



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

We have omitted some results that have been superseded by later experiments. The omitted results may be found in our 1988 edition Physics Letters **B204** (1988).

η MASS

The new measurements from CLEO-c and KLOE seem to resolve the obvious inconsistency of the previously available high-precision η mass measurements by NA48 (LAI 02) and GEM (ABDEL-BARY 05) in favor of the higher η mass from NA48. Therefore we now use only the results from LAI 02, MILLER 07, and AMBROSINO 07B for our η mass average.

<u>VALUE (MeV)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
547.853 ± 0.024 OUR AVERAGE				
547.874 ± 0.007 ± 0.029		AMBROSINO 07B	KLOE	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
547.785 ± 0.017 ± 0.057	16k	MILLER 07	CLEO	$\psi(2S) \rightarrow J/\psi\eta$
547.843 ± 0.030 ± 0.041	1134	LAI 02	NA48	$\eta \rightarrow 3\pi^0$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
547.311 ± 0.028 ± 0.032		¹ ABDEL-BARY 05	SPEC	$d p \rightarrow {}^3\text{He} X$
547.12 ± 0.06 ± 0.25		KRUSCHE 95D	SPEC	$\gamma p \rightarrow \eta p$, threshold
547.30 ± 0.15		PLOUIN 92	SPEC	$d p \rightarrow \eta {}^3\text{He}$
547.45 ± 0.25		DUANE 74	SPEC	$\pi^- p \rightarrow n$ neutrals
548.2 ± 0.65		FOSTER 65C	HBC	
549.0 ± 0.7	148	FOELSCHE 64	HBC	
548.0 ± 1.0	91	ALFF-...	62	HBC
549.0 ± 1.2	53	BASTIEN 62	62	HBC

¹ ABDEL-BARY 05 disagrees significantly with the measurements of similar precision by LAI 02, MILLER 07, and AMBROSINO 07B. See comment in the header.

η WIDTH

This is the partial decay rate $\Gamma(\eta \rightarrow \gamma\gamma)$ divided by the fitted branching fraction for that mode. See the note at the start of the $\Gamma(2\gamma)$ data block, next below.

<u>VALUE (keV)</u>	<u>DOCUMENT ID</u>
1.30 ± 0.07 OUR FIT	

η DECAY MODES

<u>Mode</u>	<u>Fraction (Γ_i/Γ)</u>	<u>Scale factor/ Confidence level</u>
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Neutral modes

Γ_1	neutral modes	$(71.91 \pm 0.34) \%$	$S=1.2$
Γ_2	2γ	$(39.31 \pm 0.20) \%$	$S=1.1$
Γ_3	$3\pi^0$	$(32.57 \pm 0.23) \%$	$S=1.1$
Γ_4	$\pi^0 2\gamma$	$(2.7 \pm 0.5) \times 10^{-4}$	$S=1.1$
Γ_5	$2\pi^0 2\gamma$	$< 1.2 \times 10^{-3}$	CL=90%
Γ_6	4γ	$< 2.8 \times 10^{-4}$	CL=90%
Γ_7	invisible	$< 6 \times 10^{-4}$	CL=90%

Charged modes

Γ_8	charged modes	$(28.10 \pm 0.34) \%$	$S=1.2$
Γ_9	$\pi^+ \pi^- \pi^0$	$(22.74 \pm 0.28) \%$	$S=1.2$
Γ_{10}	$\pi^+ \pi^- \gamma$	$(4.60 \pm 0.16) \%$	$S=2.0$
Γ_{11}	$e^+ e^- \gamma$	$(6.9 \pm 0.4) \times 10^{-3}$	$S=1.2$
Γ_{12}	$\mu^+ \mu^- \gamma$	$(3.1 \pm 0.4) \times 10^{-4}$	
Γ_{13}	$e^+ e^-$	$< 5.6 \times 10^{-6}$	CL=90%
Γ_{14}	$\mu^+ \mu^-$	$(5.8 \pm 0.8) \times 10^{-6}$	
Γ_{15}	$2e^+ 2e^-$	$(2.40 \pm 0.22) \times 10^{-5}$	
Γ_{16}	$\pi^+ \pi^- e^+ e^- (\gamma)$	$(2.68 \pm 0.11) \times 10^{-4}$	
Γ_{17}	$e^+ e^- \mu^+ \mu^-$	$< 1.6 \times 10^{-4}$	CL=90%
Γ_{18}	$2\mu^+ 2\mu^-$	$< 3.6 \times 10^{-4}$	CL=90%
Γ_{19}	$\mu^+ \mu^- \pi^+ \pi^-$	$< 3.6 \times 10^{-4}$	CL=90%
Γ_{20}	$\pi^+ \pi^- 2\gamma$	$< 2.0 \times 10^{-3}$	
Γ_{21}	$\pi^+ \pi^- \pi^0 \gamma$	$< 5 \times 10^{-4}$	CL=90%
Γ_{22}	$\pi^0 \mu^+ \mu^- \gamma$	$< 3 \times 10^{-6}$	CL=90%

Charge conjugation (C), Parity (P), Charge conjugation \times Parity (CP), or Lepton Family number (LF) violating modes

Γ_{23}	$\pi^0 \gamma$	C	$< 9 \times 10^{-5}$	CL=90%
Γ_{24}	$\pi^+ \pi^-$	P, CP	$< 1.3 \times 10^{-5}$	CL=90%
Γ_{25}	$2\pi^0$	P, CP	$< 3.5 \times 10^{-4}$	CL=90%
Γ_{26}	$2\pi^0 \gamma$	C	$< 5 \times 10^{-4}$	CL=90%
Γ_{27}	$3\pi^0 \gamma$	C	$< 6 \times 10^{-5}$	CL=90%
Γ_{28}	3γ	C	$< 1.6 \times 10^{-5}$	CL=90%
Γ_{29}	$4\pi^0$	P, CP	$< 6.9 \times 10^{-7}$	CL=90%
Γ_{30}	$\pi^0 e^+ e^-$	C	[a] $< 4 \times 10^{-5}$	CL=90%
Γ_{31}	$\pi^0 \mu^+ \mu^-$	C	[a] $< 5 \times 10^{-6}$	CL=90%
Γ_{32}	$\mu^+ e^- + \mu^- e^+$	LF	$< 6 \times 10^{-6}$	CL=90%

[a] C parity forbids this to occur as a single-photon process.

CONSTRAINED FIT INFORMATION

An overall fit to a decay rate and 19 branching ratios uses 49 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 56.4$ for 41 degrees of freedom.

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

x_3	26							
x_4	-1	-1						
x_9	-66	-73	-1					
x_{10}	-44	-46	0	12				
x_{11}	-5	-5	0	-6	-3			
x_{12}	0	0	0	-1	0	0		
x_{16}	0	0	0	0	0	0	0	
Γ	-10	-2	0	6	4	1	0	0
	x_2	x_3	x_4	x_9	x_{10}	x_{11}	x_{12}	x_{16}

Mode	Rate (keV)	Scale factor
Γ_2 2γ	0.510 ± 0.026	
Γ_3 $3\pi^0$	0.423 ± 0.022	
Γ_4 $\pi^0 2\gamma$	$(3.5 \pm 0.7) \times 10^{-4}$	
Γ_9 $\pi^+ \pi^- \pi^0$	0.295 ± 0.016	
Γ_{10} $\pi^+ \pi^- \gamma$	0.060 ± 0.004	1.2
Γ_{11} $e^+ e^- \gamma$	0.0089 ± 0.0007	1.1
Γ_{12} $\mu^+ \mu^- \gamma$	$(4.0 \pm 0.6) \times 10^{-4}$	
Γ_{16} $\pi^+ \pi^- e^+ e^- (\gamma)$	$(3.48 \pm 0.23) \times 10^{-4}$	

η DECAY RATES

$\Gamma(2\gamma)$

Γ_2

See the table immediately above giving the fitted decay rates. Following the advice of NEFKENS 02, we have removed the Primakoff-effect measurement from the average. See also the "Note on the Decay Width $\Gamma(\eta \rightarrow \gamma\gamma)$," in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1451, for a discussion of the various measurements.

VALUE (keV)	EVTS	DOCUMENT ID	TECN	COMMENT
0.510 ± 0.026 OUR FIT				
0.510 ± 0.026 OUR AVERAGE				
$0.51 \pm 0.12 \pm 0.05$	36	BARU	90 MD1	$e^+ e^- \rightarrow e^+ e^- \eta$
$0.490 \pm 0.010 \pm 0.048$	2287	ROE	90 ASP	$e^+ e^- \rightarrow e^+ e^- \eta$
$0.514 \pm 0.017 \pm 0.035$	1295	WILLIAMS	88 CBAL	$e^+ e^- \rightarrow e^+ e^- \eta$
$0.53 \pm 0.04 \pm 0.04$		BARTEL	85E JADE	$e^+ e^- \rightarrow e^+ e^- \eta$

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

0.476 ± 0.062		² RODRIGUES	08	CNTR	Reanalysis
0.64 ± 0.14 ± 0.13		AIHARA	86	TPC	$e^+e^- \rightarrow e^+e^-\eta$
0.56 ± 0.16	56	WEINSTEIN	83	CBAL	$e^+e^- \rightarrow e^+e^-\eta$
0.324 ± 0.046		BROWMAN	74B	CNTR	Primakoff effect
1.00 ± 0.22		³ BEMPORAD	67	CNTR	Primakoff effect

² RODRIGUES 08 uses a more sophisticated calculation for the inelastic background due to incoherent photoproduction to reanalyze the η photoproduction data on Be and Cu at 9 GeV from BROWMAN 74B. This brings the value of $\Gamma(\eta \rightarrow 2\gamma)$ in line with direct measurements of the width. The error here is only statistical.

³ BEMPORAD 67 gives $\Gamma(2\gamma) = 1.21 \pm 0.26$ keV assuming $\Gamma(2\gamma)/\Gamma(\text{total}) = 0.314$.

Bemporad private communication gives $\Gamma(2\gamma)^2/\Gamma(\text{total}) = 0.380 \pm 0.083$. We evaluate this using $\Gamma(2\gamma)/\Gamma(\text{total}) = 0.38 \pm 0.01$. Not included in average because the uncertainty resulting from the separation of the coulomb and nuclear amplitudes has apparently been underestimated.

η BRANCHING RATIOS

Neutral modes

$\Gamma(\text{neutral modes})/\Gamma_{\text{total}}$ $\Gamma_1/\Gamma = (\Gamma_2 + \Gamma_3 + \Gamma_4)/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.7191 ± 0.0034 OUR FIT		Error includes scale factor of 1.2.		
0.705 ± 0.008	16k	BASILE	71D	CNTR MM spectrometer
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.79 ± 0.08		BUNIATOV	67	OSPK

$\Gamma(2\gamma)/\Gamma_{\text{total}}$ Γ_2/Γ

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
39.31 ± 0.20 OUR FIT		Error includes scale factor of 1.1.		
39.49 ± 0.17 ± 0.30	65k	ABEGG	96	SPEC $pd \rightarrow {}^3\text{He}\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
38.45 ± 0.40 ± 0.36	14k	⁴ LOPEZ	07	CLEO $\psi(2S) \rightarrow J/\psi\eta$

⁴ Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error.

$\Gamma(2\gamma)/\Gamma(\text{neutral modes})$ $\Gamma_2/\Gamma_1 = \Gamma_2/(\Gamma_2 + \Gamma_3 + \Gamma_4)$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.5467 ± 0.0019 OUR FIT				
0.548 ± 0.023 OUR AVERAGE		Error includes scale factor of 1.5.		
0.535 ± 0.018		BUTTRAM	70	OSPK
0.59 ± 0.033		BUNIATOV	67	OSPK
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.52 ± 0.09	88	ABROSIMOV	80	HLBC
0.60 ± 0.14	113	KENDALL	74	OSPK
0.57 ± 0.09		STRUGALSKI	71	HLBC
0.579 ± 0.052		FELDMAN	67	OSPK
0.416 ± 0.044		DIGIUGNO	66	CNTR Error doubled
0.44 ± 0.07		GRUNHAUS	66	OSPK
0.39 ± 0.06		⁵ JONES	66	CNTR

⁵ This result from combining cross sections from two different experiments.

$\Gamma(3\pi^0)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
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32.57±0.23 OUR FIT Error includes scale factor of 1.1.

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

34.03±0.56±0.49 1821 ⁶ LOPEZ 07 CLEO $\psi(2S) \rightarrow J/\psi\eta$ ⁶ Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error. $\Gamma(3\pi^0)/\Gamma(\text{neutral modes})$ $\Gamma_3/\Gamma_1 = \Gamma_3/(\Gamma_2+\Gamma_3+\Gamma_4)$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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0.4529±0.0019 OUR FIT**0.439 ±0.024**

BUTTRAM 70 OSPK

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

0.44 ±0.08 75 ABROSIMOV 80 HLBC

0.32 ±0.09 STRUGALSKI 71 HLBC

0.41 ±0.033 BUNIATOV 67 OSPK Not indep. of $\Gamma(2\gamma)/\Gamma(\text{neutral modes})$

0.177 ±0.035 FELDMAN 67 OSPK

0.209 ±0.054 DIGIUGNO 66 CNTR Error doubled

0.29 ±0.10 GRUNHAUS 66 OSPK

 $\Gamma(3\pi^0)/\Gamma(2\gamma)$ Γ_3/Γ_2

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
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0.829±0.006 OUR FIT**0.829±0.007 OUR AVERAGE**0.884±0.022±0.019 1821 LOPEZ 07 CLEO $\psi(2S) \rightarrow J/\psi\eta$ 0.817±0.012±0.032 17.4k ⁷ AKHMETSHIN 05 CMD2 $e^+e^- \rightarrow \phi \rightarrow \eta\gamma$ 0.826±0.024 ACHASOV 00D SND $e^+e^- \rightarrow \phi \rightarrow \eta\gamma$ 0.832±0.005±0.012 KRUSCHE 95D SPEC $\gamma p \rightarrow \eta p$, threshold0.841±0.034 AMSLER 93 CBAR $\bar{p}p \rightarrow \pi^+\pi^-\eta$ at rest

0.822±0.009 ALDE 84 GAM2

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

0.796±0.016±0.016 ACHASOV 00 SND See ACHASOV 00D

0.91 ±0.14 COX 70B HBC

0.75 ±0.09 DEVONS 70 OSPK

0.88 ±0.16 BALTAY 67D DBC

1.1 ±0.2 CENCE 67 OSPK

1.25 ±0.39 BACCI 63 CNTR Inverse BR reported

⁷ Uses result from AKHMETSHIN 01B. $\Gamma(\pi^0 2\gamma)/\Gamma_{\text{total}}$ Γ_4/Γ

Early results are summarized in the review by LANDSBERG 85.

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
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2.7 ±0.5 OUR FIT Error includes scale factor of 1.1.**2.21±0.24±0.47** ≈ 500 ⁸ PRAKHOV 08 CRYB $\pi^- p \rightarrow \eta n \approx$ threshold

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

3.5 ±0.7 ±0.6 1.6k ^{9,10} PRAKHOV 05 CRYB See PRAKHOV 08<8.4 90 7 ACHASOV 01D SND $e^+e^- \rightarrow \phi \rightarrow \eta\gamma$ <30 90 0 DAVYDOV 81 GAM2 $\pi^- p \rightarrow \eta n$

⁸ PRAKHOV 08 is a reanalysis of the data of PRAKHOV 05, using for the first time the invariant-mass spectrum of the two photons.

⁹ Normalized using $\Gamma(\eta \rightarrow 2\gamma)/\Gamma = 0.3943 \pm 0.0026$.

¹⁰ This measurement and the independent analysis of the same data by KNECHT 04 both imply a lower value of $\Gamma(\pi^0 2\gamma)$ than the one obtained by ALDE 84 from $\Gamma(\pi^0 2\gamma)/\Gamma(2\gamma)$.

$\Gamma(\pi^0 2\gamma)/\Gamma(2\gamma)$ Γ_4/Γ_2

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	CHG	COMMENT
0.69±0.13 OUR FIT					Error includes scale factor of 1.1.
1.8 ±0.4		ALDE	84	GAM2	0
• • •					We do not use the following data for averages, fits, limits, etc. • • •
2.5 ±0.6	70	BINON	82	GAM2	See ALDE 84

$\Gamma(\pi^0 2\gamma)/\Gamma(3\pi^0)$ Γ_4/Γ_3

VALUE (units 10^{-4})	DOCUMENT ID	TECN	COMMENT
8.3±1.6 OUR FIT			Error includes scale factor of 1.1.
• • •			We do not use the following data for averages, fits, limits, etc. • • •
8.3±2.8±1.4	¹¹ KNECHT	04	CRYB $\pi^- p \rightarrow n\eta$

¹¹ Independent analysis of same data as PRAKHOV 05.

$\Gamma(2\pi^0 2\gamma)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<1.2 × 10⁻³	90	¹² NEFKENS	05A	CRYB $p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$
• • •				We do not use the following data for averages, fits, limits, etc. • • •
<4.0 × 10 ⁻³	90	BLIK	07	GAM4 $\pi^- p \rightarrow \eta n$

¹² Measurement is done in limited $\gamma\gamma$ energy range.

$\Gamma(4\gamma)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<2.8 × 10⁻⁴	90	BLIK	07	GAM4 $\pi^- p \rightarrow \eta n$

$\Gamma(\text{invisible})/\Gamma(2\gamma)$ Γ_7/Γ_2

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<1.65 × 10⁻³	90	¹³ ABLIKIM	06Q	BES2 $J/\psi \rightarrow \phi\eta$

¹³ Based on 58M J/ψ decays.

————— Charged modes —————

$\Gamma(\pi^+ \pi^- \pi^0)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
22.74±0.28 OUR FIT				Error includes scale factor of 1.2.
• • •				We do not use the following data for averages, fits, limits, etc. • • •
22.60±0.35±0.29	3915	¹⁴ LOPEZ	07	CLEO $\psi(2S) \rightarrow J/\psi\eta$

¹⁴ Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+ \pi^- \pi^0$, $\pi^+ \pi^- \gamma$, and $e^+ e^- \gamma$ account for all η decays within a contribution of 0.3% to the systematic error.

$\Gamma(\text{neutral modes})/\Gamma(\pi^+\pi^-\pi^0)$ $\Gamma_1/\Gamma_9 = (\Gamma_2+\Gamma_3+\Gamma_4)/\Gamma_9$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	
3.16±0.05 OUR FIT	Error includes scale factor of 1.2.			
3.26±0.30 OUR AVERAGE				
2.54±1.89	74	KENDALL	74	OSPK
3.4 ±1.1	29	AGUILAR-...	72B	HBC
2.83±0.80	70	¹⁵ BLOODWO...	72B	HBC
3.6 ±0.6	244	FLATTE	67B	HBC
2.89±0.56		ALFF-...	66	HBC
3.6 ±0.8	50	KRAEMER	64	DBC
3.8 ±1.1		PAULI	64	DBC

¹⁵ Error increased from published value 0.5 by Bloodworth (private communication).

 $\Gamma(2\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_2/Γ_9

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.728±0.028 OUR FIT	Error includes scale factor of 1.2.			
1.70 ±0.04 OUR AVERAGE				
1.704±0.032±0.026	3915	¹⁶ LOPEZ	07	CLEO $\psi(2S) \rightarrow J/\psi\eta$
1.61 ±0.14		ABLIKIM	06E	BES2 $e^+e^- \rightarrow J/\psi \rightarrow \eta\gamma$
1.78 ±0.10 ±0.13	1077	AMSLER	95	CBAR $\bar{p}p \rightarrow \pi^+\pi^-\eta$ at rest
1.72 ±0.25	401	BAGLIN	69	HLBC
1.61 ±0.39		FOSTER	65	HBC

¹⁶ LOPEZ 07 reports $\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0) / \Gamma(\eta \rightarrow 2\gamma) = \Gamma_9/\Gamma_2 = 0.587 \pm 0.011 \pm 0.009$.

 $\Gamma(3\pi^0)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_3/Γ_9

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1.432±0.026 OUR FIT	Error includes scale factor of 1.2.			
1.48 ±0.05 OUR AVERAGE				
1.46 ±0.03 ±0.09		ACHASOV	06A	SND $e^+e^- \rightarrow \eta\gamma$
1.52 ±0.04 ±0.08	23k	¹⁷ AKHMETSHIN	01B	CMD2 $e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
1.44 ±0.09 ±0.10	1627	AMSLER	95	CBAR $\bar{p}p \rightarrow \pi^+\pi^-\eta$ at rest
1.50 ^{+0.15} _{-0.29}	199	BAGLIN	69	HLBC
1.47 ^{+0.20} _{-0.17}		BULLOCK	68	HLBC

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

1.3 ±0.4		BAGLIN	67B	HLBC
0.90 ±0.24		FOSTER	65	HBC
2.0 ±1.0		FOELSCH	64	HBC
0.83 ±0.32		CRAWFORD	63	HBC

¹⁷ AKHMETSHIN 01B uses results from AKHMETSHIN 99F.

 $\Gamma(\pi^+\pi^-\pi^0)/[\Gamma(2\gamma) + \Gamma(3\pi^0)]$ $\Gamma_9/(\Gamma_2+\Gamma_3)$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.316 ±0.005 OUR FIT	Error includes scale factor of 1.2.		
0.304 ±0.012	ACHASOV	00D	SND $e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.3141±0.0081±0.0058	ACHASOV	00B	SND See ACHASOV 00D

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

Γ_{10}/Γ

VALUE (units 10^{-2}) EVTS DOCUMENT ID TECN COMMENT

4.60±0.16 OUR FIT Error includes scale factor of 2.0.

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

3.96±0.14±0.14 859 ¹⁸ LOPEZ 07 CLEO $\psi(2S) \rightarrow J/\psi\eta$

¹⁸ Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error.

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

Γ_{10}/Γ_9

VALUE EVTS DOCUMENT ID TECN COMMENT

0.202±0.007 OUR FIT Error includes scale factor of 2.3.

0.203±0.008 OUR AVERAGE Error includes scale factor of 2.4. See the ideogram below.

0.175±0.007±0.006 859 LOPEZ 07 CLEO $\psi(2S) \rightarrow J/\psi\eta$

0.209±0.004 18k THALER 73 ASPK

0.201±0.006 7250 GORMLEY 70 ASPK

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

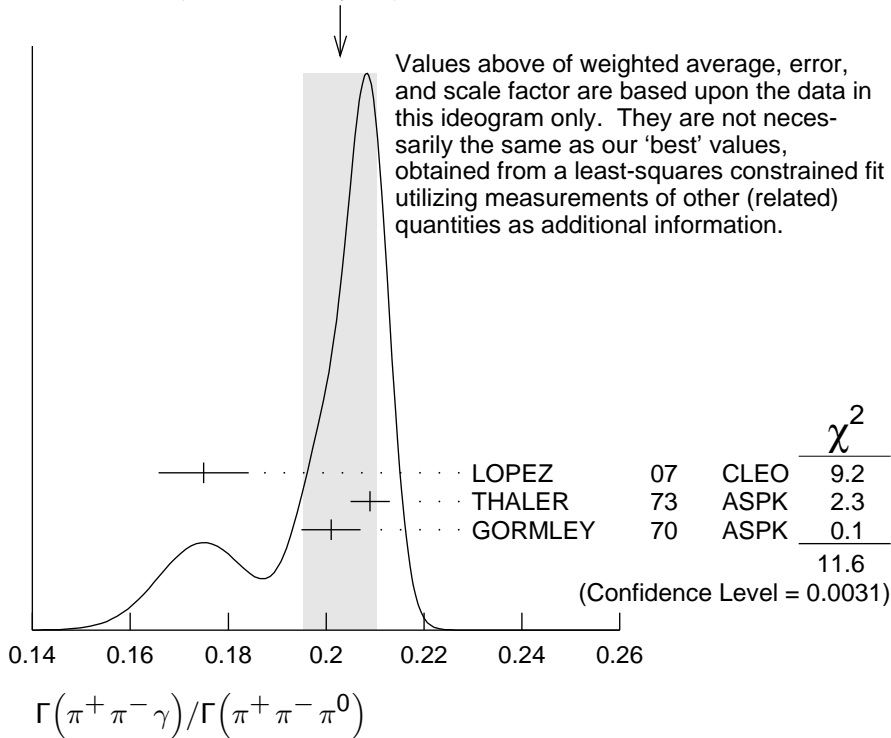
0.28 ±0.04 BALTAY 67B DBC

0.25 ±0.035 LITCHFIELD 67 DBC

0.30 ±0.06 CRAWFORD 66 HBC

0.196±0.041 FOSTER 65C HBC

WEIGHTED AVERAGE
0.203±0.008 (Error scaled by 2.4)



$\Gamma(e^+e^-\gamma)/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TECN	COMMENT
6.9 ± 0.4 OUR FIT				Error includes scale factor of 1.2.
6.7 ± 0.5 OUR AVERAGE				Error includes scale factor of 1.2.
6.6 ± 0.4 ± 0.4	1345	BERGHAUSER 11	SPEC	$\gamma p \rightarrow p\eta$
7.8 ± 0.5 ± 0.8	435 ± 31	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$
5.15 ± 0.62 ± 0.74	283	ACHASOV 01B	SND	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
7.10 ± 0.64 ± 0.46	323	AKHMETSHIN 01	CMD2	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
9.4 ± 0.7 ± 0.5	172	¹⁹ LOPEZ 07	CLEO	$\psi(2S) \rightarrow J/\psi\eta$
¹⁹ Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \rightarrow \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error.				

$\Gamma(e^+e^-\gamma)/\Gamma(\pi^+\pi^-\gamma)$ Γ_{11}/Γ_{10}

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.150 ± 0.011 OUR FIT				Error includes scale factor of 1.3.
0.237 ± 0.021 ± 0.015	172	LOPEZ 07	CLEO	$\psi(2S) \rightarrow J/\psi\eta$

$\Gamma(e^+e^-\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_{11}/Γ_9

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
3.02 ± 0.19 OUR FIT				Error includes scale factor of 1.2.
2.1 ± 0.5	80	JANE 75B	OSPK	See the erratum

$\Gamma(\text{neutral modes}) / [\Gamma(\pi^+\pi^-\pi^0) + \Gamma(\pi^+\pi^-\gamma) + \Gamma(e^+e^-\gamma)]$
 $\Gamma_1 / (\Gamma_9 + \Gamma_{10} + \Gamma_{11}) = (\Gamma_2 + \Gamma_3 + \Gamma_4) / (\Gamma_9 + \Gamma_{10} + \Gamma_{11})$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
2.57 ± 0.04 OUR FIT				Error includes scale factor of 1.2.
2.64 ± 0.23		BALTAY 67B	DBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.5 ± 1.0	280	²⁰ JAMES 66	HBC	
3.20 ± 1.26	53	²⁰ BASTIEN 62	HBC	
2.5 ± 1.0	10	²⁰ PICKUP 62	HBC	
²⁰ These experiments are not used in the averages as they do not separate clearly $\eta \rightarrow \pi^+\pi^-\pi^0$ and $\eta \rightarrow \pi^+\pi^-\gamma$ from each other. The reported values thus probably contain some unknown fraction of $\eta \rightarrow \pi^+\pi^-\gamma$.				

$\Gamma(2\gamma) / [\Gamma(\pi^+\pi^-\pi^0) + \Gamma(\pi^+\pi^-\gamma) + \Gamma(e^+e^-\gamma)]$ $\Gamma_2 / (\Gamma_9 + \Gamma_{10} + \Gamma_{11})$

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
1.402 ± 0.023 OUR FIT				Error includes scale factor of 1.2.
1.1 ± 0.4 OUR AVERAGE				
1.51 ± 0.93	75	KENDALL 74	OSPK	
0.99 ± 0.48		CRAWFORD 63	HBC	

$\Gamma(\mu^+\mu^-\gamma)/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID	TECN	COMMENT
3.1 ± 0.4 OUR FIT				
3.1 ± 0.4	600	DZHELYADIN 80	SPEC	$\pi^- p \rightarrow \eta n$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.5 ± 0.75	100	BUSHNIN 78	SPEC	See DZHELYADIN 80

$\Gamma(e^+e^-)/\Gamma_{\text{total}}$ Γ_{13}/Γ

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<5.6 × 10⁻⁶	90	²¹ AGAKISHIEV 12A	SPEC	$pp \rightarrow \eta + X$
<2.7 × 10 ⁻⁵	90	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$
<0.77 × 10 ⁻⁴	90	BROWDER 97B	CLE2	$e^+e^- \simeq 10.5 \text{ GeV}$
<2 × 10 ⁻⁴	90	WHITE 96	SPEC	$pd \rightarrow \eta {}^3\text{He}$
<3 × 10 ⁻⁴	90	DAVIES 74	RVUE	Uses ESTEN 67

²¹ AGAKISHIEV 12A uses a data sample of 3.5 GeV proton beam collisions on liquid hydrogen target collected by the HADES detector.

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

<u>VALUE (units 10⁻⁶)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
5.8±0.8 OUR AVERAGE					
5.7±0.7±0.5		114	ABEGG 94	SPEC	$pd \rightarrow \eta {}^3\text{He}$
6.5±2.1		27	DZHELYADIN 80B	SPEC	$\pi^- p \rightarrow \eta n$
5.6 ^{+0.6} _{-0.7} ±0.5		100	KESSLER 93	SPEC	See ABEGG 94
< 20	95	0	WEHMANN 68	OSPK	

$\Gamma(\mu^+\mu^-)/\Gamma(2\gamma)$ Γ_{14}/Γ_2

<u>VALUE (units 10⁻⁵)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
5.9±2.2	HYAMS 69	OSPK

$\Gamma(2e^+2e^-)/\Gamma_{\text{total}}$ Γ_{15}/Γ

<u>VALUE (units 10⁻⁵)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.4±0.2±0.1		362	²² AMBROSINO 11B	KLOE	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
<9.7	90		BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$
<6.9	90		AKHMETSHIN 01	CMD2	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$

²² This measurement is fully inclusive (includes "2e⁺2e⁻γ" channel).

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

<u>VALUE (units 10⁻⁴)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2.68±0.11 OUR FIT					
2.68±0.09±0.07		1555 ± 52	²³ AMBROSINO 09B	KLOE	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
4.3 ^{+2.0} _{-1.6} ±0.4		16	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$
4.3 ±1.3 ±0.4		16	BARGHOLTZ 07	CNTR	See BERLOWSKI 08
3.7 ^{+2.5} _{-1.8} ±0.3		4	AKHMETSHIN 01	CMD2	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$

²³ This AMBROSINO 09B value includes radiative events.

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.6 \times 10^{-4}$	90	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$

$\Gamma(2\mu^+2\mu^-)/\Gamma_{\text{total}}$ Γ_{18}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<3.6 \times 10^{-4}$	90	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$

$\Gamma(\mu^+\mu^-\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{19}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<3.6 \times 10^{-4}$	90	BERLOWSKI 08	WASA	$pd \rightarrow {}^3\text{He} \eta$

$\Gamma(\pi^+\pi^-2\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_{20}/Γ_9

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<9 \times 10^{-3}$		PRICE 67	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<16 \times 10^{-3}$	95	BALTAY 67B	DBC	

$\Gamma(\pi^+\pi^-\pi^0\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ Γ_{21}/Γ_9

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$<0.24 \times 10^{-2}$	90	0	THALER 73	ASPK	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<1.7 \times 10^{-2}$	90		ARNOLD 68	HLBC	
$<1.6 \times 10^{-2}$	95		BALTAY 67B	DBC	
$<7.0 \times 10^{-2}$			FLATTE 67	HBC	
$<0.9 \times 10^{-2}$			PRICE 67	HBC	

$\Gamma(\pi^0\mu^+\mu^-\gamma)/\Gamma_{\text{total}}$ Γ_{22}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<3 \times 10^{-6}$	90	DZHELYADIN 81	SPEC	$\pi^- p \rightarrow \eta n$

————— Forbidden modes —————

$\Gamma(\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_{23}/Γ

Forbidden by angular momentum conservation.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<9 \times 10^{-5}$	90	NEFKENS 05A	CRYB	$p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{24}/Γ

Forbidden by P and CP invariance.

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$<0.13 \times 10^{-4}$	90	16M	AMBROSINO 05A	KLOE	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<3.9 \times 10^{-4}$	90	225M	ABLIKIM 11G	BES3	$e^+e^- \rightarrow J/\psi \rightarrow \eta\gamma$
$<3.3 \times 10^{-4}$	90		AKHMETSHIN 99B	CMD2	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
$<9 \times 10^{-4}$	90		AKHMETSHIN 97C	CMD2	See AKHMETSHIN 99B
$<15 \times 10^{-4}$		0	THALER 73	ASPK	

$\Gamma(2\pi^0)/\Gamma_{\text{total}}$ Γ_{25}/Γ Forbidden by P and CP invariance.

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
$< 3.5 \times 10^{-4}$	90		BLIK	07	GAM4 $\pi^- p \rightarrow \eta n$
$< 6.9 \times 10^{-4}$	90	225M	ABLIKIM	11G	BES3 $e^+ e^- \rightarrow J/\psi \rightarrow \eta \gamma$
$< 4.3 \times 10^{-4}$	90		AKHMETSHIN	99C	CMD2 $e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$
$< 6 \times 10^{-4}$	90		²⁴ ACHASOV	98	SND $e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$

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

²⁴ACHASOV 98 observes one event in a $\pm 3\sigma$ region around the η mass, while a Monte Carlo calculation gives 10 ± 5 events. The limit here is the Poisson upper limit for one observed event and no background.

 $\Gamma(2\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_{26}/Γ Forbidden by C invariance.

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
$< 5 \times 10^{-4}$	90	NEFKENS	05	CRYB	0 $p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$
$< 17 \times 10^{-4}$	90	BLIK	07	GAM4	$\pi^- p \rightarrow \eta n$

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

 $\Gamma(3\pi^0\gamma)/\Gamma_{\text{total}}$ Γ_{27}/Γ Forbidden by C invariance.

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
$< 6 \times 10^{-5}$	90	NEFKENS	05	CRYB	0 $p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$
$< 24 \times 10^{-5}$	90	BLIK	07	GAM4	$\pi^- p \rightarrow \eta n$

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

 $\Gamma(3\gamma)/\Gamma_{\text{total}}$ Γ_{28}/Γ Forbidden by C invariance.

VALUE	CL%	DOCUMENT ID	TECN	CHG	COMMENT
$< 16 \times 10^{-5}$	90	BLIK	07	GAM4	$\pi^- p \rightarrow \eta n$
$< 4 \times 10^{-5}$	90	NEFKENS	05A	CRYB	$p(720 \text{ MeV}/c) \pi^- \rightarrow n\eta$

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

 $\Gamma(3\gamma)/\Gamma(2\gamma)$ Γ_{28}/Γ_2

VALUE	CL%	DOCUMENT ID	TECN	CHG
$< 1.2 \times 10^{-3}$	95	ALDE	84	GAM2 0

 $\Gamma(3\gamma)/\Gamma(3\pi^0)$ Γ_{28}/Γ_3

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$< 4.9 \times 10^{-5}$	90	ALOISIO	04	KLOE $\phi \rightarrow \eta \gamma$

 $\Gamma(4\pi^0)/\Gamma_{\text{total}}$ Γ_{29}/Γ Forbidden by P and CP invariance.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$< 6.9 \times 10^{-7}$	90	PRAKHOV	00	CRYB $\pi^- p \rightarrow n\eta, 720 \text{ MeV}/c$
$< 200 \times 10^{-7}$	90	BLIK	07	GAM4 $\pi^- p \rightarrow \eta n$

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

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

Γ_{30}/Γ

C parity forbids this to occur as a single-photon process.

VALUE	CL%	DOCUMENT ID	TECN
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• • • We do not use the following data for averages, fits, limits, etc. • • •

$< 1.6 \times 10^{-4}$	90	MARTYNOV 76	HLBC
$< 8.4 \times 10^{-4}$	90	BAZIN 68	DBC
$< 70 \times 10^{-4}$		RITTENBERG 65	HBC

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

Γ_{30}/Γ_9

C parity forbids this to occur as a single-photon process.

VALUE	CL%	EVTS	DOCUMENT ID	TECN
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$< 1.9 \times 10^{-4}$ 90 JANE 75 OSPK

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

$< 42 \times 10^{-4}$	90	BAGLIN 67	HLBC
$< 16 \times 10^{-4}$	90	0 BILLING 67	HLBC
$< 77 \times 10^{-4}$	0	FOSTER 65B	HBC
$< 110 \times 10^{-4}$		PRICE 65	HBC

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

Γ_{31}/Γ

C parity forbids this to occur as a single-photon process.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$< 5 \times 10^{-6}$ 90 DZHELYADIN 81 SPEC $\pi^- p \rightarrow \eta n$

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

$< 500 \times 10^{-6}$		WEHMANN 68	OSPK
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$[\Gamma(\mu^+ e^-) + \Gamma(\mu^- e^+)]/\Gamma_{\text{total}}$

Γ_{32}/Γ

Forbidden by lepton family number conservation.

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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$< 6 \times 10^{-6}$ 90 WHITE 96 SPEC $p d \rightarrow \eta \text{}^3\text{He}$

η C-NONCONSERVING DECAY PARAMETERS

$\pi^+ \pi^- \pi^0$ LEFT-RIGHT ASYMMETRY PARAMETER

Measurements with an error $> 1.0 \times 10^{-2}$ have been omitted.

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN
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$0.09^{+0.11}_{-0.12}$ OUR AVERAGE

$+0.09 \pm 0.10^{+0.09}_{-0.14}$	1.34M	AMBROSINO 08D	KLOE
0.28 ± 0.26	165k	JANE 74	OSPK
-0.05 ± 0.22	220k	LAYTER 72	ASPK

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

1.5 ± 0.5	37k	²⁵ GORMLEY 68C	ASPK
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²⁵The GORMLEY 68C asymmetry is probably due to unmeasured (**E** × **B**) spark chamber effects. New experiments with (**E** × **B**) controls don't observe an asymmetry.

$\pi^+\pi^-\pi^0$ SEXTANT ASYMMETRY PARAMETER

Measurements with an error $> 2.0 \times 10^{-2}$ have been omitted.

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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$0.12^{+0.10}_{-0.11}$ OUR AVERAGE

$+0.08 \pm 0.10^{+0.08}_{-0.13}$	1.34M	AMBROSINO	08D	KLOE
0.20 ± 0.25	165k	JANE	74	OSPK
0.10 ± 0.22	220k	LAYTER	72	ASPK
0.5 ± 0.5	37k	GORMLEY	68C	WIRE

$\pi^+\pi^-\pi^0$ QUADRANT ASYMMETRY PARAMETER

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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-0.09 ± 0.09 OUR AVERAGE

$-0.05 \pm 0.10^{+0.03}_{-0.05}$	1.34M	AMBROSINO	08D	KLOE
-0.30 ± 0.25	165k	JANE	74	OSPK
-0.07 ± 0.22	220k	LAYTER	72	ASPK

$\pi^+\pi^-\gamma$ LEFT-RIGHT ASYMMETRY PARAMETER

Measurements with an error $> 2.0 \times 10^{-2}$ have been omitted.

<u>VALUE (units 10^{-2})</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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0.9 ± 0.4 OUR AVERAGE

1.2 ± 0.6	35k	JANE	74B	OSPK
0.5 ± 0.6	36k	THALER	72	ASPK
1.22 ± 1.56	7257	GORMLEY	70	ASPK

$\pi^+\pi^-\gamma$ PARAMETER β (*D-wave*)

Sensitive to a *D-wave* contribution: $dN/d\cos\theta = \sin^2\theta (1 + \beta \cos^2\theta)$.

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>
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-0.02 ± 0.07 OUR AVERAGE Error includes scale factor of 1.3.

0.11 ± 0.11	35k	JANE	74B	OSPK
-0.060 ± 0.065	7250	GORMLEY	70	WIRE

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

0.12 ± 0.06	²⁶	THALER	72	ASPK
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²⁶ The authors don't believe this indicates *D-wave* because the dependence of β on the γ energy is inconsistent with the theoretical prediction. A $\cos^2\theta$ dependence can also come from *P-* and *F-wave* interference.

η CP-NONCONSERVING DECAY PARAMETER

$\pi^+\pi^-\pi^0 e^+e^-$ DECAY-PLANE ASYMMETRY PARAMETER A_ϕ

In the η rest frame, the total momentum of the e^+e^- pair is equal and opposite to that of the $\pi^+\pi^-$ pair. Let \hat{z} be the unit vector along the momentum of the e^+e^- pair; let \hat{n}_{ee} and $\hat{n}_{\pi\pi}$ be the unit vectors normal to the e^+e^- and $\pi^+\pi^-$ planes; and let ϕ be the angle between the two normals. Then

$$\sin\phi \cos\phi = [(\hat{n}_{ee} \times \hat{n}_{\pi\pi}) \cdot \hat{z}] (\hat{n}_{ee} \cdot \hat{n}_{\pi\pi}),$$

and

$$A_\phi \equiv \frac{N_{\sin\phi \cos\phi > 0} - N_{\sin\phi \cos\phi < 0}}{N_{\sin\phi \cos\phi > 0} + N_{\sin\phi \cos\phi < 0}}.$$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$-0.6 \pm 2.5 \pm 1.8$	1555 ± 52	AMBROSINO 09B	KLOE	$e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$

ENERGY DEPENDENCE OF $\eta \rightarrow 3\pi$ DALITZ PLOTS

PARAMETERS FOR $\eta \rightarrow \pi^+ \pi^- \pi^0$

See the "Note on η Decay Parameters" in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1454. The following experiments fit to one or more of the coefficients a , b , c , d , or e for $|\text{matrix element}|^2 = 1 + ay + by^2 + cx + dx^2 + exy$.

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
1.34M		AMBROSINO 08D	KLOE	
3230	27	ABELE 98D	CBAR	$\bar{p}p \rightarrow \pi^0 \pi^0 \eta$ at rest
1077	28	AMSLER 95	CBAR	$\bar{p}p \rightarrow \pi^+ \pi^- \eta$ at rest
81k		LAYTER 73	ASPK	
220k		LAYTER 72	ASPK	
1138		CARPENTER 70	HBC	
349		DANBURG 70	DBC	
7250		GORMLEY 70	WIRE	
526		BAGLIN 69	HLBC	
7170		CNOPS 68	OSPK	
37k		GORMLEY 68C	WIRE	
1300		CLPWY 66	HBC	
705		LARRIBE 66	HBC	

²⁷ ABELE 98D obtains $a = -1.22 \pm 0.07$ and $b = 0.22 \pm 0.11$ when c (our d) is fixed at 0.06.

²⁸ AMSLER 95 fits to $(1+ay+by^2)$ and obtains $a = -0.94 \pm 0.15$ and $b = 0.11 \pm 0.27$.

α PARAMETER FOR $\eta \rightarrow 3\pi^0$

See the "Note on η Decay Parameters" in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1454. The value here is of α in $|\text{matrix element}|^2 = 1 + 2\alpha z$.

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
-0.0315 ± 0.0015 OUR AVERAGE				
$-0.0301 \pm 0.0035^{+0.0022}_{-0.0035}$	512k	AMBROSINO 10A	KLOE	$e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$
$-0.027 \pm 0.008 \pm 0.005$	120k	²⁹ ADOLPH 09	WASA	$pp \rightarrow pp\eta$
$-0.0322 \pm 0.0012 \pm 0.0022$	3M	³⁰ PRAKHOV 09	CRYB	$\gamma p \rightarrow p\eta$
$-0.032 \pm 0.002 \pm 0.002$	1.8M	³⁰ UNVERZAGT 09	CRYB	$\gamma p \rightarrow p\eta$
$-0.026 \pm 0.010 \pm 0.010$	75k	BASHKANOV 07	WASA	$pp \rightarrow pp\eta$
$-0.010 \pm 0.021 \pm 0.010$	12k	ACHASOV 01C	SND	$e^+ e^- \rightarrow \phi \rightarrow \eta \gamma$
-0.031 ± 0.004	1M	TIPPENS 01	CRYB	$\pi^- p \rightarrow n\eta$, 720 MeV
$-0.052 \pm 0.017 \pm 0.010$	98k	ABELE 98C	CBAR	$\bar{p}p \rightarrow 5\pi^0$
-0.022 ± 0.023	50k	ALDE 84	GAM2	

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

$-0.038 \pm 0.003^{+0.012}_{-0.008}$ 1.34M ³¹ AMBROSINO 08D KLOE

-0.32 ± 0.37 192 BAGLIN 70 HLBC

²⁹ This ADOLPH 09 result is independent of the BASHKANOV 07 result.

³⁰ The PRAKHOV 09 and UNVERZAGT 09 results are independent.

³¹ This AMBROSINO 08D value is an indirect result using $\eta \rightarrow \pi^+ \pi^0 \pi^-$ events and a rescattering matrix that mixes isospin decay amplitudes.

η REFERENCES

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ABLIKIM	11G	PR D84 032006	M. Ablikim <i>et al.</i>	(BES-III Collab.)
AMBROSINO	11B	PL B702 324	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
BERGHAUSER	11	PL B701 562	H. Berghauer <i>et al.</i>	(GIES, UCLA, GUTE)
AMBROSINO	10A	PL B694 16	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
ADOLPH	09	PL B677 24	C. Adolph <i>et al.</i>	(WASA at COSY Collab.)
AMBROSINO	09B	PL B675 283	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
PRAKHOV	09	PR C79 035204	S. Prakhov <i>et al.</i>	(MAMI-C Crystal Ball Collab.)
UNVERZAGT	09	EPJ A39 169	M. Unverzagt <i>et al.</i>	(MAMI-B Crystal Ball Collab.)
AMBROSINO	08D	JHEP 0805 006	F. Ambrosino <i>et al.</i>	(DAPHNE KLOE Collab.)
BERLOWSKI	08	PR D77 032004	M. Berlowski <i>et al.</i>	(CELSIUS/WASA Collab.)
PRAKHOV	08	PR C78 015206	S. Prakhov <i>et al.</i>	(BNL Crystal Ball Collab.)
RODRIGUES	08	PRL 101 012301	T.E. Rodrigues <i>et al.</i>	(USP, FESP, UNESP+)
AMBROSINO	07B	JHEP 0712 073	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
BARGHOLTZ	07	PL B644 299	Chr. Bargholtz <i>et al.</i>	(CELSIUS/WASA Collab.)
BASHKANOV	07	PR C76 048201	M. Bashkanov <i>et al.</i>	(CELSIUS/WASA Collab.)
BLIK	07	PAN 70 693	A.M. Blik <i>et al.</i>	(GAMS Collab.)
		Translated from YAF 70 724.		
LOPEZ	07	PRL 99 122001	A. Lopez <i>et al.</i>	(CLEO Collab.)
MILLER	07	PRL 99 122002	D.H. Miller <i>et al.</i>	(CLEO Collab.)
ABLIKIM	06E	PR D73 052008	M. Ablikim <i>et al.</i>	(BES Collab.)
ABLIKIM	06Q	PRL 97 202002	M. Ablikim <i>et al.</i>	(BES Collab.)
ACHASOV	06A	PR D74 014016	M.N. Achasov <i>et al.</i>	(SND Collab.)
ABDEL-BARY	05	PL B619 281	M. Abdel-Bary <i>et al.</i>	(GEM Collab.)
AKHMETSHIN	05	PL B605 26	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AMBROSINO	05A	PL B606 276	F. Ambrosino <i>et al.</i>	(KLOE Collab.)
NEFKENS	05	PRL 94 041601	B.M.K. Nefkens <i>et al.</i>	(BNL Crystal Ball Collab.)
NEFKENS	05A	PR C72 035212	B.M.K. Nefkens <i>et al.</i>	(BNL Crystal Ball Collab.)
PRAKHOV	05	PR C72 025201	S. Prakhov <i>et al.</i>	(BNL Crystal Ball Collab.)
ALOISIO	04	PL B591 49	A. Aloisio <i>et al.</i>	(KLOE Collab.)
KNECHT	04	PL B589 14	N. Knecht <i>et al.</i>	
LAI	02	PL B533 196	A. Lai <i>et al.</i>	(CERN NA48 Collab.)
NEFKENS	02	PS T99 114	B.M.K. Nefkens, J.W. Price	(UCLA)
ACHASOV	01B	PL B504 275	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	01C	JETPL 73 451	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 73 511.		
ACHASOV	01D	NP B600 3	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	01	PL B501 191	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.)
TIPPENS	01	PRL 87 192001	W.B. Tippens <i>et al.</i>	(BNL Crystal Ball Collab.)
ACHASOV	00	EPJ C12 25	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
ACHASOV	00B	JETP 90 17	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETF 117 22.		
ACHASOV	00D	JETPL 72 282	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
		Translated from ZETFP 72 411.		
PRAKHOV	00	PRL 84 4802	S. Prakhov <i>et al.</i>	(BNL Crystal Ball Collab.)
AKHMETSHIN	99B	PL B462 371	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	99C	PL B462 380	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
AKHMETSHIN	99F	PL B460 242	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
ABELE	98C	PL B417 193	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ABELE	98D	PL B417 197	A. Abele <i>et al.</i>	(Crystal Barrel Collab.)
ACHASOV	98	PL B425 388	M.N. Achasov <i>et al.</i>	(Novosibirsk SND Collab.)
AKHMETSHIN	97C	PL B415 452	R.R. Akhmetshin <i>et al.</i>	(Novosibirsk CMD-2 Collab.)
BROWDER	97B	PR D56 5359	T.E. Browder <i>et al.</i>	(CLEO Collab.)
ABEGG	96	PR D53 11	R. Abegg <i>et al.</i>	(Saturne SPES2 Collab.)
WHITE	96	PR D53 6658	D.B. White <i>et al.</i>	(Saturne SPES2 Collab.)
AMSLER	95	PL B346 203	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
KRUSCHE	95D	ZPHY A351 237	B. Krusche <i>et al.</i>	(TAPS + A2 Collab.)
ABEGG	94	PR D50 92	R. Abegg <i>et al.</i>	(Saturne SPES2 Collab.)
AMSLER	93	ZPHY C58 175	C. Amsler <i>et al.</i>	(Crystal Barrel Collab.)
KESSLER	93	PRL 70 892	R.S. Kessler <i>et al.</i>	(Saturne SPES2 Collab.)
PLOUIN	92	PL B276 526	F. Plouin <i>et al.</i>	(Saturne SPES4 Collab.)
BARU	90	ZPHY C48 581	S.E. Baru <i>et al.</i>	(MD-1 Collab.)
ROE	90	PR D41 17	N.A. Roe <i>et al.</i>	(ASP Collab.)
WILLIAMS	88	PR D38 1365	D.A. Williams <i>et al.</i>	(Crystal Ball Collab.)
AIHARA	86	PR D33 844	H. Aihara <i>et al.</i>	(TPC-2 γ Collab.)
BARTEL	85E	PL 160B 421	W. Bartel <i>et al.</i>	(JADE Collab.)
LANDSBERG	85	PRPL 128 301	L.G. Landsberg	(SERP)

ALDE	84	ZPHY C25 225	D.M. Alde <i>et al.</i>	(SERP, BELG, LAPP)
Also		SJNP 40 918	D.M. Alde <i>et al.</i>	(SERP, BELG, LAPP)
		Translated from YAF 40	1447.	
WEINSTEIN	83	PR D28 2896	A.J. Weinstein <i>et al.</i>	(Crystal Ball Collab.)
BINON	82	SJNP 36 391	F.G. Binon <i>et al.</i>	(SERP, BELG, LAPP+)
		Translated from YAF 36	670.	
Also		NC 71A 497	F.G. Binon <i>et al.</i>	(SERP, BELG, LAPP+)
DAVYDOV	81	LNC 32 45	V.A. Davydov <i>et al.</i>	(SERP, BELG, LAPP+)
Also		SJNP 33 825	V.A. Davydov <i>et al.</i>	(SERP, BELG, LAPP+)
		Translated from YAF 33	1534.	
DZHEL'YADIN	81	PL 105B 239	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 33 822	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 33	1529.	
ABROSIMOV	80	SJNP 31 195	A.T. Abrosimov <i>et al.</i>	(JINR)
		Translated from YAF 31	371.	
DZHEL'YADIN	80	PL 94B 548	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 32 516	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 32	998.	
DZHEL'YADIN	80B	PL 97B 471	R.I. Dzhelyadin <i>et al.</i>	(SERP)
Also		SJNP 32 518	R.I. Dzhelyadin <i>et al.</i>	(SERP)
		Translated from YAF 32	1002.	
BUSHNIN	78	PL 79B 147	Y.B. Bushnin <i>et al.</i>	(SERP)
Also		SJNP 28 775	Y.B. Bushnin <i>et al.</i>	(SERP)
		Translated from YAF 28	1507.	
MARTYNOV	76	SJNP 23 48	A.S. Martynov <i>et al.</i>	(JINR)
		Translated from YAF 23	93.	
JANE	75	PL 59B 99	M.R. Jane <i>et al.</i>	(RHEL, LOWC)
JANE	75B	PL 59B 103	M.R. Jane <i>et al.</i>	(RHEL, LOWC)
Also		PL 73B 503	M.R. Jane	
		Erratum in private communication.		
BROWMAN	74B	PRL 32 1067	A. Browman <i>et al.</i>	(CORN, BING)
DAVIES	74	NC 24A 324	J.D. Davies, J.G. Guy, R.K.P. Zia	(BIRM, RHEL+)
DUANE	74	PRL 32 425	A. Duane <i>et al.</i>	(LOIC, SHMP)
JANE	74	PL 48B 260	M.R. Jane <i>et al.</i>	(RHEL, LOWC, SUSS)
JANE	74B	PL 48B 265	M.R. Jane <i>et al.</i>	(RHEL, LOWC, SUSS)
KENDALL	74	NC 21A 387	B.N. Kendall <i>et al.</i>	(BROW, BARI, MIT)
LAYTER	73	PR D7 2565	J.G. Layter <i>et al.</i>	(COLU)
THALER	73	PR D7 2569	J.J. Thaler <i>et al.</i>	(COLU)
AGUILAR-...	72B	PR D6 29	M. Aguilar-Benitez <i>et al.</i>	(BNL)
BLOODWORTH...	72B	NP B39 525	I.J. Bloodworth <i>et al.</i>	(TNTO)
LAYTER	72	PRL 29 316	J.G. Layter <i>et al.</i>	(COLU)
THALER	72	PRL 29 313	J.J. Thaler <i>et al.</i>	(COLU)
BASILE	71D	NC 3A 796	M. Basile <i>et al.</i>	(CERN, BGNA, STRB)
STRUGALSKI	71	NP B27 429	Z.S. Strugalski <i>et al.</i>	(JINR)
BAGLIN	70	NP B22 66	C. Baglin <i>et al.</i>	(EPOL, MADR, STRB)
BUTTRAM	70	PRL 25 1358	M.T. Buttram, M.N. Kreisler, R.E. Mischke	(PRIN)
CARPENTER	70	PR D1 1303	D.W. Carpenter <i>et al.</i>	(DUKE)
COX	70B	PRL 24 534	B. Cox, L. Fortney, J.P. Golson	(DUKE)
DANBURG	70	PR D2 2564	J.S. Danburg <i>et al.</i>	(LRL)
DEVONS	70	PR D1 1936	S. Devons <i>et al.</i>	(COLU, SYRA)
GORMLEY	70	PR D2 501	M. Gormley <i>et al.</i>	(COLU, BNL)
Also		Thesis Nevis 181	M. Gormley	(COLU)
BAGLIN	69	PL 29B 445	C. Baglin <i>et al.</i>	(EPOL, UCB, MADR, STRB)
Also		NP B22 66	C. Baglin <i>et al.</i>	(EPOL, MADR, STRB)
HYAMS	69	PL 29B 128	B.D. Hyams <i>et al.</i>	(CERN, MPIM)
ARNOLD	68	PL 27B 466	R.G. Arnold <i>et al.</i>	(STRB, MADR, EPOL+)
BAZIN	68	PRL 20 895	M.J. Bazin <i>et al.</i>	(PRIN, QUKI)
BULLOCK	68	PL 27B 402	F.W. Bullock <i>et al.</i>	(LOUC)
CNOPS	68	PRL 21 1609	A.M. Cnops <i>et al.</i>	(BNL, ORNL, UCND+)
GORMLEY	68C	PRL 21 402	M. Gormley <i>et al.</i>	(COLU, BNL)
WEHMANN	68	PRL 20 748	A.W. Wehmann <i>et al.</i>	(HARV, CASE, SLAC+)
BAGLIN	67	PL 24B 637	C. Baglin <i>et al.</i>	(EPOL, UCB)
BAGLIN	67B	BAPS 12 567	C. Baglin <i>et al.</i>	(EPOL, UCB)
BALTAY	67B	PRL 19 1498	C. Baltay <i>et al.</i>	(COLU, STON)
BALTAY	67D	PRL 19 1495	C. Baltay <i>et al.</i>	(COLU, BRAN)
BEMPORAD	67	PL 25B 380	C. Bemporad <i>et al.</i>	(PISA, BONN)
Also		Private Comm.	I. Ion	
BILLING	67	PL 25B 435	K.D. Billing <i>et al.</i>	(LOUC, OXF)
BUNIATOV	67	PL 25B 560	S.A. Bunyatov <i>et al.</i>	(CERN, KARL)
CENCE	67	PRL 19 1393	R.J. Cence <i>et al.</i>	(HAWA, LRL)
ESTEN	67	PL 24B 115	M.J. Esten <i>et al.</i>	(LOUC, OXF)
FELDMAN	67	PRL 18 868	M. Feldman <i>et al.</i>	(PENN)

FLATTE	67	PRL 18 976	S.M. Flatte	(LRL)
FLATTE	67B	PR 163 1441	S.M. Flatte, C.G. Wohl	(LRL)
LITCHFIELD	67	PL 24B 486	P.J. Litchfield <i>et al.</i>	(RHEL, SACL)
PRICE	67	PRL 18 1207	L.R. Price, F.S. Crawford	(LRL)
ALFF-...	66	PR 145 1072	C. Alff-Steinberger <i>et al.</i>	(COLU, RUTG)
CLPWY	66	PR 149 1044	C. Baltay	(SCUC, LRL, PURD, WISC, YALE)
CRAWFORD	66	PRL 16 333	F.S. Crawford, L.R. Price	(LRL)
DIGIUGNO	66	PRL 16 767	G. di Giugno <i>et al.</i>	(NAPL, TRST, FRAS)
GRUNHAUS	66	Thesis	J. Grunhaus	(COLU)
JAMES	66	PR 142 896	F.E. James, H.L. Kraybill	(YALE, BNL)
JONES	66	PL 23 597	W.G. Jones <i>et al.</i>	(LOIC, RHEL)
LARRIBE	66	PL 23 600	A. Larribe <i>et al.</i>	(SACL, RHEL)
FOSTER	65	PR 138 B652	M. Foster <i>et al.</i>	(WISC, PURD)
FOSTER	65B	Athens Conf.	M. Foster, M. Good, M. Meer	(WISC)
FOSTER	65C	Thesis	M. Foster	(WISC)
PRICE	65	PRL 15 123	L.R. Price, F.S. Crawford	(LRL)
RITTENBERG	65	PRL 15 556	A. Rittenberg, G.R. Kalbfleisch	(LRL, BNL)
FOELSCH	64	PR 134 B1138	H.W.J. Foelsche, H.L. Kraybill	(YALE)
KRAEMER	64	PR 136 B496	R.W. Kraemer <i>et al.</i>	(JHU, NWES, WOOD)
PAULI	64	PL 13 351	E. Pauli, A. Muller	(SACL)
BACCI	63	PRL 11 37	C. Bacci <i>et al.</i>	(ROMA, FRAS)
CRAWFORD	63	PRL 10 546	F.S.Jr. Crawford, L.J. Lloyd, E.C. Fowler	(LRL+)
Also		PRL 16 907	F.S. Crawford, L.J. Lloyd, E.C. Fowler	(LRL+)
ALFF-...	62	PRL 9 322	C. Alff-Steinberger <i>et al.</i>	(COLU, RUTG)
BASTIEN	62	PRL 8 114	P.L. Bastien <i>et al.</i>	(LRL)
PICKUP	62	PRL 8 329	E. Pickup, D.K. Robinson, E.O. Salant	(CNRC+)
