η

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

We have omitted some results that have been superseded by later experiments.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

Recent measurements resolve the obvious inconsistency in previous η mass measurements in favor of the higher value first reported by NA48 (LAI 02). We use only precise measurements consistent with this higher mass value for our η mass average.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
547.862±0.017 OUR AVERAGE					
547.865±0.031±0.062		NIKOLAEV	14	CRYB	$\gamma p \to p\eta$
547.873±0.005±0.027	1M	GOSLAWSKI	12	SPEC	$d p \to {}^3\text{He}\,\eta$
547.874±0.007±0.029		AMBROSINO	07B	KLOE	$e^+e^- \to \phi \to \eta\gamma$
547.785±0.017±0.057	16k	MILLER	07	CLEO	$\psi(2S) \to J/\psi\eta$
547.843±0.030±0.041	1134	LAI	02	NA48	$\eta \to 3\pi^0$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
547.311±0.028±0.032		[1] ABDEL-BARY	05	SPEC	$d p \to {}^3\text{He}\,\eta$
547.12 ±0.06 ±0.25		KRUSCHE	95D	SPEC	$\gamma p \to \eta p$, threshold
547.30 ±0.15		PLOUIN	92	SPEC	$d p \to {}^3\text{He}\,\eta$
547.45 ±0.25		DUANE	74	SPEC	$\pi^- p \to n$ 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	HBC	

[1] ABDEL-BARY 05 disagrees significantly with recent measurements of similar or better precision. See comment in the header.

η WIDTH

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

VALUE (keV)	*DOCUMENT ID*
1.31±0.05 OUR FIT	

η DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Neutral modes		
Γ_1	neutral modes	(71.96±0.30) %	S=1.3
Γ_2	2γ	(39.36±0.18) %	S=1.1
Γ_3	$3\pi^0$	(32.57±0.21) %	S=1.2

Γ_4	$\pi^0 2\gamma$				$(2.55\pm0.22)\times10^{-4}$	
Γ_5	$2\pi^0 2\gamma$			<	1.2×10^{-3}	CL=90%
Γ_6	4γ			<	2.8×10^{-4}	CL=90%
Γ_7	invisible			<	1.0×10^{-4}	CL=90%

Charged modes

Γ_8	charged modes				(28.04 ± 0.30) %	S=1.3
Γ_9	$\pi^+\pi^-\pi^0$				(23.02 ± 0.25) %	S=1.2
Γ_{10}	$\pi^+\pi^-\gamma$				(4.28 ± 0.07) %	S=1.1
Γ_{11}	$e^+e^-\gamma$				$(6.9\pm0.4)\times10^{-3}$	S=1.2
Γ_{12}	$\mu^+\mu^-\gamma$				$(3.1\pm0.4)\times10^{-4}$	
Γ_{13}	e^+e^-			<	7×10^{-7}	CL=90%
Γ_{14}	$\mu^+\mu^-$				$(5.8\pm0.8)\times10^{-6}$	
Γ_{15}	$2e^+2e^-$				$(2.40\pm0.22)\times10^{-5}$	
Γ_{16}	$\pi^+\pi^-e^+e^-(\gamma)$				$(2.68\pm0.11)\times10^{-4}$	
Γ_{17}	$e^+e^-\mu^+\mu^-$			<	1.6×10^{-4}	CL=90%
Γ_{18}	$2\mu^+2\mu^-$			<	3.6×10^{-4}	CL=90%
Γ_{19}	$\mu^+\mu^-\pi^+\pi^-$			<	3.6×10^{-4}	CL=90%
Γ_{20}	$\pi^+e^-\overline{\nu}_e+$ c.c.			<	1.7×10^{-4}	CL=90%
Γ_{21}	$\pi^+\pi^-2\gamma$			<	2.1×10^{-3}	
Γ_{22}	$\pi^+\pi^-\pi^0\gamma$			<	6×10^{-4}	CL=90%
Γ_{23}	$\pi^0\mu^+\mu^-\gamma$			<	3×10^{-6}	CL=90%

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

Γ_{24}	$\pi^0\gamma$	C	[a]	<	9×10^{-5}	CL=90%
Γ_{25}	$\pi^+\pi^-$	P,CP		<	4.4×10^{-6}	CL=90%
Γ_{26}	$2\pi^0$	P,CP		<	3.5×10^{-4}	CL=90%
Γ_{27}	$2\pi^0\gamma$	C		<	5×10^{-4}	CL=90%
Γ_{28}	$3\pi^0\gamma$	C		<	6×10^{-5}	CL=90%
Γ_{29}	3γ	C		<	1.6×10^{-5}	CL=90%
Γ_{30}	$4\pi^0$	P,CP		<	6.9×10^{-7}	CL=90%
Γ_{31}	$\pi^0e^+e^-$	C	[b]	<	8×10^{-6}	CL=90%
Γ_{32}	$\pi^0\mu^+\mu^-$	C	[b]	<	5×10^{-6}	CL=90%
Γ_{33}	$\mu^+e^- + \mu^-e^+$	LF		<	6×10^{-6}	CL=90%

[a] Forbidden by angular momentum conservation.

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

CONSTRAINED FIT INFORMATION

An overall fit to 2 decay rate and 22 branching ratios uses 54 measurements and one constraint to determine 9 parameters. The overall fit has a $\chi^2 = 46.2$ for 46 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle \delta x_i \delta x_j \right\rangle / (\delta x_i \cdot \delta x_j)$, 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	12							
x_4	4	0						
x_9	−69	−76	−3					
x_{10}	−48	−52	−2	53				
x_{11}	−8	−7	0	−4	−3			
x_{12}	−1	−1	0	0	0	0		
x_{16}	0	0	0	0	0	0	0	
Γ	−13	−1	−32	9	6	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	0.515 ± 0.018	
Γ_3	$3\pi^0$	0.426 ± 0.015	
Γ_4	$\pi^0 2\gamma$	$(3.34 \pm 0.28) \times 10^{-4}$	
Γ_9	$\pi^+ \pi^- \pi^0$	0.301 ± 0.011	
Γ_{10}	$\pi^+ \pi^- \gamma$	0.0559 ± 0.0022	
Γ_{11}	$e^+ e^- \gamma$	0.0090 ± 0.0006	1.2
Γ_{12}	$\mu^+ \mu^- \gamma$	$(4.1 \pm 0.5) \times 10^{-4}$	
Γ_{16}	$\pi^+ \pi^- e^+ e^- (\gamma)$	$(3.50 \pm 0.19) \times 10^{-4}$	

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 $\Gamma(\eta \to \gamma\gamma)$," 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*
0.515±0.018 OUR FIT					
0.516±0.018 OUR AVERAGE					
$0.520 \pm 0.020 \pm 0.013$		BABUSCI	13A	KLOE	$e^+ e^- \to e^+ e^- \eta$
$0.51 \pm 0.12 \pm 0.05$	36	BARU	90	MD1	$e^+ e^- \to e^+ e^- \eta$
$0.490 \pm 0.010 \pm 0.048$	2287	ROE	90	ASP	$e^+ e^- \to e^+ e^- \eta$
$0.514 \pm 0.017 \pm 0.035$	1295	WILLIAMS	88	CBAL	$e^+ e^- \to e^+ e^- \eta$
$0.53 \pm 0.04 \pm 0.04$		BARTEL	85E	JADE	$e^+ e^- \to e^+ e^- \eta$

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

0.476±0.062		[1] RODRIGUES	08	CNTR	Reanalysis
0.64 ±0.14 ±0.13		AIHARA	86	TPC	$e^+e^- \to e^+e^-\eta$
0.56 ±0.16	56	WEINSTEIN	83	CBAL	$e^+e^- \to e^+e^-\eta$
0.324±0.046		BROWMAN	74B	CNTR	Primakoff effect
1.00 ±0.22		[2] BEMPORAD	67	CNTR	Primakoff effect

[1] 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 $\Gamma(\eta \to 2\gamma)$ in line with direct measurements of the width. The error here is only statistical.

[2] 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.

$\Gamma(\pi^0 2\gamma)$ Γ_4

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
0.334±0.028 OUR FIT					
0.33 ±0.03	1200	NEFKENS	14	CRYB	$\gamma p \to \eta p$

η BRANCHING RATIOS

Neutral modes

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.7196±0.0030 OUR FIT Error includes scale factor of 1.3.					
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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
39.36±0.18 OUR FIT Error includes scale factor of 1.1.					
39.53±0.33 OUR AVERAGE					
39.86±0.04±0.99	2m	[1] ABLIKIM	21AM	BES3	$J/\psi \to \gamma\eta$
39.49±0.17±0.30	65k	ABEGG	96	SPEC	$pd \to {}^3\text{He}\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
38.45±0.40±0.36	14k	[2] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

[1] ABLIKIM 21AM normalize the branching ratio ($\eta \to \gamma\gamma$) to B($J/\psi \to \gamma\eta$), which they measured absolutely.

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

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.5470±0.0018 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		[1] JONES	66	CNTR	

[1] This result from combining cross sections from two different experiments.

$\Gamma(3\pi^0)/\Gamma_{total}$ Γ_3/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
32.57±0.21 OUR FIT	Error includes scale factor of 1.2.				
31.96±0.07±0.84	280k	[1] ABLIKIM	21AM	BES3	$J/\psi \to \gamma\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
34.03±0.56±0.49	1821	[2] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

[1] ABLIKIM 21AM normalize the branching ratio ($\eta \to 3\pi^0$) to B($J/\psi \to \gamma\eta$), which they measured absolutely.

[2] Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \to \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, 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
0.4526±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
0.827±0.006 OUR FIT					
0.829±0.007 OUR AVERAGE					
0.884±0.022±0.019	1821	LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$
0.817±0.012±0.032	17.4k	[1] AKHMETSHIN	05	CMD2	$e^+e^- \to \phi \to \eta\gamma$
0.826±0.024		ACHASOV	00D	SND	$e^+e^- \to \phi \to \eta\gamma$
0.832±0.005±0.012		KRUSCHE	95D	SPEC	$\gamma p \to \eta p$, threshold
0.841±0.034		AMSLER	93	CBAR	$\overline{p}p \to \pi^+\pi^-\eta$ 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

[1] Uses result from AKHMETSHIN 01B.

$\Gamma(\pi^0 2\gamma)/\Gamma_{total}$ — Γ_4/Γ

Early results are summarized in the review by LANDSBERG 85.

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.55±0.22 OUR FIT						
2.21±0.24±0.47		≈ 500	[1] PRAKHOV	08	CRYB	$\pi^- p \to \eta n \approx$ threshold
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3.5 ±0.7 ±0.6		1.6k	[2,3] PRAKHOV	05	CRYB	See PRAKHOV 08
<8.4	90	7	ACHASOV	01D	SND	$e^+e^- \to \phi \to \eta\gamma$
<30	90	0	DAVYDOV	81	GAM2	$\pi^- p \to \eta n$

[1] PRAKHOV 08 is a reanalysis of the data of PRAKHOV 05, using for the first time the invariant-mass spectrum of the two photons.
[2] Normalized using $\Gamma(\eta \to 2\gamma)/\Gamma = 0.3943 \pm 0.0026$.
[3] 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
0.65±0.06 OUR FIT						
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
7.8±0.7 OUR FIT				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8.3±2.8±1.4	[1] KNECHT	04	CRYB	$\pi^- p \to n\eta$

[1] Independent analysis of same data as PRAKHOV 05.

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.2 × 10^{-3}	90	[1] NEFKENS	05A	CRYB	p(720 MeV/c) $\pi^- \to n\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<4.0 × 10^{-3}	90	BLIK	07	GAM4	$\pi^- p \to \eta n$

[1] Measurement is done in limited $\gamma\gamma$ energy range.

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

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

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<2.6 × 10^{-4}	90	[1] ABLIKIM	13	BES3	$J/\psi \to \phi\eta$

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

$<1.65 \times 10^{-3}$	90	[2] ABLIKIM	06Q	BES2	$J/\psi \to \phi\eta$

[1] Based on 225M J/ψ decays.
[2] Based on 58M J/ψ decays.

Charged modes

Γ(charged modes)/Γ_{total} $\quad\Gamma_8/\Gamma = (\Gamma_9+\Gamma_{10}+\Gamma_{11}+\Gamma_{12}+\Gamma_{16})/\Gamma$

VALUE	DOCUMENT ID
0.2804±0.0030 OUR FIT Error includes scale factor of 1.3.	

$\Gamma(\pi^+\pi^-\pi^0)/\Gamma_{total}$ $\quad\Gamma_9/\Gamma$

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
23.02±0.25 OUR FIT Error includes scale factor of 1.2.					
23.04±0.03±0.54	60k	[1] ABLIKIM	21AM	BES3	$J/\psi \to \gamma\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
22.60±0.35±0.29	3915	[2] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

[1] ABLIKIM 21AM normalize the branching ratio ($\eta \to \pi^+\pi^-\pi^0$) to B($J/\psi \to \gamma\eta$), which they measured absolutely.
[2] Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \to \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, and $e^+e^-\gamma$ account for all η decays within a contribution of 0.3% to the systematic error.

Γ(neutral modes)/$\Gamma(\pi^+\pi^-\pi^0)$ $\quad\Gamma_1/\Gamma_9 = (\Gamma_2+\Gamma_3+\Gamma_4)/\Gamma_9$

VALUE	EVTS	DOCUMENT ID		TECN
3.13±0.05 OUR FIT Error includes scale factor of 1.3.				
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	[1] 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

[1] Error increased from published value 0.5 by Bloodworth (private communication).

$\Gamma(2\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ $\quad\Gamma_2/\Gamma_9$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.710±0.025 OUR FIT Error includes scale factor of 1.2.					
1.70 ±0.04 OUR AVERAGE					
1.704±0.032±0.026	3915	[1] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$
1.61 ±0.14		ABLIKIM	06E	BES2	$e^+e^- \to J/\psi \to \eta\gamma$
1.78 ±0.10 ±0.13	1077	AMSLER	95	CBAR	$\overline{p}p \to \pi^+\pi^-\eta$ at rest
1.72 ±0.25	401	BAGLIN	69	HLBC	
1.61 ±0.39		FOSTER	65	HBC	

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

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
1.415±0.023 OUR FIT Error includes scale factor of 1.2.					
1.48 ±0.05 OUR AVERAGE					
1.46 ±0.03 ±0.09		ACHASOV	06A	SND	$e^+e^- \to \eta\gamma$
1.52 ±0.04 ±0.08	23k	[1] AKHMETSHIN	01B	CMD2	$e^+e^- \to \phi \to \eta\gamma$
1.44 ±0.09 ±0.10	1627	AMSLER	95	CBAR	$\overline{p}p \to \pi^+\pi^-\eta$ 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		FOELSCHE	64	HBC	
0.83 ±0.32		CRAWFORD	63	HBC	

[1] AKHMETSHIN 01B uses results from AKHMETSHIN 99F.

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

VALUE	DOCUMENT ID		TECN	COMMENT
0.320 ±0.005 OUR FIT Error includes scale factor of 1.2.				
0.304 ±0.012	ACHASOV	00D	SND	$e^+e^- \to \phi \to \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.3141±0.0081±0.0058	ACHASOV	00B	SND	See ACHASOV 00D

$\Gamma(\pi^+\pi^-\gamma)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
4.28±0.07 OUR FIT Error includes scale factor of 1.1.					
4.38±0.02±0.10	200k	[1] ABLIKIM	21AM	BES3	$J/\psi \to \gamma\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
3.96±0.14±0.14	859	[2] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

[1] ABLIKIM 21AM normalize the branching ratio ($\eta \to \pi^+\pi^-\gamma$) to B($J/\psi \to \gamma\eta$), which they measured absolutely.

[2] Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \to \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, 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
0.1858±0.0025 OUR FIT					
0.1847±0.0030 OUR AVERAGE Error includes scale factor of 1.1.					
0.1856±0.0005±0.0028	200k	BABUSCI	13	KLOE	$e^+e^- \to \phi \to \eta\gamma$
0.175 ±0.007 ±0.006	859	LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.209 ±0.004	18k	THALER	73	ASPK	
0.201 ±0.006	7250	GORMLEY	70	ASPK	
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	

$\Gamma(e^+e^-\gamma)/\Gamma_{total}$ 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	$\gamma p \to p\eta$
7.8 ±0.5 ±0.8	435 ± 31	BERLOWSKI	08	WASA	$pd \to {}^3\text{He}\,\eta$
5.15±0.62±0.74	283	ACHASOV	01B	SND	$e^+e^- \to \phi \to \eta\gamma$
7.10±0.64±0.46	323	AKHMETSHIN	01	CMD2	$e^+e^- \to \phi \to \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
9.4 ±0.7 ±0.5	172	[1] LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

[1] Not independent of other results listed for LOPEZ 07. Assuming decays of $\eta \to \gamma\gamma$, $3\pi^0$, $\pi^+\pi^-\pi^0$, $\pi^+\pi^-\gamma$, 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
0.161±0.010 OUR FIT Error includes scale factor of 1.2.					
0.237±0.021±0.015	172	LOPEZ	07	CLEO	$\psi(2S) \to J/\psi\eta$

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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
2.98±0.19 OUR FIT Error includes scale factor of 1.3.					
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
2.57±0.04 OUR FIT Error includes scale factor of 1.3.				
2.64±0.23		BALTAY	67B	DBC
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.5 ±1.0	280	[1] JAMES	66	HBC
3.20±1.26	53	[1] BASTIEN	62	HBC
2.5 ±1.0	10	[1] PICKUP	62	HBC

[1] These experiments are not used in the averages as they do not separate clearly $\eta \to \pi^+\pi^-\pi^0$ and $\eta \to \pi^+\pi^-\gamma$ from each other. The reported values thus probably contain some unknown fraction of $\eta \to \pi^+\pi^-\gamma$.

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

VALUE	EVTS	DOCUMENT ID		TECN
1.407±0.020 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

$\Gamma(\mu^+\mu^-\gamma)/\Gamma_{total}$ 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	$\pi^- p \to \eta n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.5±0.75	100	BUSHNIN	78	SPEC	See DZHELYADIN 80

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<7 × 10^−7	90	ACHASOV	18B	CNTR	Inverse reaction $e^+e^- \to \eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<2.3 \times 10^{-6}$	90	AGAKISHIEV	14		$pp \to \eta + X$
$<5.6 \times 10^{-6}$	90	[1] AGAKISHIEV	12A	SPEC	$pp \to \eta + X$
$<2.7 \times 10^{-5}$	90	BERLOWSKI	08	WASA	$pd \to {}^3\text{He}\,\eta$
$<0.77 \times 10^{-4}$	90	BROWDER	97B	CLE2	$e^+e^- \simeq 10.5$ GeV
$<2 \times 10^{-4}$	90	WHITE	96	SPEC	$pd \to \eta\,{}^3\text{He}$
$<3 \times 10^{-4}$	90	DAVIES	74	RVUE	Uses ESTEN 67

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

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

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
5.8±0.8 OUR AVERAGE						
5.7±0.7±0.5		114	ABEGG	94	SPEC	$pd \to \eta\,{}^3\text{He}$
6.5±2.1		27	DZHELYADIN	80B	SPEC	$\pi^- p \to \eta n$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$5.6^{+0.6}_{-0.7}\pm0.5$		100	KESSLER	93	SPEC	See ABEGG 94
< 20	95	0	WEHMANN	68	OSPK	

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

VALUE (units 10^{-5})	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
5.9±2.2	HYAMS	69	OSPK

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

VALUE (units 10^{-5})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.4±0.2±0.1		362	[1] AMBROSINO	11B	KLOE	$e^+e^- \to \phi \to \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<9.7	90		BERLOWSKI	08	WASA	$pd \to {}^3\text{He}\,\eta$
<6.9	90		AKHMETSHIN	01	CMD2	$e^+e^- \to \phi \to \eta\gamma$

[1] This measurement is fully inclusive (includes "$2e^+2e^-\gamma$" channel).

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.68±0.11 OUR FIT					
2.68±0.09±0.07	1555 ± 52	[1] AMBROSINO	09B	KLOE	$e^+e^- \to \phi \to \eta\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$4.3\,^{+2.0}_{-1.6}\pm0.4$	16	BERLOWSKI	08	WASA	$pd \to {}^3\text{He}\,\eta$
4.3 ±1.3 ±0.4	16	BARGHOLTZ	07	CNTR	See BERLOWSKI 08
$3.7\,^{+2.5}_{-1.8}\pm0.3$	4	AKHMETSHIN	01	CMD2	$e^+e^- \to \phi \to \eta\gamma$

[1] This AMBROSINO 09B value includes radiative events.

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

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

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

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

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

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

$\Gamma(\pi^+e^-\overline{\nu}_e + \text{c.c.})/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_{20}/Γ_9

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<7.3 \times 10^{-4}$	90	ABLIKIM	13G	BES3	$J/\psi \to \phi\eta$

$\Gamma(\pi^+\pi^-2\gamma)/\Gamma(\pi^+\pi^-\pi^0)$ — Γ_{21}/Γ_9

VALUE	CL%	DOCUMENT ID		TECN
$< 9 \times 10^{-3}$		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_{22}/Γ_9

VALUE	CL%	EVTS	DOCUMENT ID		TECN
$<0.24 \times 10^{-2}$	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

$\Gamma(\pi^0\mu^+\mu^-\gamma)/\Gamma_{total}$ — Γ_{23}/Γ

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

Forbidden modes

$\Gamma(\pi^0\gamma)/\Gamma_{total}$ — Γ_{24}/Γ

Forbidden by angular momentum conservation.

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

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ — Γ_{25}/Γ

Forbidden by P and CP invariance.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$< 4.4 \times 10^{-6}$	90	83M	[1] BABUSCI	20A	KLOE	$e^+e^- \to \phi \to \eta\gamma$

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

$< 5.3 \times 10^{-17}$			[2] ZHEVLAKOV	19	THEO	from nEDM limits
$< 1.6 \times 10^{-5}$	90	25M	AAIJ	17D	LHCB	in $D \to \pi\pi\pi$ decays
$< 3.9 \times 10^{-4}$	90	225M	ABLIKIM	11G	BES3	$e^+e^- \to J/\psi \to \eta\gamma$
$< 1.3 \times 10^{-5}$	90	16M	AMBROSINO	05A	KLOE	$e^+e^- \to \phi \to \eta\gamma$
$< 3.3 \times 10^{-4}$	90		AKHMETSHIN	99B	CMD2	$e^+e^- \to \phi \to \eta\gamma$
$< 9 \times 10^{-4}$	90		AKHMETSHIN	97C	CMD2	See AKHMETSHIN 99B
$<15 \times 10^{-4}$		0	THALER	73	ASPK	

[1] BABUSCI 20A combines new data with the previous AMBROSINO 05A data, and thus supersedes AMBROSINO 05A.

[2] ZHEVLAKOV 19 derives the value from the experimental limits of nEDM by a calculation using an effective Lagrangian.

$\Gamma(2\pi^0)/\Gamma_{total}$ Γ_{26}/Γ

Forbidden by *P* and *CP* invariance.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{<3.5 \times 10^{-4}}$	90		BLIK	07	GAM4	$\pi^- p \to \eta n$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<2.7 \times 10^{-17}$			[1] ZHEVLAKOV	19	THEO	from nEDM limits
$<6.9 \times 10^{-4}$	90	225M	ABLIKIM	11G	BES3	$e^+e^- \to J/\psi \to \eta\gamma$
$<4.3 \times 10^{-4}$	90		AKHMETSHIN	99C	CMD2	$e^+e^- \to \phi \to \eta\gamma$
$<6 \times 10^{-4}$	90		[2] ACHASOV	98	SND	$e^+e^- \to \phi \to \eta\gamma$

[1] ZHEVLAKOV 19 derives the value from the experimental limits of nEDM by a calculation using an effective Lagrangian.

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

$\Gamma(2\pi^0\gamma)/\Gamma_{total}$ Γ_{27}/Γ

Forbidden by *C* invariance.

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
$\mathbf{< 5 \times 10^{-4}}$	90	NEFKENS	05	CRYB	0	p(720 MeV/c) $\pi^- \to n\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<17 \times 10^{-4}$	90	BLIK	07	GAM4		$\pi^- p \to \eta n$

$\Gamma(3\pi^0\gamma)/\Gamma_{total}$ Γ_{28}/Γ

Forbidden by *C* invariance.

VALUE	CL%	DOCUMENT ID		TECN	CHG	COMMENT
$\mathbf{< 6 \times 10^{-5}}$	90	NEFKENS	05	CRYB	0	p(720 MeV/c) $\pi^- \to n\eta$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$<24 \times 10^{-5}$	90	BLIK	07	GAM4		$\pi^- p \to \eta n$

$\Gamma(3\gamma)/\Gamma_{total}$ Γ_{29}/Γ

Forbidden by *C* invariance.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<16 \times 10^{-5}$	90	BLIK	07	GAM4	$\pi^- p \to \eta n$
$< 4 \times 10^{-5}$	90	NEFKENS	05A	CRYB	p(720 MeV/c) $\pi^- \to n\eta$

$\Gamma(3\gamma)/\Gamma(2\gamma)$ — Γ_{29}/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_{29}/Γ_3

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

$\Gamma(4\pi^0)/\Gamma_{total}$ — Γ_{30}/Γ

Forbidden by *P* and *CP* invariance.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$< 6.9 \times 10^{-7}$	90	PRAKHOV	00	CRYB	$\pi^- p \to n\eta$, 720 MeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<200 \times 10^{-7}$	90	BLIK	07	GAM4	$\pi^- p \to \eta n$

$\Gamma(\pi^0 e^+ e^-)/\Gamma_{total}$ — Γ_{31}/Γ

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$< 7.5 \times 10^{-6}$	90	ADLARSON	18C	WASA	$p d \to \eta\, ^3$He
$< 1.6 \times 10^{-4}$	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_{31}/Γ_9

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$< 3.28 \times 10^{-5}$	90	ADLARSON	18C	WASA	$p d \to \eta\, ^3$He
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$< 1.9 \times 10^{-4}$	90	JANE	75	OSPK	
$< 42 \times 10^{-4}$	90	BAGLIN	67	HLBC	
$< 16 \times 10^{-4}$	90	BILLING	67	HLBC	
$< 77 \times 10^{-4}$		FOSTER	65B	HBC	
$<110 \times 10^{-4}$		PRICE	65	HBC	

$\Gamma(\pi^0 \mu^+ \mu^-)/\Gamma_{total}$ — Γ_{32}/Γ

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$< 5 \times 10^{-6}$	90	DZHELYADIN	81	SPEC	$\pi^- p \to \eta n$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<500 \times 10^{-6}$		WEHMANN	68	OSPK	

$[\Gamma(\mu^+ e^-) + \Gamma(\mu^- e^+)]/\Gamma_{total}$ — Γ_{33}/Γ

Forbidden by lepton family number conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6 \times 10^{-6}$	90	WHITE	96	SPEC	$p d \to \eta\, ^3$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
$0.09^{+0.11}_{-0.12}$ 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	[1] GORMLEY	68C	ASPK

[1] The GORMLEY 68C asymmetry is probably due to unmeasured ($\mathbf{E} \times \mathbf{B}$) spark chamber effects. New experiments with ($\mathbf{E} \times \mathbf{B}$) 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.

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN
$0.12^{+0.10}_{-0.11}$ 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

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

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN
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: $dN/d\cos\theta = \sin^2\theta\ (1 + \beta\ \cos^2\theta)$.

VALUE	EVTS	DOCUMENT ID		TECN
-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		[1] THALER	72	ASPK

[1] 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

$\pi^+\pi^- e^+ e^-$ 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*
$-0.6\pm2.5\pm1.8$	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," page 1454, in our 1994 edition (Physical Review **D50** 1173 (1994)). The following experiments fit to one or more of the coefficients *a*, *b*, *c*, *d*, *e*, *f* or *g* for $|\text{matrix element}|^2 = 1 + ay + by^2 + cx + dx^2 + exy + fy^3 + gx^2y$.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •					
	4.7M	[1] ANASTASI	16A	KLOE	$e^+e^- \rightarrow \phi \rightarrow \eta\gamma$
	79k	ABLIKIM	15G	BES3	$e^+e^- \rightarrow J/\psi \rightarrow \gamma\eta$
	174k	ADLARSON	14A	WASA	$pd \rightarrow \eta\ ^3\text{He}$
	1.34M	AMBROSINO	08D	KLOE	
	3230	[2] ABELE	98D	CBAR	$\overline{p}p \rightarrow \pi^0\pi^0\eta$ at rest
	1077	[3] AMSLER	95	CBAR	$\overline{p}p \rightarrow \pi^+\pi^-\eta$ 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	

[1] ANASTASI 16A measure the Dalitz parameters *a*, *b*, *d*, *f*, and *g*. This is the first measurement of *g*.

[2] ABELE 98D obtains $a = -1.22 \pm 0.07$ and $b = 0.22 \pm 0.11$ when *c* (or *d*) is fixed at 0.06.

[3] 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 $\eta \to 3\pi^0$

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
−0.0288±0.0012 OUR AVERAGE		Error includes scale factor of 1.1.			
−0.0265±0.0010±0.0009	7M	PRAKHOV	18	CRYB	$\gamma p \to p\eta$
−0.055 ±0.014 ±0.004	33k	ABLIKIM	15G	BES3	$e^+e^- \to J/\psi \to \gamma\eta$
−0.0301±0.0035$^{+0.0022}_{-0.0035}$	512k	AMBROSINO	10A	KLOE	$e^+e^- \to \phi \to \eta\gamma$
−0.027 ±0.008 ±0.005	120k	[1] ADOLPH	09	WASA	$pp \to pp\eta$
−0.0322±0.0012±0.0022	3M	[2] PRAKHOV	09	CRYB	$\gamma p \to p\eta$
−0.032 ±0.002 ±0.002	1.8M	[2] UNVERZAGT	09	CRYB	$\gamma p \to p\eta$
−0.026 ±0.010 ±0.010	75k	BASHKANOV	07	WASA	$pp \to pp\eta$
−0.010 ±0.021 ±0.010	12k	ACHASOV	01C	SND	$e^+e^- \to \phi \to \eta\gamma$
−0.031 ±0.004	1M	TIPPENS	01	CRYB	$\pi^- p \to n\eta$, 720 MeV
−0.052 ±0.017 ±0.010	98k	ABELE	98C	CBAR	$\overline{p}p \to 5\pi^0$
−0.022 ±0.023	50k	ALDE	84	GAM2	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.038 ±0.003 $^{+0.012}_{-0.008}$	1.34M	[3] AMBROSINO	08D	KLOE	
−0.32 ±0.37	192	BAGLIN	70	HLBC	

[1] This ADOLPH 09 result is independent of the BASHKANOV 07 result.

[2] The PRAKHOV 09 and UNVERZAGT 09 results are independent.

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

PARAMETER Λ IN $\eta \to \ell^+\ell^-\gamma$ DECAY

In the pole approximation the electromagnetic transition form factor for a resonance of mass M is given by the expression:

$$|F|^2 = (1 - M^2_{\ell\ell}/\Lambda^2)^{-2},$$

where for the parameter Λ vector dominance predicts $\Lambda \approx 0.770$ GeV.

VALUE (GeV/c^2)	EVTS	DOCUMENT ID		TECN	COMMENT
0.716 ±0.011 OUR AVERAGE					
0.712 ±0.020		[1] ADLARSON	17B	A2MM	$\gamma p \to \eta p$
0.7191±0.0125±0.0093		[2] ARNALDI	16	NA60	400 GeV p-A collisions
0.716 ±0.031 ±0.009		[3] ARNALDI	09	NA60	158A In−In collisions
0.72 ±0.09	600	DZHELYADIN	80	SPEC	$\pi^- p \to \eta n$, $\eta \to \gamma\mu^+\mu^-$

[1] ADLARSON 17B reports $\Lambda^{-2}(\eta \to \gamma e^+e^-) = 1.97 \pm 0.11$ (GeV/c^2)$^{-2}$ which we converted to the quoted Λ value and uncertainty (total=statistical plus systematic).

[2] ARNALDI 16 reports $\Lambda^{-2}(\eta \to \gamma\mu^+\mu^-) = 1.934 \pm 0.067 \pm 0.050$ (GeV/c^2)$^{-2}$ which we converted to the quoted Λ value.

[3] ARNALDI 09 reports $\Lambda^{-2}(\eta \to \gamma\mu^+\mu^-) = 1.95 \pm 0.17 \pm 0.05$ (GeV/c^2)$^{-2}$ which we converted to the quoted Λ value.

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BABUSCI	20A	JHEP 2010 047	D. Babusci *et al.*	(KLOE-2 Collab.)
ZHEVLAKOV	19	PR D99 031703	A.S. Zhevlakov *et al.*	(TMSK, MAINZ, TUBIN+)
ACHASOV	18B	PR D98 052007	M.N. Achasov *et al.*	(SND Collab.)
ADLARSON	18C	PL B784 378	P. Adlarson *et al.*	(WASA-at-COSY Collab.)
PRAKHOV	18	PR C97 065203	S. Prakhov *et al.*	(A2 Collab. at MAMI)
AAIJ	17D	PL B764 233	R. Aaij *et al.*	(LHCb Collab.)
ADLARSON	17B	PR C95 035208	P. Adlarson *et al.*	(A2 Collab. at MAMI)
ANASTASI	16A	JHEP 1605 019	A. Anastasi *et al.*	(KLOE-2 Collab.)
ARNALDI	16	PL B757 437	R. Arnaldi *et al.*	(NA60 Collab.)
ABLIKIM	15G	PR D92 012014	M. Ablikim *et al.*	(BESIII Collab.)
ADLARSON	14A	PR C90 045207	P. Adlarson *et al.*	(WASA-at-COSY Collab.)
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ABLIKIM	13	PR D87 012009	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	13G	PR D87 032006	M. Ablikim *et al.*	(BESIII Collab.)
BABUSCI	13	PL B718 910	D. Babusci *et al.*	(KLOE/KLOE-2 Collab.)
BABUSCI	13A	JHEP 1301 119	D. Babusci *et al.*	(KLOE-2 Collab.)
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GOSLAWSKI	12	PR D85 112011	P. Goslawski *et al.*	(COSY-ANKE Collab.)
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ALDE	84	ZPHY C25 225	D.M. Alde *et al.*	(SERP, BELG, LAPP)
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DAVYDOV	81	LNC 32 45	V.A. Davydov *et al.*	(SERP, BELG, LAPP+)
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DZHELYADIN	81	PL 105B 239	R.I. Dzhelyadin *et al.*	(SERP)
Also		SJNP 33 822	R.I. Dzhelyadin *et al.*	(SERP)
		Translated from YAF 33 1529.		
ABROSIMOV	80	SJNP 31 195	A.T. Abrosimov *et al.*	(JINR)
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DZHELYADIN	80	PL 94B 548	R.I. Dzhelyadin *et al.*	(SERP)
Also		SJNP 32 516	R.I. Dzhelyadin *et al.*	(SERP)
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