX	0 $\overline{p}p \rightarrow$ $K^\pm (K^0)\pi^\mp \pi^+ \pi^-$
1460±10		BERTIN	95 OBLX	0 $\overline{p}p \rightarrow K\overline{K}\pi\pi\pi$
$1490^{+14}_{-8}{}^{+3}_{-16}$	1100	BAI	90C MRK3	$J/\psi \rightarrow \gamma K^0_S K^\pm \pi^\mp$
1475± 4		RATH	89 MPS	21.4 $\pi^- p \rightarrow$ $n K^0_S K^0_S \pi^0$

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

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

[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	$J/\psi \rightarrow \gamma K^0_S K^\pm \pi^\mp$
1433± 8	296	AUGUSTIN	90	DM2	$J/\psi \rightarrow \gamma K^+ K^- \pi^0$
1453± 7	170	RATH	89	MPS	21.4 $\pi^- p \rightarrow K^0_S K^0_S \pi^0 n$
1440^{+20}_{-15}	174	EDWARDS	82E	CBAL	$J/\psi \rightarrow \gamma K^+ K^- \pi^0$
1440^{+10}_{-15}		SCHARRE	80	MRK2	$J/\psi \rightarrow \gamma K^0_S K^\pm \pi^\mp$
1425± 7	800	[10] BAILLON	67	HBC	$0\ \overline{p} p \rightarrow K \overline{K} \pi \pi \pi$

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

$\eta(1440)$ WIDTH

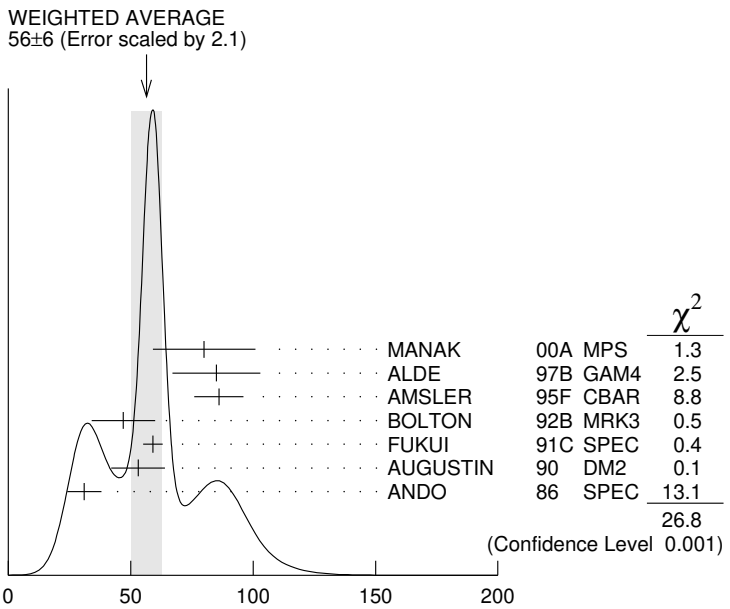
VALUE (MeV)	*DOCUMENT ID*
50 – 80 OUR ESTIMATE	Contains possibly two overlapping pseudoscalars.

$\eta\pi\pi$ 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.



			χ^2
MANAK	00A	MPS	1.3
ALDE	97B	GAM4	2.5
AMSLER	95F	CBAR	8.8
BOLTON	92B	MRK3	0.5
FUKUI	91C	SPEC	0.4
AUGUSTIN	90	DM2	0.1
ANDO	86	SPEC	13.1
			26.8
(Confidence Level			0.001)

$\eta(1440)$ 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	$J/\psi \to \pi^+\pi^-\gamma\gamma$
90 ± 26	[13] COFFMAN	90	MRK3	$J/\psi \to \pi^+\pi^-2\gamma$

[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	$J/\psi \to \gamma\pi^+\pi^-\pi^+\pi^-$
144 ± 13	3270	[14] BISELLO	89B	DM2	$J/\psi \to 4\pi\gamma$

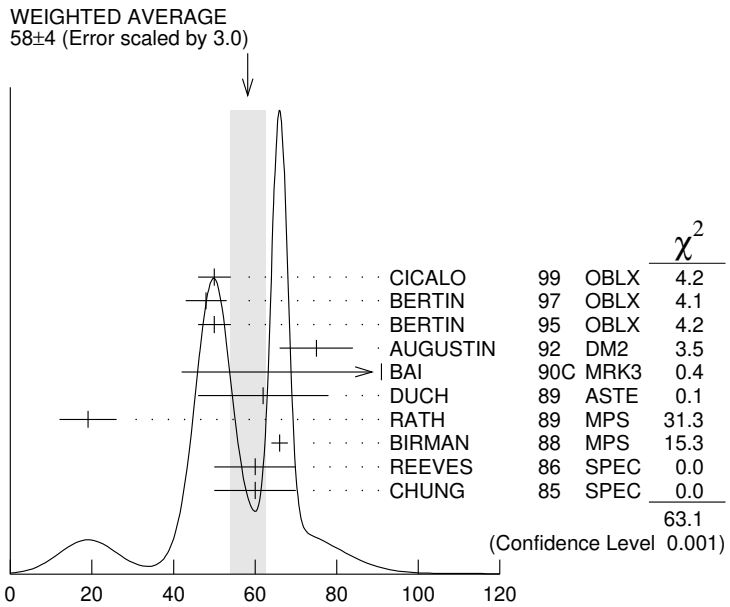
[14] Estimated by us from various fits.

$K\overline{K}\pi$ 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 ± 4		CICALO	99	OBLX	0 $\overline{p}p \to K^\pm K^0_S \pi^\mp \pi^+ \pi^-$
48 ± 5		[15] BERTIN	97	OBLX	0.0 $\overline{p}p \to K^\pm (K^0) \pi^\mp \pi^+ \pi^-$
50 ± 4		[15] BERTIN	95	OBLX	0 $\overline{p}p \to K\overline{K}\pi\pi\pi$
75 ± 9		AUGUSTIN	92	DM2	$J/\psi \to \gamma K\overline{K}\pi$
91^{+67+15}_{-31-38}		[16] BAI	90C	MRK3	$J/\psi \to \gamma K^0_S K^\pm \pi^\mp$
62 ± 16	500	DUCH	89	ASTE	$\overline{p}p \to K\overline{K}\pi\pi\pi$
19 ± 7		[16] RATH	89	MPS	21.4 $\pi^- p \to n K^0_S K^0_S \pi^0$
66 ± 2	8800	BIRMAN	88	MPS	8 $\pi^- p \to K^+ \overline{K}^0 \pi^- n$
60 ± 10	620	REEVES	86	SPEC	6.6 $p\overline{p} \to K K \pi X$
60 ± 10		CHUNG	85	SPEC	8 $\pi^- p \to K\overline{K}\pi n$

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

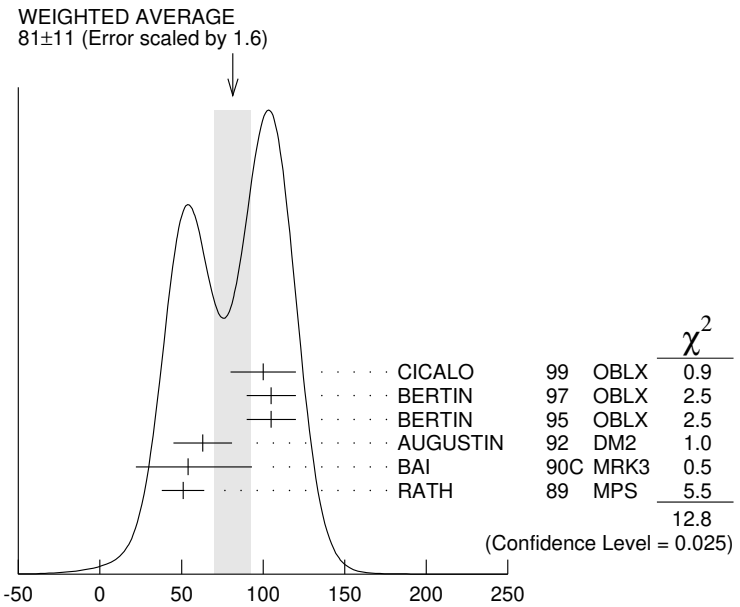
[16] From fit to the $a_0(980)\,\pi\ 0^{-+}$ partial wave , but $a_0(980)\,\pi\ 1^{++}$ cannot be excluded.



$\eta(1440)$ width $K\overline{K}\pi$ mode ($a_0(980)$ π 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 $\overline{p}p \rightarrow$ $K^{\pm} K^0_S \pi^{\mp} \pi^+ \pi^-$
105±15	BERTIN	97	OBLX	0.0 $\overline{p}p \rightarrow$ $K^{\pm}(K^0)\pi^{\mp} \pi^+ \pi^-$
105±15	BERTIN	95	OBLX	0 $\overline{p}p \rightarrow$ $K\overline{K}\pi\pi\pi$
63±18	AUGUSTIN	92	DM2	$J/\psi \rightarrow$ $\gamma K\overline{K}\pi$
54^{+37+13}_{-21-24}	BAI	90C	MRK3	$J/\psi \rightarrow$ $\gamma K^0_S K^{\pm}\pi^{\mp}$
51±13	RATH	89	MPS	21.4 $\pi^- p \rightarrow$ $n K^0_S K^0_S \pi^0$



$\eta(1440)$ 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	$\eta(\pi\pi)_S$-wave	seen
Γ_6	$f_0(980)\eta$	seen
Γ_7	4π	seen
Γ_8	$\gamma\gamma$	
Γ_9	$\rho^0\gamma$	

$\eta(1440)$ $\Gamma(i)\Gamma(\gamma\gamma)/\Gamma(total)$

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

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

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

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

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

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	$e^+e^- \to e^+e^-\pi^+\pi^-\gamma$

[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	$J/\psi \to \eta\pi\pi\gamma$
<1.1	90	SCHARRE	80	MRK2	$J/\psi \to \eta\pi\pi\gamma$
<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 $\overline{p}p \to K\overline{K}\pi\pi\pi$
~ 0.8	500	[20] DUCH	89	ASTE	$\overline{p}p \to \pi^+\pi^- K^\pm\pi^\mp K^0$
~ 0.75		[20] REEVES	86	SPEC	6.6 $p\overline{p} \to KK\pi X$

$\Gamma(a_0(980)\pi)/\Gamma(\eta\pi\pi)$ 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 $\pi^- p\to\ \eta\pi^0\pi^0 n$
$0.56\pm0.04\pm0.03$		[21] AMSLER	95F	CBAR	0 $\overline{p}p\to\ \pi^+\pi^-\pi^0\pi^0\eta$

$\Gamma(a_0(980)\pi)/\Gamma(\eta(\pi\pi)_{S\text{-wave}})$ 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 $\pi^- p\to\ \eta\pi^+\pi^- n$
$0.70\pm0.12\pm0.20$		[22] BAI	99	BES	$J/\psi\to\ \gamma\eta\pi^+\pi^-$

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

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

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

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

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

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

$\Gamma(\eta(\pi\pi)_{S\text{-wave}})/\Gamma(\eta\pi\pi)$ 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 $\pi^- p\to\ \eta\pi^0\pi^0 n$

$\Gamma(a_0(980)\pi)/\Gamma(\eta(\pi\pi)_{S\text{-wave}})$ 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 $\overline{p}p\to\ \eta3\pi^0$

[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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CICALO	99	PL B462 453	C. Cicalo *et al.*	(OBELIX Collab.)
ABELE	98E	NP B514 45	A. Abele *et al.*	(Crystal Barrel Collab.)
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