

$N(1680) 5/2^+$ $I(J^P) = \frac{1}{2}(\frac{5}{2}^+)$ Status: ****

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

 $N(1680)$ POLE POSITION**REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1665 to 1680 (\approx 1675) OUR ESTIMATE			
1678 \pm 5	SOKHOYAN	15A	DPWA Multichannel
1674 \pm 2 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
1667 \pm 5	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1668	HUNT	19	DPWA Multichannel
1669	ROENCHEN	15A	DPWA Multichannel
1660	SHKLYAR	13	DPWA Multichannel
1676 \pm 6	ANISOVICH	12A	DPWA Multichannel
1666 \pm 8	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
1674	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1667	VRANA	00	DPWA Multichannel
1673	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

– 2×IMAGINARY PART

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
110 to 135 (\approx 120) OUR ESTIMATE			
113 \pm 4	SOKHOYAN	15A	DPWA Multichannel
129 \pm 3 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
110 \pm 10	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
118	HUNT	19	DPWA Multichannel
100	ROENCHEN	15A	DPWA Multichannel
98	SHKLYAR	13	DPWA Multichannel
113 \pm 4	ANISOVICH	12A	DPWA Multichannel
135 \pm 6	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
115	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
122	VRANA	00	DPWA Multichannel
135	HOEHLER	93	ARGD $\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

 $N(1680)$ ELASTIC POLE RESIDUE**MODULUS $|r|$**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
35 to 45 (\approx 40) OUR ESTIMATE			
45 \pm 4	SOKHOYAN	15A	DPWA Multichannel
44 \pm 1 \pm 1	¹ SVARC	14	L+P $\pi N \rightarrow \pi N$
34 \pm 2	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

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

34	ROENCHEN	15A	DPWA	Multichannel
33	SHKLYAR	13	DPWA	Multichannel
43±4	ANISOVICH	12A	DPWA	Multichannel
44	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
42	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
44	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

PHASE θ

<u>VALUE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
------------------	--------------------	-------------	----------------

–20 to 10 (≈ -5) OUR ESTIMATE

5±10	SOKHOYAN	15A	DPWA	Multichannel
–16± 1±1	¹ SVARC	14	L+P	$\pi N \rightarrow \pi N$
–25± 5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$

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

–19	ROENCHEN	15A	DPWA	Multichannel
–32	SHKLYAR	13	DPWA	Multichannel
– 2±10	ANISOVICH	12A	DPWA	Multichannel
–19	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
– 4	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
–17	HOEHLER	93	ARGD	$\pi N \rightarrow \pi N$

¹ Fit to the amplitudes of HOEHLER 79.

N(1680) INELASTIC POLE RESIDUE

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

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Delta\pi, P\text{-wave}$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
----------------	------------------	--------------------	-------------	----------------

0.15±0.03	–60 ± 30	SOKHOYAN	15A	DPWA	Multichannel
-----------	----------	----------	-----	------	--------------

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

0.15±0.03	–70 ± 45	ANISOVICH	12A	DPWA	Multichannel
-----------	----------	-----------	-----	------	--------------

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Delta\pi, F\text{-wave}$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
----------------	------------------	--------------------	-------------	----------------

0.23±0.04	90 ± 12	SOKHOYAN	15A	DPWA	Multichannel
-----------	---------	----------	-----	------	--------------

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

0.23±0.04	85 ± 15	ANISOVICH	12A	DPWA	Multichannel
-----------	---------	-----------	-----	------	--------------

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow N\eta$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
----------------	------------------	--------------------	-------------	----------------

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

0.027	136	ROENCHEN	15A	DPWA	Multichannel
-------	-----	----------	-----	------	--------------

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Lambda K$

<u>MODULUS</u>	<u>PHASE (°)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
----------------	------------------	--------------------	-------------	----------------

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

0.001	90	ROENCHEN	15A	DPWA	Multichannel
-------	----	----------	-----	------	--------------

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow \Sigma K$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.004	148	ROENCHEN	15A DPWA	Multichannel

Normalized residue in $N\pi \rightarrow N(1680) \rightarrow N(\pi\pi)_{S=0}^{I=0}$

<u>MODULUS</u>	<u>PHASE ($^{\circ}$)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.29 \pm 0.06	-45 \pm 15	SOKHOYAN	15A DPWA	Multichannel
0.26 \pm 0.04	-56 \pm 15	ANISOVICH	12A DPWA	Multichannel

 $N(1680)$ BREIT-WIGNER MASS

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
1680 to 1690 (\approx 1685) OUR ESTIMATE			
1686 \pm 5	GOLOVATCH	19 DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
1681.0 \pm 0.1	¹ HUNT	19 DPWA	Multichannel
1690 \pm 5	SOKHOYAN	15A DPWA	Multichannel
1676 \pm 2	¹ SHKLYAR	13 DPWA	Multichannel
1680.1 \pm 0.2	¹ ARNDT	06 DPWA	$\pi N \rightarrow \pi N, \eta N$
1680 \pm 10	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
1684 \pm 3	HOEHLER	79 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1689 \pm 6	ANISOVICH	12A DPWA	Multichannel
1682.7 \pm 0.5	¹ SHRESTHA	12A DPWA	Multichannel
1680 \pm 7	BATINIC	10 DPWA	$\pi N \rightarrow N\pi, N\eta$
1679 \pm 3	VRANA	00 DPWA	Multichannel

¹Statistical error only. **$N(1680)$ BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
115 to 130 (\approx 120) OUR ESTIMATE			
118 \pm 20	GOLOVATCH	19 DPWA	$\gamma p \rightarrow \pi^+ \pi^- p$
123 \pm 3	¹ HUNT	19 DPWA	Multichannel
119 \pm 4	SOKHOYAN	15A DPWA	Multichannel
115 \pm 1	¹ SHKLYAR	13 DPWA	Multichannel
128.0 \pm 1.1	¹ ARNDT	06 DPWA	$\pi N \rightarrow \pi N, \eta N$
120 \pm 10	CUTKOSKY	80 IPWA	$\pi N \rightarrow \pi N$
128 \pm 8	HOEHLER	79 IPWA	$\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
118 \pm 6	ANISOVICH	12A DPWA	Multichannel
126 \pm 1	¹ SHRESTHA	12A DPWA	Multichannel
142 \pm 7	BATINIC	10 DPWA	$\pi N \rightarrow N\pi, N\eta$
128 \pm 9	VRANA	00 DPWA	Multichannel

¹Statistical error only.

$N(1680)$ DECAY MODES

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

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	60–70 %
Γ_2 $N\eta$	<1 %
Γ_3 $N\pi\pi$	28–53 %
Γ_4 $\Delta(1232)\pi$	11–23 %
Γ_5 $\Delta(1232)\pi$, P -wave	4–10 %
Γ_6 $\Delta(1232)\pi$, F -wave	1–13 %
Γ_7 $N\rho$	8–11 %
Γ_8 $N\rho$, $S=3/2$, P -wave	6–8 %
Γ_9 $N\rho$, $S=3/2$, F -wave	2–3 %
Γ_{10} $N\sigma$	9–19 %
Γ_{11} $p\gamma$	0.21–0.32 %
Γ_{12} $p\gamma$, helicity=1/2	0.001–0.011 %
Γ_{13} $p\gamma$, helicity=3/2	0.20–0.32 %
Γ_{14} $n\gamma$	0.021–0.046 %
Γ_{15} $n\gamma$, helicity=1/2	0.004–0.029 %
Γ_{16} $n\gamma$, helicity=3/2	0.01–0.024 %

 $N(1680)$ BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
60 to 70 (≈ 65) OUR ESTIMATE					
68.0 \pm 0.1	¹ HUNT	19	DPWA	Multichannel	
62 \pm 4	SOKHOYAN	15A	DPWA	Multichannel	
68 \pm 1	¹ SHKLYAR	13	DPWA	Multichannel	
70.1 \pm 0.1	¹ ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$	
62 \pm 5	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$	
65 \pm 2	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$	
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●					
64 \pm 5	ANISOVICH	12A	DPWA	Multichannel	
68.0 \pm 0.5	¹ SHRESTHA	12A	DPWA	Multichannel	
67 \pm 3	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$	
69 \pm 2	VRANA	00	DPWA	Multichannel	

¹Statistical error only.

$\Gamma(N\eta)/\Gamma_{\text{total}}$					Γ_2/Γ
VALUE (%)	DOCUMENT ID	TECN	COMMENT		
0.2 \pm 0.1	MUELLER	20	DPWA	Multichannel	
0.09 \pm 0.02	¹ HUNT	19	DPWA	Multichannel	
<1	SHKLYAR	13	DPWA	Multichannel	
0.15 ^{+0.35} _{-0.10}	TIATOR	99	DPWA	$\gamma p \rightarrow p\eta$	

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

1.0 ±0.3	¹ SHRESTHA	12A	DPWA	Multichannel
0.4 ±0.2	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
<1	THOMA	08	DPWA	Multichannel
0 ±1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

$\Gamma(N\pi\pi)/\Gamma_{\text{total}}$ Γ_3/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
28–53 % OUR ESTIMATE			
24±4	GOLOVATCH	19	DPWA $\gamma p \rightarrow \pi^+ \pi^- p$

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
13 ±1	¹ HUNT	19	DPWA Multichannel
7 ±3	SOKHOYAN	15A	DPWA Multichannel

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

5 ±3	ANISOVICH	12A	DPWA	Multichannel
10.5±0.9	¹ SHRESTHA	12A	DPWA	Multichannel
14 ±3	VRANA	00	DPWA	Multichannel

¹Statistical error only.

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
< 0.3	¹ HUNT	19	DPWA Multichannel
10 ±3	SOKHOYAN	15A	DPWA Multichannel

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

10 ±3	ANISOVICH	12A	DPWA	Multichannel
1.0±0.1	¹ SHRESTHA	12A	DPWA	Multichannel
1 ±1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

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

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
6–8 % OUR ESTIMATE			
7±1	¹ HUNT	19	DPWA Multichannel

¹Statistical error only.

$\Gamma(N\rho, S=3/2, F\text{-wave})/\Gamma_{\text{total}}$ Γ_9/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
2–3 % OUR ESTIMATE			
2.4±0.4	¹ HUNT	19	DPWA Multichannel

¹Statistical error only.

$\Gamma(N\sigma)/\Gamma_{\text{total}}$ Γ_{10}/Γ

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
8.7±1.5	¹ HUNT	19	DPWA Multichannel
14 ±5	SOKHOYAN	15A	DPWA Multichannel

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

14 ± 7	ANISOVICH	12A	DPWA	Multichannel
9.4 ± 0.8	¹ SHRESTHA	12A	DPWA	Multichannel
9 ± 1	VRANA	00	DPWA	Multichannel

¹Statistical error only.

N(1680) PHOTON DECAY AMPLITUDES AT THE POLE

N(1680) → pγ, helicity-1/2 amplitude A_{1/2}

MODULUS (GeV ^{-1/2})	PHASE (°)	DOCUMENT ID	TECN	COMMENT
-0.013 ± 0.003	-20 ± 17	SOKHOYAN	15A	DPWA Multichannel
-0.013 ^{+0.002} _{-0.005}	-42 ⁺⁹ ₋₁₈	ROENCHEN	14	DPWA

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

-0.022	-28	ROENCHEN	15A	DPWA Multichannel
--------	-----	----------	-----	-------------------

N(1680) → pγ, helicity-3/2 amplitude A_{3/2}

MODULUS (GeV ^{-1/2})	PHASE (°)	DOCUMENT ID	TECN	COMMENT
0.135 ± 0.005	1 ± 3	SOKHOYAN	15A	DPWA Multichannel
0.126 ^{+0.001} _{-0.002}	-7 ⁺³ ₋₂	ROENCHEN	14	DPWA

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

0.102	-11	ROENCHEN	15A	DPWA Multichannel
-------	-----	----------	-----	-------------------

N(1680) BREIT-WIGNER PHOTON DECAY AMPLITUDES

N(1680) → pγ, helicity-1/2 amplitude A_{1/2}

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
-0.018 to -0.005 (≈ -0.010) OUR ESTIMATE			
-0.0278 ± 0.0036	GOLOVATCH 19	DPWA	γ p → π ⁺ π ⁻ p
-0.026 ± 0.004	¹ HUNT 19	DPWA	Multichannel
-0.015 ± 0.002	SOKHOYAN 15A	DPWA	Multichannel
0.003 ± 0.001	¹ SHKLYAR 13	DPWA	Multichannel
-0.007 ± 0.002	¹ WORKMAN 12A	DPWA	γ N → Nπ
-0.017 ± 0.001	¹ DUGGER 07	DPWA	γ N → π N

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

-0.013 ± 0.003	ANISOVICH	12A	DPWA	Multichannel
-0.017 ± 0.001	¹ SHRESTHA	12A	DPWA	Multichannel
-0.025	DRECHSEL	07	DPWA	γ N → π N

¹Statistical error only.

N(1680) → pγ, helicity-3/2 amplitude A_{3/2}

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
0.130 to 0.140 (≈ 0.135) OUR ESTIMATE			
0.128 ± 0.011	GOLOVATCH 19	DPWA	γ p → π ⁺ π ⁻ p
0.112 ± 0.005	¹ HUNT 19	DPWA	Multichannel
0.136 ± 0.005	SOKHOYAN 15A	DPWA	Multichannel
0.116 ± 0.001	¹ SHKLYAR 13	DPWA	Multichannel
0.140 ± 0.002	¹ WORKMAN 12A	DPWA	γ N → Nπ
0.134 ± 0.002	¹ DUGGER 07	DPWA	γ N → π N

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

0.135±0.006	ANISOVICH	12A	DPWA	Multichannel
0.136±0.001	¹ SHRESTHA	12A	DPWA	Multichannel
0.134	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

$N(1680) \rightarrow n\gamma$, helicity-1/2 amplitude $A_{1/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-----------------------------------	--------------------	-------------	----------------

0.020 to 0.040 (≈ 0.030) OUR ESTIMATE

0.005±0.004	¹ HUNT	19	DPWA	Multichannel
0.034±0.006	ANISOVICH	13B	DPWA	Multichannel
0.026±0.004	¹ CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$

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

0.029±0.002	¹ SHRESTHA	12A	DPWA	Multichannel
0.028	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

$N(1680) \rightarrow n\gamma$, helicity-3/2 amplitude $A_{3/2}$

<u>VALUE (GeV^{-1/2})</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-----------------------------------	--------------------	-------------	----------------

-0.050 to -0.025 (≈ -0.035) OUR ESTIMATE

-0.061±0.004	¹ HUNT	19	DPWA	Multichannel
-0.044±0.009	ANISOVICH	13B	DPWA	Multichannel
-0.029±0.002	¹ CHEN	12A	DPWA	$\gamma N \rightarrow \pi N$

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

-0.059±0.002	¹ SHRESTHA	12A	DPWA	Multichannel
-0.038	DRECHSEL	07	DPWA	$\gamma N \rightarrow \pi N$

¹Statistical error only.

$N(1680)$ REFERENCES

For early references, see Physics Letters **111B** 1 (1982). For very early references, see Reviews of Modern Physics **37** 633 (1965).

MUELLER	20	PL B803 135323	J. Mueller <i>et al.</i>	(CBELSA/TAPS Collab.)
GOLOVATCH	19	PL B788 371	E. Golovatch <i>et al.</i>	(CLAS Collab.)
HUNT	19	PR C99 055205	B.C. Hunt, D.M. Manley	
ROENCHEN	15A	EPJ A51 70	D. Roenchen <i>et al.</i>	
SOKHOYAN	15A	EPJ A51 95	V. Sokhoyan <i>et al.</i>	(CBELSA/TAPS Collab.)
PDG	14	CP C38 070001	K. Olive <i>et al.</i>	(PDG Collab.)
ROENCHEN	14	EPJ A50 101	D. Roenchen <i>et al.</i>	
Also		EPJ A51 63 (errat.)	D. Roenchen <i>et al.</i>	
SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	(RBI Zagreb, UNI Tuzla)
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich <i>et al.</i>	
SHKLYAR	13	PR C87 015201	V. Shklyar, H. Lenske, U. Mosel	(GIES)
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
CHEN	12A	PR C86 015206	W. Chen <i>et al.</i>	(DUKE, GWU, MSST, ITEP+)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
THOMA	08	PL B659 87	U. Thoma <i>et al.</i>	(CB-ELSA Collab.)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)

DUGGER	07	PR C76 025211	M. Dugger <i>et al.</i>	(JLab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT, ANL)
TIATOR	99	PR C60 035210	L. Tiator <i>et al.</i>	
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
