$\Delta(1920)\ 3/2^+$

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

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

Δ(1920) POLE POSITION

REAL PART

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1850 to 1950 (≈ 1900) OUR ESTIMATE				
1883± 2	ROENCHEN	22	DPWA	Multichannel
1875±30	SOKHOYAN	15A	DPWA	Multichannel
1906±10±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
1900±80	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1910	HUNT	19	DPWA	Multichannel
1715	ROENCHEN	15A	DPWA	Multichannel
1875±30	GUTZ	14	DPWA	Multichannel
1890±30	ANISOVICH	12A	DPWA	Multichannel
1880	VRANA	00	DPWA	Multichannel
1900	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*
200 to 400 (≈ 300) OUR ESTIMATE				
844± 5	ROENCHEN	22	DPWA	Multichannel
300± 40	SOKHOYAN	15A	DPWA	Multichannel
310± 20±11	[1] SVARC	14	L+P	$\pi N \to \pi N$
300±100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
472	HUNT	19	DPWA	Multichannel
882	ROENCHEN	15A	DPWA	Multichannel
300± 40	GUTZ	14	DPWA	Multichannel
300± 60	ANISOVICH	12A	DPWA	Multichannel
120	VRANA	00	DPWA	Multichannel

[1] Fit to the amplitudes of HOEHLER 79.

Δ(1920) ELASTIC POLE RESIDUE

MODULUS $|r|$

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
15 to 35 (≈ 25) OUR ESTIMATE				
41±3	ROENCHEN	22	DPWA	Multichannel
16±6	SOKHOYAN	15A	DPWA	Multichannel
26±3±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
24±4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
38	ROENCHEN	15A	DPWA	Multichannel

16±6	GUTZ	14	DPWA	Multichannel
17±8	ANISOVICH	12A	DPWA	Multichannel

[1] Fit to the amplitudes of HOEHLER 79.

PHASE θ

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−150 to −50 (≈ −100) OUR ESTIMATE				
11± 4	ROENCHEN	22	DPWA	Multichannel
− 50±25	SOKHOYAN	15A	DPWA	Multichannel
−130± 5±3	[1] SVARC	14	L+P	$\pi N \to \pi N$
−150±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
146	ROENCHEN	15A	DPWA	Multichannel
− 50±25	GUTZ	14	DPWA	Multichannel
− 40±20	ANISOVICH	12A	DPWA	Multichannel

[1] Fit to the amplitudes of HOEHLER 79.

Δ(1920) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \to \Delta(1920) \to \Delta\eta$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.15±0.04	70 ± 20	GUTZ	14	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.17±0.08	70 ± 20	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to \Sigma K$

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.20±0.01	104 ± 2	ROENCHEN	22	DPWA	Multichannel
0.09±0.03	80 ± 40	ANISOVICH	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.17	−35	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to \Delta\pi$, P-wave

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.057±0.003	−48 ± 3	ROENCHEN	22	DPWA	Multichannel
0.20 ±0.08	−105 ± 25	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.069	131	ROENCHEN	15A	DPWA	Multichannel
0.20 ±0.12	−120 ± 30	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to \Delta\pi$, F-wave

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.020±0.002	147 ± 4	ROENCHEN	22	DPWA	Multichannel
0.37 ±0.10	−90 ± 20	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.013	−115	ROENCHEN	15A	DPWA	Multichannel
0.28 ±0.07	−95 ± 35	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to N(1535)\pi$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.03±0.02	35 ± 45	GUTZ	14	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to N a_0(980)$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.03±0.02	−85 ± 45	GUTZ	14	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to N(1440)\pi$

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.04±0.03	undefined	SOKHOYAN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1920) \to N(1520)\pi$, S-wave

MODULUS	*PHASE (°)*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.05±0.05	undefined	SOKHOYAN	15A	DPWA	Multichannel

$\Delta(1920)$ BREIT-WIGNER MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1870 to 1970 (≈ 1920) OUR ESTIMATE				
1976± 49	HUNT	19	DPWA	Multichannel
1880± 30	SOKHOYAN	15A	DPWA	Multichannel
2146± 32	[1] SHRESTHA	12A	DPWA	Multichannel
1920± 80	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1868± 10	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1880± 30	GUTZ	14	DPWA	Multichannel
1900± 30	ANISOVICH	12A	DPWA	Multichannel
2057± 1	PENNER	02C	DPWA	Multichannel
1889±100	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Delta(1920)$ BREIT-WIGNER WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
240 to 360 (≈ 300) OUR ESTIMATE				
509±170	HUNT	19	DPWA	Multichannel
300± 40	SOKHOYAN	15A	DPWA	Multichannel
400± 80	[1] SHRESTHA	12A	DPWA	Multichannel
300±100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
220± 80	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
300± 40	GUTZ	14	DPWA	Multichannel
310± 60	ANISOVICH	12A	DPWA	Multichannel
525± 32	PENNER	02C	DPWA	Multichannel
123± 53	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

Δ(1920) DECAY MODES

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

	Mode	Fraction (Γ_i/Γ)
Γ_1	$N\pi$	5–20 %
Γ_2	ΣK	2–6 %
Γ_3	$N\pi\pi$	>46 %
Γ_4	$\Delta(1232)\pi$	>46 %
Γ_5	$\Delta(1232)\pi$, *P*-wave	2–28 %
Γ_6	$\Delta(1232)\pi$, *F*-wave	44–72 %
Γ_7	$N(1440)\pi$, *P*-wave	4–86 %
Γ_8	$N(1520)\pi$, *S*-wave	<5 %
Γ_9	$N(1535)\pi$	<2 %
Γ_{10}	$N a_0(980)$	seen
Γ_{11}	$\Delta(1232)\eta$	5–17 %
Γ_{12}	$N\gamma$	0.01–0.84 %
Γ_{13}	$N\gamma$, helicity=1/2	0.0–0.42 %
Γ_{14}	$N\gamma$, helicity=3/2	0.01–0.42 %

Δ(1920) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5–20 % OUR ESTIMATE				
10.5±3.0	[1] HUNT	19	DPWA	Multichannel
8 ±4	SOKHOYAN	15A	DPWA	Multichannel
20 ±5	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
14 ±4	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8 ±4	GUTZ	14	DPWA	Multichannel
8 ±4	ANISOVICH	12A	DPWA	Multichannel
16 ±4	[1] SHRESTHA	12A	DPWA	Multichannel
15 ±1	PENNER	02C	DPWA	Multichannel
5 ±4	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Sigma K)/\Gamma_{total}$ Γ_2/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
2–6 % OUR ESTIMATE				
4 ±2	ANISOVICH	12A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.1±0.3	PENNER	02C	DPWA	Multichannel

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

VALUE (%)	DOCUMENT ID		TECN	COMMENT
2–28 % OUR ESTIMATE				
< 1.6	[1] HUNT	19	DPWA	Multichannel
18 ±10	SOKHOYAN	15A	DPWA	Multichannel

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

22 ±12		ANISOVICH	12A	DPWA	Multichannel
7 ± 5	[1]	SHRESTHA	12A	DPWA	Multichannel
41 ± 3		VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{total}$ Γ_6/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
44–72 % OUR ESTIMATE				
58±14	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
45±20	ANISOVICH	12A	DPWA	Multichannel

$\Gamma(N(1440)\pi, P\text{-wave})/\Gamma_{total}$ Γ_7/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
4–86 % OUR ESTIMATE				
77±9	[1] HUNT	19	DPWA	Multichannel
< 4	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<20	[1] SHRESTHA	12A	DPWA	Multichannel
53±8	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

$\Gamma(N(1520)\pi, S\text{-wave})/\Gamma_{total}$ Γ_8/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<5 OUR ESTIMATE				
<5	SOKHOYAN	15A	DPWA	Multichannel

$\Gamma(N(1535)\pi)/\Gamma_{total}$ Γ_9/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<2 OUR ESTIMATE				
<2	GUTZ	14	DPWA	Multichannel

$\Gamma(N a_0(980))/\Gamma_{total}$ Γ_{10}/Γ

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

$\Gamma(\Delta(1232)\eta)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5–17 % OUR ESTIMATE				
11±6	GUTZ	14	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
15±8	ANISOVICH	12A	DPWA	Multichannel

Δ(1920) PHOTON DECAY AMPLITUDES AT THE POLE

Δ(1920) → Nγ, helicity-1/2 amplitude $A_{1/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.138±0.006	−8.9 ± 2.0	ROENCHEN	22	DPWA	Multichannel
0.110±0.030	−50 ± 20	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.192	46	ROENCHEN	15A	DPWA	Multichannel

Δ(1920) → Nγ, helicity-3/2 amplitude $A_{3/2}$

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.252±0.007	14 ± 2	ROENCHEN	22	DPWA	Multichannel
−0.100±0.040	0 ± 20	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.522	67	ROENCHEN	15A	DPWA	Multichannel

Δ(1920) BREIT-WIGNER PHOTON DECAY AMPLITUDES

Δ(1920) → Nγ, helicity-1/2 amplitude $A_{1/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.028±0.010	[1] HUNT	19	DPWA	Multichannel
0.110±0.030	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.110±0.030	GUTZ	14	DPWA	Multichannel
$0.130^{+0.030}_{-0.060}$	ANISOVICH	12A	DPWA	Multichannel
0.051±0.010	[1] SHRESTHA	12A	DPWA	Multichannel
−0.007	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

Δ(1920) → Nγ, helicity-3/2 amplitude $A_{3/2}$

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.043±0.014	[1] HUNT	19	DPWA	Multichannel
−0.105±0.035	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.105±0.035	GUTZ	14	DPWA	Multichannel
$-0.115^{+0.025}_{-0.050}$	ANISOVICH	12A	DPWA	Multichannel
0.017±0.015	[1] SHRESTHA	12A	DPWA	Multichannel
−0.001	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

$\Delta(1920)$ REFERENCES

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

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.*	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)
GUTZ	14	EPJ A50 74	E. Gutz *et al.*	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)
SVARC	14	PR C89 045205	A. Svarc *et al.*	(RBI Zagreb, UNI Tuzla)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
HORN	08A	EPJ A38 173	I. Horn *et al.*	(CB-ELSA Collab.)
Also		PRL 101 202002	I. Horn *et al.*	(CB-ELSA Collab.)
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
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