NODE=B011

$\Delta(1905)\ 5/2^+$

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

Older and obsolete values are listed and referenced in the 2014 edition, Chinese Physics **C38** 070001 (2014). NODE=B011

Δ(1905) POLE POSITION

NODE=B011215

REAL PART

NODE=B011RE
NODE=B011RE

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1750 to 1800 (≈ 1770) OUR ESTIMATE				→ UNCHECKED ←
1795±20	SARANTSEV	25	DPWA	Multichannel
1707± 1	ROENCHEN	22	DPWA	Multichannel
1752± 3±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
1830±40	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1819	HUNT	19	DPWA	Multichannel
1795	ROENCHEN	15A	DPWA	Multichannel
1800± 6	SOKHOYAN	15A	DPWA	Multichannel
1800± 6	GUTZ	14	DPWA	Multichannel
1819	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
1793	VRANA	00	DPWA	Multichannel
1829	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79. NODE=B011RE;LINKAGE=SV

−2×IMAGINARY PART

NODE=B011IM
NODE=B011IM

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
260 to 340 (≈ 300) OUR ESTIMATE				→ UNCHECKED ←
280±20	SARANTSEV	25	DPWA	Multichannel
127± 4	ROENCHEN	22	DPWA	Multichannel
346± 6±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
280±60	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
253	HUNT	19	DPWA	Multichannel
247	ROENCHEN	15A	DPWA	Multichannel
290±15	SOKHOYAN	15A	DPWA	Multichannel
290±15	GUTZ	14	DPWA	Multichannel
247	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
302	VRANA	00	DPWA	Multichannel
303	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79. NODE=B011IM;LINKAGE=SV

Δ(1905) ELASTIC POLE RESIDUE

NODE=B011220

MODULUS |r|

NODE=B011RER
NODE=B011RER

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
15 to 25 (≈ 20) OUR ESTIMATE				→ UNCHECKED ←
3.7±1.0	ROENCHEN	22	DPWA	Multichannel
19 ±2	SOKHOYAN	15A	DPWA	Multichannel
24 ±1 ±1	[1] SVARC	14	L+P	$\pi N \to \pi N$
25 ±8	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
5.3	ROENCHEN	15A	DPWA	Multichannel
19 ±2	GUTZ	14	DPWA	Multichannel
20 ±2	ANISOVICH	12A	DPWA	Multichannel
15	ARNDT	06	DPWA	$\pi N \to \pi N, \eta N$
25	HOEHLER	93	SPED	$\pi N \to \pi N$

[1] Fit to the amplitudes of HOEHLER 79. NODE=B011RER;LINKAGE=SV

PHASE θ

NODE=B011IMR
NODE=B011IMR

VALUE (°)	DOCUMENT ID		TECN	COMMENT
−120 to −30 (≈ −45) OUR ESTIMATE				→ UNCHECKED ←
− 92± 6	ROENCHEN	22	DPWA	Multichannel
− 45± 4	SOKHOYAN	15A	DPWA	Multichannel
−114± 1±2	[1] SVARC	14	L+P	$\pi N \to \pi N$
− 50±20	CUTKOSKY	80	IPWA	$\pi N \to \pi N$

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

− 89	ROENCHEN	15A	DPWA	Multichannel
− 45± 4	GUTZ	14	DPWA	Multichannel
− 44± 5	ANISOVICH	12A	DPWA	Multichannel
− 30	ARNDT	06	DPWA	$\pi N \to \pi N$, ηN

[1] Fit to the amplitudes of HOEHLER 79.

NODE=B011IMR;LINKAGE=SV

Δ(1905) INELASTIC POLE RESIDUE

NODE=B011240

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

NODE=B011240

Normalized residue in $N\pi \to \Delta(1905) \to \Delta\pi$, P-wave

NODE=B011RS1
NODE=B011RS1

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.10 ±0.01	−109 ± 7	ROENCHEN	22	DPWA	Multichannel
0.19 ±0.07	10 ± 30	SOKHOYAN	15A	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.0870	72	ROENCHEN	15A	DPWA	Multichannel
0.25 ±0.06	0 ± 15	ANISOVICH	12A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1905) \to \Delta\pi$, F-wave

NODE=B011A00
NODE=B011A00

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.017±0.002	18 ± 8	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.009	64	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1905) \to \Sigma K$

NODE=B011A01
NODE=B011A01

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.0020±0.0002	154 ± 6	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.001	−155	ROENCHEN	15A	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1905) \to N(1535)\pi$

NODE=B011RS2
NODE=B011RS2

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.025±0.010	130 ± 35	GUTZ	14	DPWA	Multichannel

Normalized residue in $N\pi \to \Delta(1905) \to \Delta(1232)\eta$

NODE=B011RS3
NODE=B011RS3

MODULUS	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.07±0.02	40 ± 20	GUTZ	14	DPWA	Multichannel

Δ(1905) BREIT-WIGNER MASS

NODE=B011M

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1855 to 1910 (≈ 1880) OUR ESTIMATE				
1845 ±20	SARANTSEV	25	DPWA	Multichannel
1883 ±19	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$
1866 ± 9	[1] HUNT	19	DPWA	Multichannel
1857.8± 1.6	[1] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
1910 ±30	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
1905 ±20	HOEHLER	79	IPWA	$\pi N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1856 ± 6	SOKHOYAN	15A	DPWA	Multichannel
1856 ± 6	GUTZ	14	DPWA	Multichannel
1818 ± 8	[1] SHRESTHA	12A	DPWA	Multichannel
1873 ±77	VRANA	00	DPWA	Multichannel

NODE=B011M
→ UNCHECKED ←

[1] Statistical error only.

NODE=B011M;LINKAGE=A

Δ(1905) BREIT-WIGNER WIDTH

NODE=B011W

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
270 to 400 (≈ 330) OUR ESTIMATE				
315 ± 20	SARANTSEV	25	DPWA	Multichannel
327 ± 69	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$
289 ± 20	[1] HUNT	19	DPWA	Multichannel
320.6± 8.6	[1] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
400 ±100	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
260 ± 20	HOEHLER	79	IPWA	$\pi N \to \pi N$

NODE=B011W
→ UNCHECKED ←

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

325 ± 15	SOKHOYAN	15A	DPWA	Multichannel
325 ± 15	GUTZ	14	DPWA	Multichannel
278 ± 18	[1] SHRESTHA	12A	DPWA	Multichannel
461 ±111	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B011W;LINKAGE=A

Δ(1905) DECAY MODES

NODE=B011225;NODE=B011

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

NODE=B011

	Mode	Fraction (Γ_i/Γ)	
Γ_1	$N\pi$	9–15%	DESIG=1
Γ_2	$N\pi\pi$	>65%	DESIG=3
Γ_3	$\Delta(1232)\pi$	>48%	DESIG=181;OUR EST
Γ_4	$\Delta(1232)\pi$, P-wave	8–43%	DESIG=4
Γ_5	$\Delta(1232)\pi$, F-wave	40–58%	DESIG=5
Γ_6	$N\rho$	(25±10) %	DESIG=186
Γ_7	$N\rho$, S=3/2, P-wave	17–35%	DESIG=7
Γ_8	$N(1535)\pi$	< 1 %	DESIG=11
Γ_9	$N(1680)\pi$, P-wave	5–15%	DESIG=13
Γ_{10}	$\Delta(1232)\eta$	2–6%	DESIG=12
Γ_{11}	$N\gamma$	0.012–0.036 %	DESIG=185;OUR EST
Γ_{12}	$N\gamma$, helicity=1/2	0.002–0.006 %	DESIG=9;OUR EST
Γ_{13}	$N\gamma$, helicity=3/2	0.01–0.03 %	DESIG=10;OUR EST

Δ(1905) BRANCHING RATIOS

NODE=B011230

$\Gamma(N\pi)/\Gamma_{total}$ Γ_1/Γ

NODE=B011R1
NODE=B011R1

VALUE (%)	DOCUMENT ID		TECN	COMMENT
9–15% OUR ESTIMATE				→ UNCHECKED ←
13 ±4	SEIFEN	25	DPWA	Multichannel
17 ±1	[1] HUNT	19	DPWA	Multichannel
12.2±0.1	[1] ARNDT	06	DPWA	$\pi N \to \pi N$, ηN
8 ±3	CUTKOSKY	80	IPWA	$\pi N \to \pi N$
15 ±2	HOEHLER	79	IPWA	$\pi N \to \pi N$

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

13 ±2	SOKHOYAN	15A	DPWA	Multichannel
13 ±2	GUTZ	14	DPWA	Multichannel
6 ±1	[1] SHRESTHA	12A	DPWA	Multichannel
9 ±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B011R1;LINKAGE=A

$\Gamma(N\pi\pi)/\Gamma_{total}$ Γ_2/Γ

NODE=B011R00
NODE=B011R00

VALUE	DOCUMENT ID		TECN	COMMENT
>65% OUR ESTIMATE				→ UNCHECKED ←
0.85±0.15	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+\pi^- p$

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

NODE=B011R04
NODE=B011R04

VALUE (%)	DOCUMENT ID		TECN	COMMENT
19±8	SARANTSEV	25	DPWA	Multichannel

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

NODE=B011R8
NODE=B011R8

VALUE (%)	DOCUMENT ID		TECN	COMMENT
8–43% OUR ESTIMATE				→ UNCHECKED ←
14 ± 7	SARANTSEV	25	DPWA	Multichannel
20 ±12	SEIFEN	25	DPWA	Multichannel
8.4± 0.5	[1] HUNT	19	DPWA	Multichannel

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

33 ±10	SOKHOYAN	15A	DPWA	Multichannel
28 ± 7	[1] SHRESTHA	12A	DPWA	Multichannel
23 ± 1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B011R8;LINKAGE=A

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

NODE=B011R7
NODE=B011R7

VALUE (%)	DOCUMENT ID		TECN	COMMENT
40–58% OUR ESTIMATE				→ UNCHECKED ←
5±3	SARANTSEV	25	DPWA	Multichannel
49±9	[1] HUNT	19	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
64±8	[1] SHRESTHA	12A	DPWA	Multichannel
44±1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B011R7;LINKAGE=A

$\Gamma(N\rho)/\Gamma_{total}$ Γ_6/Γ

NODE=B011R05
NODE=B011R05

VALUE (%)	DOCUMENT ID		TECN	COMMENT
25±10	SARANTSEV	25	DPWA	Multichannel

$\Gamma(N\rho, S{=}3/2, P\text{-wave})/\Gamma_{total}$ Γ_7/Γ

NODE=B011R6
NODE=B011R6

VALUE (%)	DOCUMENT ID		TECN	COMMENT
17–35% OUR ESTIMATE				→ UNCHECKED ←
25±10	SARANTSEV	25	DPWA	Multichannel
26± 9	[1] HUNT	19	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
< 6	[1] SHRESTHA	12A	DPWA	Multichannel
24± 1	VRANA	00	DPWA	Multichannel

[1] Statistical error only.

NODE=B011R6;LINKAGE=A

$\Gamma(N(1535)\pi)/\Gamma_{total}$ Γ_8/Γ

NODE=B011R01
NODE=B011R01

VALUE (%)	DOCUMENT ID		TECN	COMMENT
< 1 % OUR ESTIMATE				→ UNCHECKED ←
<1	SEIFEN	25	DPWA	Multichannel
<1	GUTZ	14	DPWA	Multichannel

$\Gamma(N(1680)\pi, P\text{-wave})/\Gamma_{total}$ Γ_9/Γ

NODE=B011R03
NODE=B011R03

VALUE (%)	DOCUMENT ID		TECN	COMMENT
5–15% OUR ESTIMATE				→ UNCHECKED ←
6±2	SEIFEN	25	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10±5	SOKHOYAN	15A	DPWA	Multichannel

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

NODE=B011R02
NODE=B011R02

VALUE (%)	DOCUMENT ID		TECN	COMMENT
2–6% OUR ESTIMATE				→ UNCHECKED ←
4±2	GUTZ	14	DPWA	Multichannel

$\Delta(1905)$ PHOTON DECAY AMPLITUDES AT THE POLE

NODE=B011260

$\Delta(1905) \to N\gamma$, helicity-1/2 amplitude $A_{1/2}$

NODE=B011PA1
NODE=B011PA1

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
0.030±0.007	−35 ± 15	SARANTSEV	25	DPWA	Multichannel
0.055±0.004	−159 ± 2	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.053	89	ROENCHEN	15A	DPWA	Multichannel
0.025±0.005	−28 ± 12	SOKHOYAN	15A	DPWA	Multichannel

$\Delta(1905) \to N\gamma$, helicity-3/2 amplitude $A_{3/2}$

NODE=B011PA2
NODE=B011PA2

MODULUS ($GeV^{-1/2}$)	PHASE (°)	DOCUMENT ID		TECN	COMMENT
−0.072±0.010	−10 ± 20	SARANTSEV	25	DPWA	Multichannel
−0.168±0.020	172 ± 0.9	ROENCHEN	22	DPWA	Multichannel
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.030	80	ROENCHEN	15A	DPWA	Multichannel
−0.050±0.004	5 ± 10	SOKHOYAN	15A	DPWA	Multichannel

Δ(1905) BREIT-WIGNER PHOTON DECAY AMPLITUDES

NODE=B011235

Δ(1905) → Nγ, helicity-1/2 amplitude $A_{1/2}$

NODE=B011A1
NODE=B011A1

→ UNCHECKED ←

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
0.017 to 0.027 (≈ 0.022) OUR ESTIMATE				
0.032±0.008	SARANTSEV	25	DPWA	Multichannel
0.019±0.0076	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+ \pi^- p$
0.077±0.010	[1] HUNT	19	DPWA	Multichannel
0.020±0.002	[1] DUGGER	13	DPWA	$\gamma N \to \pi N$
0.019±0.002	[1] WORKMAN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.025±0.005	SOKHOYAN	15A	DPWA	Multichannel
0.025±0.005	GUTZ	14	DPWA	Multichannel
0.066±0.018	[1] SHRESTHA	12A	DPWA	Multichannel
0.018	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

NODE=B011A1;LINKAGE=A

Δ(1905) → Nγ, helicity-3/2 amplitude $A_{3/2}$

NODE=B011A2
NODE=B011A2

→ UNCHECKED ←

VALUE ($GeV^{-1/2}$)	DOCUMENT ID		TECN	COMMENT
−0.055 to −0.035 (≈ −0.045) OUR ESTIMATE				
−0.075 ±0.010	SARANTSEV	25	DPWA	Multichannel
−0.0432±0.0173	GOLOVATCH	19	DPWA	$\gamma p \to \pi^+ \pi^- p$
−0.053 ±0.029	[1] HUNT	19	DPWA	Multichannel
−0.049 ±0.005	[1] DUGGER	13	DPWA	$\gamma N \to \pi N$
−0.038 ±0.004	WORKMAN	12A	DPWA	$\gamma N \to \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.050 ±0.005	SOKHOYAN	15A	DPWA	Multichannel
−0.050 ±0.005	GUTZ	14	DPWA	Multichannel
−0.223 ±0.029	[1] SHRESTHA	12A	DPWA	Multichannel
−0.028	DRECHSEL	07	DPWA	$\gamma N \to \pi N$

[1] Statistical error only.

NODE=B011A2;LINKAGE=A

Δ(1905) REFERENCES

NODE=B011

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

NODE=B011

SARANTSEV	25	PR C112 015202	A.V. Sarantsev *et al.*	(Bonn-Gatchina Collab.)	REFID=63294
SEIFEN	25	EPJ A61 173	T. Seifen *et al.*	(CBELSA/TAPS Collab.)	REFID=63593
ROENCHEN	22	EPJ A58 229	D. Roenchen *et al.*	(JULI, GWU, BONN+)	REFID=61999
GOLOVATCH	19	PL B788 371	E. Golovatch *et al.*	(CLAS Collab.)	REFID=59418
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
GUTZ	14	EPJ A50 74	E. Gutz *et al.*	(CBELSA/TAPS Collab.)	REFID=55697
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
DUGGER	13	PR C88 065203	M. Dugger *et al.*	(JLab CLAS Collab.)	REFID=55645
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
WORKMAN	12A	PR C86 015202	R. Workman *et al.*	(GWU)	REFID=54335
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)	REFID=52105
ARNDT	06	PR C74 045205	R.A. Arndt *et al.*	(GWU)	REFID=51535
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)	REFID=47593
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