NODE=B019

$\Delta(1600)\ 3/2^+$

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

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

NODE=B019

$\Delta(1600)$ POLE POSITION

NODE=B019215

REAL PART

NODE=B019RE
NODE=B019RE

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
1470 to 1590 (≈ 1520) OUR ESTIMATE				→ UNCHECKED ←
1590± 1	ROENCHEN	22	DPWA	Multichannel
1515±20	SOKHOYAN	15A	DPWA	Multichannel
1469±10±5	[1] SVARC	14	L+P	$\pi N \to \pi N$
1550±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1619	HUNT	19	DPWA	Multichannel
1552	ROENCHEN	15A	DPWA	Multichannel
1498±25	ANISOVICH	12A	DPWA	Multichannel
1457	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1599	VRANA	00	DPWA	Multichannel
1550	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79.

NODE=B019RE;LINKAGE=SV

−2×IMAGINARY PART

NODE=B019IM
NODE=B019IM

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
150 to 320 (≈ 280) OUR ESTIMATE				→ UNCHECKED ←
136± 1	ROENCHEN	22	DPWA	Multichannel
250±30	SOKHOYAN	15A	DPWA	Multichannel
314±18±8	[1] SVARC	14	L+P	$\pi N \to \pi N$
200±60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
295	HUNT	19	DPWA	Multichannel
350	ROENCHEN	15A	DPWA	Multichannel
230±50	ANISOVICH	12A	DPWA	Multichannel
400	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
312	VRANA	00	DPWA	Multichannel

[1] Fit to the amplitudes of HOEHLER 79.

NODE=B019IM;LINKAGE=SV

$\Delta(1600)$ ELASTIC POLE RESIDUE

NODE=B019220

MODULUS $|r|$

NODE=B019RER
NODE=B019RER

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
10 to 40 (≈ 25) OUR ESTIMATE				→ UNCHECKED ←
11±1	ROENCHEN	22	DPWA	Multichannel
13±3	SOKHOYAN	15A	DPWA	Multichannel
38±2±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
17±4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
23	ROENCHEN	15A	DPWA	Multichannel
11±6	ANISOVICH	12A	DPWA	Multichannel
44	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN

[1] Fit to the amplitudes of HOEHLER 79.

NODE=B019RER;LINKAGE=SV

PHASE θ

NODE=B019IMR
NODE=B019IMR

VALUE (°)	*DOCUMENT ID*		*TECN*	*COMMENT*
180 to 250 (≈ 210) OUR ESTIMATE				→ UNCHECKED ←
−106± 1	ROENCHEN	22	DPWA	Multichannel
−155±20	SOKHOYAN	15A	DPWA	Multichannel
173± 5±5	[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. • • •				
−155	ROENCHEN	15A	DPWA	Multichannel
−160±33	ANISOVICH	12A	DPWA	Multichannel
+147	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN

[1] Fit to the amplitudes of HOEHLER 79.

NODE=B019IMR;LINKAGE=SV

Δ(1600) INELASTIC POLE RESIDUE

NODE=B019240

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

NODE=B019240

Normalized residue in $N\pi \rightarrow \Delta(1600) \rightarrow \Delta\pi$, P-wave

NODE=B019RS1
NODE=B019RS1

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.30±0.02	87 ± 2	ROENCHEN	22	DPWA	Multichannel
0.15±0.04	30 ± 35	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.31	31	ROENCHEN	15A	DPWA	Multichannel
0.14±0.10	154 ± 40	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \rightarrow \Delta(1600) \rightarrow \Delta\pi$, F-wave

NODE=B019RS2
NODE=B019RS2

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT	
0.004±0.0002	−62 ± 5	ROENCHEN	22	DPWA	Multichannel	OCCUR=2
0.010±0.005		SOKHOYAN	15A	DPWA	Multichannel	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.013	29	ROENCHEN	15A	DPWA	Multichannel	OCCUR=2
0.010±0.005		ANISOVICH	12A	DPWA	Multichannel	

Normalized residue in $N\pi \rightarrow \Delta(1600) \rightarrow \Sigma K$

NODE=B019A00
NODE=B019A00

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.14±0.01	14 ± 1	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.13	−5.6	ROENCHEN	15A	DPWA	Multichannel

Δ(1600) BREIT-WIGNER MASS

NODE=B019M

NODE=B019M

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1500 to 1640 (≈ 1570) OUR ESTIMATE				→ UNCHECKED ←
1664±16	[1] HUNT	19	DPWA	Multichannel
1520±20	SOKHOYAN	15A	DPWA	Multichannel
1600±50	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
1522±13	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1510±20	ANISOVICH	12A	DPWA	Multichannel
1626± 8	[1] SHRESTHA	12A	DPWA	Multichannel
1667± 1	PENNER	02C	DPWA	Multichannel
1687±44	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B019M;LINKAGE=A

Δ(1600) BREIT-WIGNER WIDTH

NODE=B019W

NODE=B019W

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
200 to 300 (≈ 250) OUR ESTIMATE				→ UNCHECKED ←
322± 46	[1] HUNT	19	DPWA	Multichannel
235± 30	SOKHOYAN	15A	DPWA	Multichannel
300±100	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
220± 40	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
220± 45	ANISOVICH	12A	DPWA	Multichannel
225± 18	[1] SHRESTHA	12A	DPWA	Multichannel
397± 10	PENNER	02C	DPWA	Multichannel
493± 75	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B019W;LINKAGE=A

Δ(1600) DECAY MODES

NODE=B019225;NODE=B019

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

NODE=B019

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$N\pi$	8–24%	DESIG=1
Γ_2	$N\pi\pi$	58–84 %	DESIG=11;OUR EST
Γ_3	$\Delta(1232)\pi$	58–82 %	DESIG=22;OUR EST
Γ_4	$\Delta(1232)\pi$, P-wave	72–82%	DESIG=3
Γ_5	$\Delta(1232)\pi$, F-wave	<2%	DESIG=4
Γ_6	$N(1440)\pi$	17–27%	DESIG=24
Γ_7	$N\gamma$	0.001–0.035 %	DESIG=25;OUR EST
Γ_8	$N\gamma$, helicity=1/2	0.0–0.02 %	DESIG=9;OUR EST
Γ_9	$N\gamma$, helicity=3/2	0.001–0.015 %	DESIG=10;OUR EST

Δ(1600) BRANCHING RATIOS

NODE=B019230

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

NODE=B019R1
NODE=B019R1

VALUE (%)	DOCUMENT ID		TECN	COMMENT
8–24% OUR ESTIMATE				→ UNCHECKED ←
10.7±1.9	[1] HUNT	19	DPWA	Multichannel
14 ±4	SOKHOYAN	15A	DPWA	Multichannel
18 ±4	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
21 ±6	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
12 ±5	ANISOVICH	12A	DPWA	Multichannel
8 ±2	[1] SHRESTHA	12A	DPWA	Multichannel
13 ±1	PENNER	02C	DPWA	Multichannel
28 ±5	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B019R1;LINKAGE=A

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

NODE=B019R8
NODE=B019R8

VALUE (%)	DOCUMENT ID		TECN	COMMENT
72–82% OUR ESTIMATE				→ UNCHECKED ←
64± 6	[1] HUNT	19	DPWA	Multichannel
77± 5	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
78± 6	ANISOVICH	12A	DPWA	Multichannel
70± 3	[1] SHRESTHA	12A	DPWA	Multichannel
59±10	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B019R8;LINKAGE=A

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

NODE=B019R10
NODE=B019R10

VALUE (%)	DOCUMENT ID		TECN	COMMENT
<2% OUR ESTIMATE				→ UNCHECKED ←
<2	SOKHOYAN	15A	DPWA	Multichannel

$\Gamma(N(1440)\pi)/\Gamma_{total}$ Γ_6/Γ

NODE=B019R9
NODE=B019R9

VALUE (%)	DOCUMENT ID		TECN	COMMENT
17–27% OUR ESTIMATE				→ UNCHECKED ←
22±5	[1] HUNT	19	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
22±3	[1] SHRESTHA	12A	DPWA	Multichannel
13±4	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B019R9;LINKAGE=A

Δ(1600) PHOTON DECAY AMPLITUDES AT THE POLE

NODE=B019260

Δ(1600) → $N\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B019PA1
NODE=B019PA1

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.025±0.005	0.5 ± 3.0	ROENCHEN	22	DPWA	Multichannel
0.053±0.010	130 ± 15	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.230	−42	ROENCHEN	15A	DPWA	Multichannel

$\Delta(1600) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

NODE=B019PA2
NODE=B019PA2

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
-0.006 ± 0.0013	62 ± 32	ROENCHEN	22	DPWA	Multichannel
0.055 ± 0.010	152 ± 15	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.332	-71	ROENCHEN	15A	DPWA	Multichannel

$\Delta(1600)$ BREIT-WIGNER PHOTON DECAY AMPLITUDES

NODE=B019235

$\Delta(1600) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B019A1
NODE=B019A1

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.060 to -0.030 (≈ -0.045) OUR ESTIMATE				→ UNCHECKED ←
0.0082 ± 0.0014	[1] HUNT	19	DPWA	Multichannel
-0.051 ± 0.010	SOKHOYAN	15A	DPWA	Multichannel
-0.018 ± 0.015	[1] ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.050 ± 0.009	ANISOVICH	12A	DPWA	Multichannel
0.006 ± 0.005	[1] SHRESTHA	12A	DPWA	Multichannel
0.0	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

NODE=B019A1;LINKAGE=A

$\Delta(1600) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

NODE=B019A2
NODE=B019A2

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
-0.050 to -0.020 (≈ -0.035) OUR ESTIMATE				→ UNCHECKED ←
0.048 ± 0.014	[1] HUNT	19	DPWA	Multichannel
-0.055 ± 0.010	SOKHOYAN	15A	DPWA	Multichannel
-0.025 ± 0.015	[1] ARNDT	96	IPWA	$\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.040 ± 0.012	ANISOVICH	12A	DPWA	Multichannel
0.052 ± 0.008	[1] SHRESTHA	12A	DPWA	Multichannel
-0.024	PENNER	02D	DPWA	Multichannel

[1] Statistical error only.

NODE=B019A2;LINKAGE=A

$\Delta(1600)$ REFERENCES

NODE=B019

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

NODE=B019

ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)	REFID=61999
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley		REFID=59985
ROENCHEN	15A	EPJ A51 70	D. Roenchen *et al.*		REFID=58183
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan *et al.*	(CBELSA/TAPS Collab.)	REFID=56757
PDG	14	CP C38 070001	K. Olive *et al.*	(PDG Collab.)	REFID=55687
SVARC	14	PR C89 045205	A. Svarc *et al.*	(RBI Zagreb, UNI Tuzla)	REFID=55775
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich *et al.*	(BONN, PNPI)	REFID=54041
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)	REFID=54862
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)	REFID=51535
PENNER	02C	PR C66 055211	G. Penner, U. Mosel	(GIES)	REFID=49129
PENNER	02D	PR C66 055212	G. Penner, U. Mosel	(GIES)	REFID=49130
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)	REFID=47593
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)	REFID=44675
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	REFID=43821
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky *et al.*	(CMU, LBL) IJP	REFID=30064
Also		PR D20 2839	R.E. Cutkosky *et al.*	(CMU, LBL) IJP	REFID=40096
HOEHLER	79	PDAT 12-1	G. Hohler *et al.*	(KARLT) IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP	REFID=30859