$\Delta(1900)$ $1/2^-$

$I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$ Status: ∗∗

OMITTED FROM SUMMARY TABLE

Some obsolete results published before 1980 were last included in our 2006 edition, Journal of Physics **G33** 1 (2006). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics **G33** 1 (2006).

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

$\Delta(1900)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1840 to 1920 (≈ 1860) OUR ESTIMATE				
1840 ±20	GUTZ	14	DPWA	Multichannel
1840 ±30	ANISOVICH	12A	DPWA	Multichannel
1890 ±50	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1908 ±30	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1868 ±12	SHRESTHA	12A	DPWA	Multichannel
1802 ±87	VRANA	00	DPWA	Multichannel
1920 ±24	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
1918.5±23.0	CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$

$\Delta(1900)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
295 ±30	GUTZ	14	DPWA	Multichannel
300 ±45	ANISOVICH	12A	DPWA	Multichannel
170 ±50	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
140 ±40	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
234 ±27	SHRESTHA	12A	DPWA	Multichannel
48 ±45	VRANA	00	DPWA	Multichannel
263 ±39	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
93.5±54.0	CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$

$\Delta(1900)$ POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1845±20	GUTZ	14	DPWA	Multichannel
1865±35±19	[1] SVARC	14	MLS	$\pi N \rightarrow \pi N$
1845±25	ANISOVICH	12A	DPWA	Multichannel
1780	[2] HOEHLER	93	SPED	$\pi N \rightarrow \pi N$
1870±40	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

1844	SHRESTHA	12A	DPWA	Multichannel
1795	VRANA	00	DPWA	Multichannel
2029 or 2025	[3] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$

−2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
295±35	GUTZ	14	DPWA	Multichannel
187±50±19	[1] SVARC	14	MLS	$\pi N \to \pi N$
300±45	ANISOVICH	12A	DPWA	Multichannel
180±50	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
223	SHRESTHA	12A	DPWA	Multichannel
58	VRANA	00	DPWA	Multichannel
164 or 163	[3] LONGACRE	78	IPWA	$\pi N \to N\pi\pi$

Δ(1900) ELASTIC POLE RESIDUE

MODULUS |r|

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
11±2	GUTZ	14	DPWA	Multichannel
11±4±2	[1] SVARC	14	MLS	$\pi N \to \pi N$
10±3	ANISOVICH	12A	DPWA	Multichannel
10±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−115±20	GUTZ	14	DPWA	Multichannel
20±27±19	[1] SVARC	14	MLS	$\pi N \to \pi N$
−125±20	ANISOVICH	12A	DPWA	Multichannel
+ 20±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

Δ(1900) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to \Delta(1900) \to \Sigma K$

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
7±2	−50 ± 30	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1900) \to \Delta\pi$, D-wave

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
12^{+8}_{-5}	110 ± 20	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1900) \to \Delta(1232)\eta$

MODULUS (%)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
1.3±0.6	**not defined**	GUTZ	14	DPWA	Multichannel

$\Delta(1900)$ DECAY MODES

The following branching fractions are our estimates, not fits or averages.

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	10–30 %
Γ_2	ΣK	
Γ_3	$N\pi\pi$	
Γ_4	$\Delta\pi$	
Γ_5	$\Delta(1232)\pi$, D-wave	
Γ_6	$N\rho$	
Γ_7	$N\rho$, S=1/2, S-wave	
Γ_8	$N\rho$, S=3/2, D-wave	
Γ_9	$N(1440)\pi$, S-wave	
Γ_{10}	$\Delta(1232)\eta$	(1.0±1.0) %
Γ_{11}	$N\gamma$, helicity=1/2	

$\Delta(1900)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ — Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
7± 2	GUTZ	14	DPWA	Multichannel
7± 3	ANISOVICH	12A	DPWA	Multichannel
10± 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
8± 4	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8± 1	SHRESTHA	12A	DPWA	Multichannel
33±10	VRANA	00	DPWA	Multichannel
41± 4	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$
28	CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Sigma K$ — $(\Gamma_1\Gamma_2)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
<0.03	CANDLIN	84	DPWA	$\pi^+ p \rightarrow \Sigma^+ K^+$

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \rightarrow \Delta(1900) \rightarrow \Delta(1232)\pi$, 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. • • •				
+0.25±0.07	MANLEY	92	IPWA	$\pi N \rightarrow \pi N$ & $N\pi\pi$

$\Gamma(\Delta(1232)\pi$, D-wave$)/\Gamma_{total}$ — Γ_5/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
15^{+50}_{-10}	ANISOVICH	12A	DPWA	Multichannel
28± 1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
56± 6	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1900) \to N\rho$, S=1/2, S-wave — $(\Gamma_1\Gamma_7)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.14 ± 0.11	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S=1/2, S\text{-wave})/\Gamma_{total}$ — Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
30 ± 2	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
12 ± 4	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1900) \to N\rho$, S=3/2, D-wave — $(\Gamma_1\Gamma_8)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.37 ± 0.07	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{total}$ — Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5 ± 1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
23 ± 5	SHRESTHA	12A	DPWA	Multichannel

$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{total}$ in $N\pi \to \Delta(1900) \to N(1440)\pi$, S-wave — $(\Gamma_1\Gamma_9)^{1/2}/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.16 ± 0.11	MANLEY	92	IPWA	$\pi N \to \pi N$ & $N\pi\pi$

$\Gamma(N(1440)\pi, S\text{-wave})/\Gamma_{total}$ — Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
4 ± 1	VRANA	00	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<1	SHRESTHA	12A	DPWA	Multichannel

$\Gamma(\Delta(1232)\eta)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
1 ± 1	GUTZ	14	DPWA	Multichannel

$\Delta(1900)$ PHOTON DECAY AMPLITUDES

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

$\Delta(1900) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.057 ± 0.014	GUTZ	14	DPWA	Multichannel
0.059 ± 0.016	[4] ANISOVICH	12A	DPWA	Phase = $(60 \pm 25)^\circ$
-0.004 ± 0.016	CRAWFORD	83	IPWA	$\gamma N \to \pi N$
0.029 ± 0.008	AWAJI	81	DPWA	$\gamma N \to \pi N$

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

-0.082 ± 0.009	SHRESTHA	12A	DPWA Multichannel

Δ(1900) FOOTNOTES

[1] Fit to the amplitudes of HOEHLER 79.

[2] See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

[3] 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.

[4] This ANISOVICH 12A value is the complex helicity amplitude at the pole position.

Δ(1900) REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

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)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ARNDT	06	PR C74 045205	R.A. Arndt et al.	(GWU)
PDG	06	JP G33 1	W.-M. Yao et al.	(PDG Collab.)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
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) IJP
HOEHLER	79	PDAT 12-1	G. Hohler et al.	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre et al.	(LBL, SLAC)