$\Delta(1930)\ 5/2^-$

$I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$ Status: ***

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014).

$\Delta(1930)$ POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1820 to 1880 (≈ 1850) OUR ESTIMATE				
1812±10	SARANTSEV	25	DPWA	Multichannel
1821± 2	ROENCHEN	22	DPWA	Multichannel
1848± 9±19	[1] SVARC	14	L+P	$\pi N \to \pi N$
1890±50	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1863	HUNT	19	DPWA	Multichannel
1836	ROENCHEN	15A	DPWA	Multichannel
2001	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1883	VRANA	00	DPWA	Multichannel
1850	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

−2×IMAGINARY PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
300 to 450 (≈ 320) OUR ESTIMATE				
420±25	SARANTSEV	25	DPWA	Multichannel
447± 7	ROENCHEN	22	DPWA	Multichannel
321±17±7	[1] SVARC	14	L+P	$\pi N \to \pi N$
260±60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
260	HUNT	19	DPWA	Multichannel
724	ROENCHEN	15A	DPWA	Multichannel
387	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
250	VRANA	00	DPWA	Multichannel
180	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

$\Delta(1930)$ ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
8 to 20 (≈ 14) OUR ESTIMATE				
15±2	ROENCHEN	22	DPWA	Multichannel
9±1±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
18±6	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
34	ROENCHEN	15A	DPWA	Multichannel
7	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
20	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
−100 to −10 (≈ − 50) OUR ESTIMATE				
−108± 5	ROENCHEN	22	DPWA	Multichannel
− 37± 3±7	[1] SVARC	14	L+P	$\pi N \to \pi N$
− 20±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−155	ROENCHEN	15A	DPWA	Multichannel
− 12	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$

[1] Fit to the amplitudes of HOEHLER 79.

$\Delta(1930)$ INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to \Delta(1930) \to \Sigma K$

MODULUS	*PHASE* (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.010±0.001	**49 ± 5**	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.043	−0.5	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1930) \to \Delta\pi$, D-wave

MODULUS	*PHASE* (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.12±0.02	**64 ± 4**	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.15	30	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1930) \to \Delta\pi$, G-wave

MODULUS	*PHASE* (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.008±0.001	**148 ± 2**	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.009	121	ROENCHEN	15A	DPWA	Multichannel

$\Delta(1930)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1900 to 2000 (≈ 1950) OUR ESTIMATE				
1834± 10	SARANTSEV	25	DPWA	Multichannel
1988± 32	[1] HUNT	19	DPWA	Multichannel
2233± 53	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1940± 30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1901± 15	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1930± 12	[1] SHRESTHA	12A	DPWA	Multichannel
1932±100	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

Δ(1930) BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
200 to 400 (≈ 300) OUR ESTIMATE				
425± 25	SARANTSEV	25	DPWA	Multichannel
500±160	[1] HUNT	19	DPWA	Multichannel
773±187	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
320± 60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
195± 60	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
235± 39	[1] SHRESTHA	12A	DPWA	Multichannel
316±237	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

Δ(1930) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	5–15 %
Γ_2	$N\pi\pi$	
Γ_3	$\Delta(1232)\pi$	(33 ±9) %
Γ_4	$\Delta(1232)\pi$, *D*-wave	(28 ±7) %
Γ_5	$\Delta(1232)\pi$, *G*-wave	(5 ±5) %
Γ_6	$N\rho$	(33 ±8) %
Γ_7	$N\rho$, S=1/2	(3.0±2.0) %
Γ_8	$N\rho$, S=3/2 , *G*-wave	(30 ±8) %
Γ_9	$N\gamma$	0.0–0.01 %
Γ_{10}	$N\gamma$, helicity=1/2	0.0–0.005 %
Γ_{11}	$N\gamma$, helicity=3/2	0.0–0.004 %

Δ(1930) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
5 to 15 (≈ 10) OUR ESTIMATE				
9.5±0.1	[1] HUNT	19	DPWA	Multichannel
8.1±1.2	[1] ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
14 ±4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
4 ±3	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
7.9±0.4	[1] SHRESTHA	12A	DPWA	Multichannel
9 ±8	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Delta(1232)\pi)/\Gamma_{total}$ Γ_3/Γ

VALUE (%)	*DOCUMENT ID*		*TECN*	*COMMENT*
33±9	SARANTSEV	25	DPWA	Multichannel

$\Gamma(\Delta(1232)\pi, D\text{-wave})/\Gamma_{total}$ Γ_4/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
28±7	SARANTSEV	25	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5±5	SARANTSEV	25	DPWA	Multichannel

$\Gamma(N\rho)/\Gamma_{total}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
33±8	SARANTSEV	25	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
3±2	SARANTSEV	25	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
30±8	SARANTSEV	25	DPWA	Multichannel

$\Delta(1930)$ PHOTON DECAY AMPLITUDES AT THE POLE

$\Delta(1930) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.036±0.008	117 ± 30	SARANTSEV	25	DPWA	Multichannel
0.104±0.009	129 ± 8	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.270	33	ROENCHEN	15A	DPWA	Multichannel

$\Delta(1930) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.020±0.008	−150 ± 30	SARANTSEV	25	DPWA	Multichannel
0.322±0.022	142 ± 4	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.153	81	ROENCHEN	15A	DPWA	Multichannel

$\Delta(1930)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

$\Delta(1930) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.037±0.008	SARANTSEV	25	DPWA	Multichannel
−0.043±0.008	[1] HUNT	19	DPWA	Multichannel
−0.007±0.010	[1] ARNDT	96	IPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.011±0.003	[1] SHRESTHA	12A	DPWA	Multichannel

[1] Statistical error only.

$\Delta(1930) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.020 ± 0.008	SARANTSEV	25	DPWA	Multichannel
-0.020 ± 0.017	[1] HUNT	19	DPWA	Multichannel
0.005 ± 0.010	[1] ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.002 ± 0.002	[1] SHRESTHA	12A	DPWA	Multichannel

[1] Statistical error only.

$\Delta(1930)$ REFERENCES

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

SARANTSEV	25	PR C112 015202	A.V. Sarantsev *et al.*	(Bonn-Gatchina Collab.)
ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*	
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc *et al.*	(RBI Zagreb, UNI Tuzla)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
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