$\Delta(1940)\ 3/2^-$

$I(J^P) = \frac{3}{2}(\frac{3}{2}^-)$ Status: ∗∗

OMITTED FROM SUMMARY TABLE

The latest GWU analysis (ARNDT 06) finds no evidence for this resonance.

$\Delta(1940)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1940 to 2060 (≈ 2000) OUR ESTIMATE				
2050 ± 40	GUTZ	14	DPWA	Multichannel
1995 $^{+105}_{-60}$	ANISOVICH	12A	DPWA	Multichannel
2058.1 ± 34.5	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
1940 ±100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1990 ± 40	HORN	08A	DPWA	Multichannel
2057 ±110	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Delta(1940)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
450 ± 70	GUTZ	14	DPWA	Multichannel
450 ±100	ANISOVICH	12A	DPWA	Multichannel
198.4 ± 45.5	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
200 ±100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
410 ± 70	HORN	08A	DPWA	Multichannel
460 ±320	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Delta(1940)$ POLE POSITION

REAL PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
2040 ± 50	GUTZ	14	DPWA	Multichannel
1878 ± 11 ± 5.5	[1] SVARC	14	MLS	$\pi N \to \pi N$
1990 $^{+100}_{-50}$	ANISOVICH	12A	DPWA	Multichannel
1900 ± 100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1915 or 1926	[2] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1985 ± 30	HORN	08A	DPWA	Multichannel

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
450±90	GUTZ	14	DPWA	Multichannel
212±21±6	[1] SVARC	14	MLS	$\pi N \to \pi N$
450±90	ANISOVICH	12A	DPWA	Multichannel
200±60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
190 or 186	[2] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
390±50	HORN	08A	DPWA	Multichannel

Δ(1940) ELASTIC POLE RESIDUE

MODULUS |r|

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
4±3	GUTZ	14	DPWA	Multichannel
9±1±1	[1] SVARC	14	MLS	$\pi N \to \pi N$
4±4	ANISOVICH	12A	DPWA	Multichannel
8±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
− 50±35	GUTZ	14	DPWA	Multichannel
140± 7±7	[1] SVARC	14	MLS	$\pi N \to \pi N$
135±45	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

Δ(1940) INELASTIC POLE RESIDUE

The "normalized residue" is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \to \Delta(1940) \to \Delta(1232)\eta$

MODULUS (%)	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
<1	not defined	GUTZ	14	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1940) \to N(1535)\pi$

MODULUS (%)	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
<3	not defined	GUTZ	14	DPWA	Multichannel

Δ(1940) DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	
Γ_2	ΣK	
Γ_3	$N\pi\pi$	
Γ_4	$\Delta(1232)\pi$, *S*-wave	
Γ_5	$\Delta(1232)\pi$, *D*-wave	

Γ_6	$N\rho$, S=3/2, S-wave	
Γ_7	$N(1535)\pi$	(8±6) %
Γ_8	$N a_0(980)$	
Γ_9	$\Delta(1232)\eta$	(10±6) %
Γ_{10}	$N\gamma$, helicity=1/2	
Γ_{11}	$N\gamma$, helicity=3/2	

Δ(1940) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
2± 1	GUTZ	14	DPWA	Multichannel
18	CHEW	80	BPWA	$\pi^+ p \to \pi^+ p$
5± 2	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
9± 4	HORN	08A	DPWA	Multichannel
18±12	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1940) \to \Sigma K$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
<0.015	CANDLIN	84	DPWA	$\pi^+ p \to \Sigma^+ K^+$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1940) \to \Delta(1232)\pi$, S-wave — $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.11±0.10	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1940) \to \Delta(1232)\pi$, D-wave — $(\Gamma_1\Gamma_5)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.27±0.16	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1940) \to N\rho$, S=3/2, S-wave — $(\Gamma_1\Gamma_6)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
+0.25±0.10	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N(1535)\pi)/\Gamma_{total}$ — Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
8±6	GUTZ	14	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2±1	HORN	08A	DPWA	Multichannel

$\Gamma(N a_0(980))/\Gamma_{total}$ — Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2±1	HORN	08A	DPWA	Multichannel

$\Gamma(\Delta(1232)\eta)/\Gamma_{total}$ — Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
10±6	GUTZ	14	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4±2	HORN	08A	DPWA	Multichannel

Δ(1940) PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics **G33** 1 (2006).

Δ(1940) → $N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
$0.170^{+0.110}_{-0.080}$	GUTZ	14	DPWA	Multichannel
−0.036±0.058	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.160±0.040	HORN	08A	DPWA	Multichannel

Δ(1940) → $N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.150±0.080	GUTZ	14	DPWA	Multichannel
−0.031±0.012	AWAJI	81	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.110±0.030	HORN	08A	DPWA	Multichannel

Δ(1940) FOOTNOTES

[1] Fit to the amplitudes of HOEHLER 79.

[2] LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \to N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

Δ(1940) REFERENCES

GUTZ	14	EPJ A50 74	E. Gutz *et al.*	(CBELSA/TAPS Collab.)
SVARC	14	PR C89 045205	A. Svarc *et al.*	
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
HORN	08A	EPJ A38 173	I. Horn *et al.*	(CB-ELSA Collab.)
Also		PRL 101 202002	I. Horn *et al.*	(CB-ELSA Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
PDG	06	JP G33 1	W.-M. Yao *et al.*	(PDG Collab.)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley *et al.*	(VPI)
CANDLIN	84	NP B238 477	D.J. Candlin *et al.*	(EDIN, RAL, LOWC)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii *et al.*	(NAGO)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL)
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT)
LONGACRE	78	PR D17 1795	R.S. Longacre *et al.*	(LBL, SLAC)