Λ

$I(J^P) = 0(\frac{1}{2}^+)$ Status: ∗∗∗∗

We have omitted some results that have been superseded by later experiments. See our earlier editions.

Λ MASS

The fit uses Λ, Σ^+, Σ^0, Σ^- mass and mass-difference measurements.

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
1115.683±0.006 OUR FIT					
1115.683±0.006 OUR AVERAGE					
1115.678±0.006±0.006	20k	HARTOUNI	94	SPEC	pp 27.5 GeV/c
1115.690±0.008±0.006	18k	[1] HARTOUNI	94	SPEC	pp 27.5 GeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1115.59 ±0.08	935	HYMAN	72	HEBC	
1115.39 ±0.12	195	MAYEUR	67	EMUL	
1115.6 ±0.4		LONDON	66	HBC	
1115.65 ±0.07	488	[2] SCHMIDT	65	HBC	
1115.44 ±0.12		[3] BHOWMIK	63	RVUE	

[1] We assume CPT invariance: this is the $\overline{\Lambda}$ mass as measured by HARTOUNI 94. See below for the fractional mass difference, testing CPT.

[2] The SCHMIDT 65 masses have been reevaluated using our April 1973 proton and $K^\pm$ and $\pi^\pm$ masses. P. Schmidt, private communication (1974).

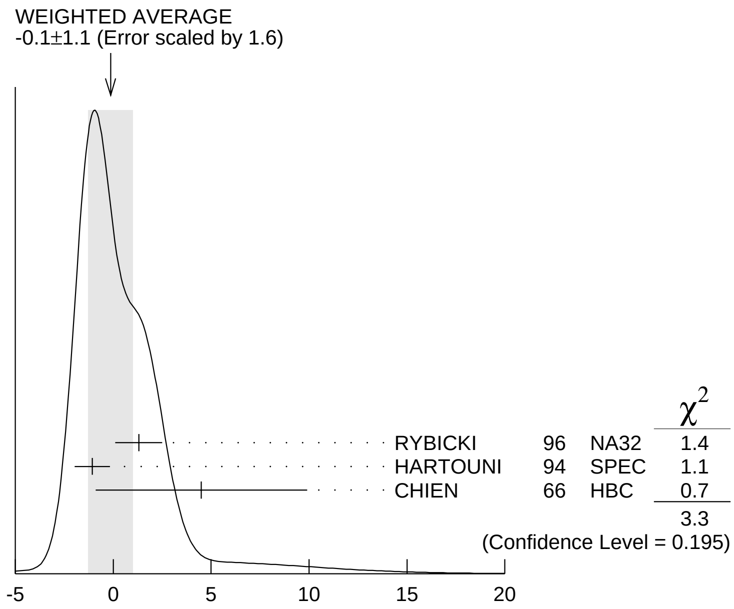
[3] The mass has been raised 35 keV to take into account a 46 keV increase in the proton mass and an 11 keV decrease in the $\pi^\pm$ mass (note added Reviews of Modern Physics **39** 1 (1967)).

$(m_\Lambda - m_{\overline{\Lambda}}) / m_\Lambda$

A test of CPT invariance.

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
− 0.1 ± 1.1 OUR AVERAGE	Error includes scale factor of 1.6. See the ideogram below.				
+ 1.3 ± 1.2	31k	[4] RYBICKI	96	NA32	π^- Cu, 230 GeV
− 1.08 ± 0.90		HARTOUNI	94	SPEC	pp 27.5 GeV/c
4.5 ± 5.4		CHIEN	66	HBC	6.9 GeV/c $\overline{p}p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−26 ±13		BADIER	67	HBC	2.4 GeV/c $\overline{p}p$

[4] RYBICKI 96 is an analysis of old ACCMOR (NA32) data.

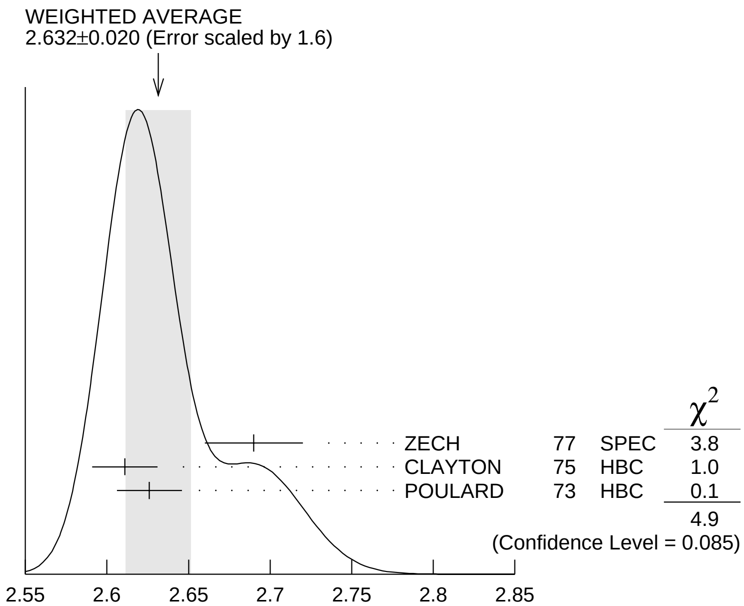


$(m_{\Lambda} - m_{\overline{\Lambda}}) \big/ m_{\Lambda}$

Λ MEAN LIFE

Measurements with an error $\geq 0.1 \times 10^{-10}$ s have been omitted altogether, and only the latest high-statistics measurements are used for the average.

VALUE (10^{-10} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.632±0.020 OUR AVERAGE		Error includes scale factor of 1.6. See the ideogram below.			
2.69 ±0.03	53k	ZECH	77	SPEC	Neutral hyperon beam
2.611±0.020	34k	CLAYTON	75	HBC	0.96–1.4 GeV/c $K^- p$
2.626±0.020	36k	POULARD	73	HBC	0.4–2.3 GeV/c $K^- p$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.69 ±0.05	6582	ALTHOFF	73B	OSPK	$\pi^+ n \rightarrow \Lambda K^+$
2.54 ±0.04	4572	BALTAY	71B	HBC	$K^- p$ at rest
2.535±0.035	8342	GRIMM	68	HBC	
2.47 ±0.08	2600	HEPP	68	HBC	
2.35 ±0.09	916	BURAN	66	HLBC	
$2.452^{+0.056}_{-0.054}$	2213	ENGELMANN	66	HBC	
2.59 ±0.09	794	HUBBARD	64	HBC	
2.59 ±0.07	1378	SCHWARTZ	64	HBC	
2.36 ±0.06	2239	BLOCK	63	HEBC	



Λ mean life (10^{-10} s)

$(\tau_{\Lambda} - \tau_{\overline{\Lambda}}) / \tau_{\Lambda}$

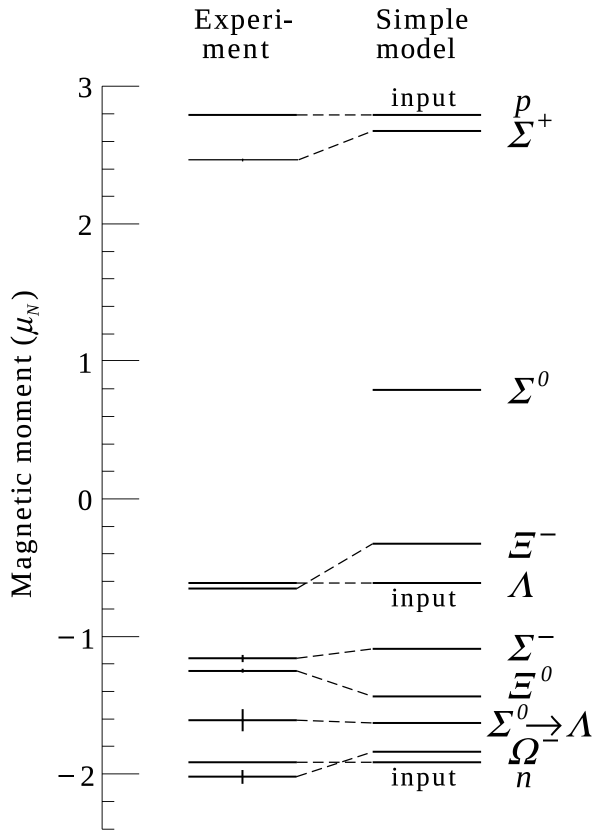
A test of *CPT* invariance.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.044±0.085	BADIER	67	HBC	2.4 GeV/c $\overline{p}p$

BARYON MAGNETIC MOMENTS

Written 1994 by C.G. Wohl (LBNL).

The figure shows the measured magnetic moments of the stable baryons. It also shows the predictions of the simplest quark model, using the measured p, n, and Λ moments as input. In this model, the moments are [1]



$$\mu_p = (4\mu_u - \mu_d)/3 \qquad \mu_n = (4\mu_d - \mu_u)/3$$
$$\mu_{\Sigma^+} = (4\mu_u - \mu_s)/3 \qquad \mu_{\Sigma^-} = (4\mu_d - \mu_s)/3$$
$$\mu_{\Xi^0} = (4\mu_s - \mu_u)/3 \qquad \mu_{\Xi^-} = (4\mu_s - \mu_d)/3$$
$$\mu_\Lambda = \mu_s \qquad \mu_{\Sigma^0} = (2\mu_u + 2\mu_d - \mu_s)/3$$
$$\mu_{\Omega^-} = 3\mu_s$$

and the $\Sigma^0 \to \Lambda$ transition moment is

$$\mu_{\Sigma^0\Lambda} = (\mu_d - \mu_u)/\sqrt{3}\ .$$

The quark moments that result from this model are $\mu_u = +1.852\,\mu_N$, $\mu_d = -0.972\,\mu_N$, and $\mu_s = -0.613\,\mu_N$. The corresponding effective quark masses, taking the quarks to be Dirac point particles, where $\mu = q\hbar/2m$, are 338, 322, and 510

MeV. As the figure shows, the model gives a good first approximation to the experimental moments. For efforts to make a better model, we refer to the literature [2].

References

1. See, for example, D.H. Perkins, *Introduction to High Energy Physics* (Addison-Wesley, Reading, MA, 1987), or D. Griffiths, *Introduction to Elementary Particles* (Harper & Row, New York, 1987).
2. See, for example, J. Franklin, Phys. Rev. **D29**, 2648 (1984);
   H.J. Lipkin, Nucl. Phys. **B241**, 477 (1984);
   K. Suzuki, H. Kumagai, and Y. Tanaka, Europhys. Lett. **2**, 109 (1986);
   S.K. Gupta and S.B. Khadkikar, Phys. Rev. **D36**, 307 (1987);
   M.I. Krivoruchenko, Sov. J. Nucl. Phys. **45**, 109 (1987);
   L. Brekke and J.L. Rosner, Comm. Nucl. Part. Phys. **18**, 83 (1988);
   K.-T. Chao, Phys. Rev. **D41**, 920 (1990) and references cited therein Also, see references cited in discussions of results in the experimental papers..

Λ MAGNETIC MOMENT

See the "Note on Baryon Magnetic Moments" above. Measurements with an error $\geq 0.15\ \mu_N$ have been omitted.

VALUE (μ_N)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
−0.613 ±0.004 OUR AVERAGE					
−0.606 ±0.015	200k	COX	81	SPEC	
−0.6138±0.0047	3M	SCHACHIN...	78	SPEC	
−0.59 ±0.07	350k	HELLER	77	SPEC	
−0.57 ±0.05	1.2M	BUNCE	76	SPEC	
−0.66 ±0.07	1300	DAHL-JENSEN	71	EMUL	200 kG field

Λ ELECTRIC DIPOLE MOMENT

A nonzero value is forbidden by both T invariance and P invariance.

VALUE (10^{-16} $e$cm)	CL%	DOCUMENT ID		TECN
< 1.5	95	[5] PONDROM	81	SPEC
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<100	95	[6] BARONI	71	EMUL
<500	95	GIBSON	66	EMUL

[5] PONDROM 81 measures $(-3.0 \pm 7.4) \times 10^{-17}$ e-cm.
[6] BARONI 71 measures $(-5.9 \pm 2.9) \times 10^{-15}$ e-cm.

Λ DECAY MODES

	Mode	Fraction (Γ_i/Γ)
Γ_1	$p\pi^-$	(63.9 ± 0.5) %
Γ_2	$n\pi^0$	(35.8 ± 0.5) %
Γ_3	$n\gamma$	$(1.75 \pm 0.15) \times 10^{-3}$
Γ_4	$p\pi^-\gamma$	[a] $(8.4 \pm 1.4) \times 10^{-4}$
Γ_5	$pe^-\overline{\nu}_e$	$(8.32 \pm 0.14) \times 10^{-4}$
Γ_6	$p\mu^-\overline{\nu}_\mu$	$(1.57 \pm 0.35) \times 10^{-4}$

[a] See the Listings below for the pion momentum range used in this measurement.

CONSTRAINED FIT INFORMATION

An overall fit to 5 branching ratios uses 20 measurements and one constraint to determine 5 parameters. The overall fit has a $\chi^2 =$ 10.5 for 16 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta x_i \delta x_j\right\rangle/(\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

	x_1	x_2	x_3	x_5
x_2	−100			
x_3	−2	−1		
x_5	46	−46	−1	
x_6	0	0	0	0

Λ BRANCHING RATIOS

$\Gamma(p\pi^-)/\Gamma(N\pi)$ — $\Gamma_1/(\Gamma_1+\Gamma_2)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.641±0.005 OUR FIT					
0.640±0.005 OUR AVERAGE					
0.646±0.008	4572	BALTAY	71B	HBC	$K^- p$ at rest
0.635±0.007	6736	DOYLE	69	HBC	$\pi^- p \to \Lambda K^0$
0.643±0.016	903	HUMPHREY	62	HBC	
0.624±0.030		CRAWFORD	59B	HBC	$\pi^- p \to \Lambda K^0$

$\Gamma(n\pi^0)/\Gamma(N\pi)$ — $\Gamma_2/(\Gamma_1+\Gamma_2)$

VALUE	EVTS	DOCUMENT ID		TECN
0.359±0.005 OUR FIT				
0.310±0.028 OUR AVERAGE				
0.35 ±0.05		BROWN	63	HLBC
0.291±0.034	75	CHRETIEN	63	HLBC

$\Gamma(n\gamma)/\Gamma_{total}$ — Γ_3/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.75±0.15 OUR FIT					
1.75±0.15	1816	LARSON	93	SPEC	$K^- p$ at rest
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.78\pm0.24^{+0.14}_{-0.16}$	287	NOBLE	92	SPEC	See LARSON 93

$\Gamma(n\gamma)/\Gamma(n\pi^0)$ — Γ_3/Γ_2

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.86±0.74±0.57	24	BIAGI	86	SPEC	SPS hyperon beam

$\Gamma(p\pi^-\gamma)/\Gamma(p\pi^-)$ — Γ_4/Γ_1

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.32±0.22	72	BAGGETT	72C	HBC	π^- < 95 MeV/c

$\Gamma(pe^-\overline{\nu}_e)/\Gamma(p\pi^-)$ — Γ_5/Γ_1

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
1.301±0.019 OUR FIT					
1.301±0.019 OUR AVERAGE					
1.335±0.056	7111	BOURQUIN	83	SPEC	SPS hyperon beam
1.313±0.024	10k	WISE	80	SPEC	
1.23 ±0.11	544	LINDQUIST	77	SPEC	$\pi^- p \to K^0 \Lambda$
1.27 ±0.07	1089	KATZ	73	HBC	
1.31 ±0.06	1078	ALTHOFF	71	OSPK	
1.17 ±0.13	86	[7] CANTER	71	HBC	$K^- p$ at rest
1.20 ±0.12	143	[8] MALONEY	69	HBC	
1.17 ±0.18	120	[8] BAGLIN	64	FBC	K^- freon 1.45 GeV/c
1.23 ±0.20	150	[8] ELY	63	FBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					

1.32 ±0.15	218	[7] LINDQUIST	71	OSPK	See LINDQUIST 77

[7] Changed by us from $\Gamma(p e^- \overline{\nu}_e)/\Gamma(N\pi)$ assuming the authors used $\Gamma(p\pi^-)/\Gamma_{total} = 2/3$.

[8] Changed by us from $\Gamma(p e^- \overline{\nu}_e)/\Gamma(N\pi)$ because $\Gamma(p e^- \nu)/\Gamma(p\pi^-)$ is the directly measured quantity.

$\Gamma(p\mu^-\overline{\nu}_\mu)/\Gamma(N\pi)$ $\qquad\qquad \Gamma_6/(\Gamma_1+\Gamma_2)$

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.57±0.35 OUR FIT					
1.57±0.35 OUR AVERAGE					
1.4 ±0.5	14	BAGGETT	72B	HBC	$K^- p$ at rest
2.4 ±0.8	9	CANTER	71B	HBC	$K^- p$ at rest
1.3 ±0.7	3	LIND	64	RVUE	
1.5 ±1.2	2	RONNE	64	FBC	

Λ DECAY PARAMETERS

See the "Note on Baryon Decay Parameters" in the neutron Listings. Some early results have been omitted.

α_- FOR $\Lambda \to p\pi^-$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.642±0.013 OUR AVERAGE					
0.584±0.046	8500	ASTBURY	75	SPEC	
0.649±0.023	10325	CLELAND	72	OSPK	
0.67 ±0.06	3520	DAUBER	69	HBC	From Ξ decay
0.645±0.017	10130	OVERSETH	67	OSPK	Λ from $\pi^- p$
0.62 ±0.07	1156	CRONIN	63	CNTR	Λ from $\pi^- p$

ϕ ANGLE FOR $\Lambda \to p\pi^-$ $\qquad\qquad (\tan\phi = \beta\ /\ \gamma)$

VALUE (°)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
− 6.5± 3.5 OUR AVERAGE					
− 7.0± 4.5	10325	CLELAND	72	OSPK	Λ from $\pi^- p$
− 8.0± 6.0	10130	OVERSETH	67	OSPK	Λ from $\pi^- p$
13.0±17.0	1156	CRONIN	63	OSPK	Λ from $\pi^- p$

$\alpha_0\ /\ \alpha_- = \alpha(\Lambda \to n\pi^0)\ /\ \alpha(\Lambda \to p\pi^-)$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.01 ±0.07 OUR AVERAGE					
1.000±0.068	4760	[9] OLSEN	70	OSPK	$\pi^+ n \to \Lambda K^+$
1.10 ±0.27		CORK	60	CNTR	

[9] OLSEN 70 compares proton and neutron distributions from Λ decay.

$\left[\alpha_-(\Lambda) + \alpha_+(\overline{\Lambda})\right]\ /\ \left[\alpha_-(\Lambda) - \alpha_+(\overline{\Lambda})\right]$

Zero if *CP* is conserved; α_- and α_+ are the asymmetry parameters for $\Lambda \to p\pi^-$ and $\overline{\Lambda} \to \overline{p}\pi^+$ decay.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
−0.03±0.06 OUR AVERAGE					
+0.01±0.10	770	TIXIER	88	DM2	$J/\psi \to \Lambda\overline{\Lambda}$
−0.07±0.09	4063	BARNES	87	CNTR	$\overline{p}p \to \overline{\Lambda}\Lambda$ LEAR
−0.02±0.14	10k	[10] CHAUVAT	85	CNTR	pp, $\overline{p}p$ ISR

[10] CHAUVAT 85 actually gives $\alpha_{+}(\overline{\Lambda})/\alpha_{-}(\Lambda) = -1.04 \pm 0.29$. Assumes polarization is same in $\overline{p}p \rightarrow \overline{\Lambda}X$ and $pp \rightarrow \Lambda X$. Tests of this assumption, based on C-invariance and fragmentation, are satisfied by the data.

g_A / g_V FOR $\Lambda \rightarrow pe^- \overline{\nu}_e$

Measurements with fewer than 500 events have been omitted. Where necessary, signs have been changed to agree with our conventions, which are given in the "Note on Baryon Decay Parameters" in the neutron Listings. The measurements all assume that the form factor $g_2 = 0$. See also the footnote on DWORKIN 90.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.718±0.015 OUR AVERAGE					
−0.719±0.016±0.012	37k	[11] DWORKIN	90	SPEC	$e\nu$ angular corr.
−0.70 ±0.03	7111	BOURQUIN	83	SPEC	$\Xi \rightarrow \Lambda\pi^-$
−0.734±0.031	10k	[12] WISE	81	SPEC	$e\nu$ angular correl.
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.63 ±0.06	817	ALTHOFF	73	OSPK	Polarized Λ

[11] The tabulated result assumes the weak-magnetism coupling $w \equiv g_W(0)/g_V(0)$ to be 0.97, as given by the CVC hypothesis and as assumed by the other listed measurements. However, DWORKIN 90 *measures* w to be 0.15 ± 0.30, and then $g_A/g_V = -0.731 \pm 0.016$.

[12] This experiment measures only the absolute value of g_A/g_V.

Λ REFERENCES

We have omitted some papers that have been superseded by later experiments. See our earlier editions.

RYBICKI	96	APP B27 2155	K. Rybicki	
HARTOUNI	94	PRL 72 1322	E.P. Hartouni *et al.*	(BNL E766 Collab.)
Also	94B	PRL 72 2821 (erratum)	E.P. Hartouni *et al.*	(BNL E766 Collab.)
LARSON	93	PR D47 799	K.D. Larson *et al.*	(BNL-811 Collab.)
NOBLE	92	PRL 69 414	A.J. Noble *et al.*	(BIRM, BOST, BRCO+)
DWORKIN	90	PR D41 780	J. Dworkin *et al.*	(MICH, WISC, RUTG+)
TIXIER	88	PL B212 523	M.H. Tixier *et al.*	(DM2 Collab.)
BARNES	87	PL B199 147	P.D. Barnes *et al.*	(CMU, SACL, LANL+)
BIAGI	86	ZPHY C30 201	S.F. Biagi *et al.*	(BRIS, CERN, GEVA+)
CHAUVAT	85	PL 163B 273	P. Chauvat *et al.*	(CERN, CLER, UCLA+)
BOURQUIN	83	ZPHY C21 1	M.H. Bourquin *et al.*	(BRIS, GEVA, HEIDP+)
COX	81	PRL 46 877	P.T. Cox *et al.*	(MICH, WISC, RUTG, MINN+)
PONDROM	81	PR D23 814	L. Pondrom *et al.*	(WISC, MICH, RUTG+)
WISE	81	PL 98B 123	J.E. Wise *et al.*	(MASA, BNL)
WISE	80	PL 91B 165	J.E. Wise *et al.*	(MASA, BNL)
SCHACHIN...	78	PRL 41 1348	L. Schachinger *et al.*	(MICH, RUTG, WISC)
HELLER	77	PL 68B 480	K. Heller *et al.*	(MICH, WISC, HEIDH)
LINDQUIST	77	PR D16 2104	J. Lindquist *et al.*	(EFI, OSU, ANL)
Also	76	JPG 2 L211	J. Lindquist *et al.*	(EFI, WUSL, OSU+)
ZECH	77	NP B124 413	G. Zech *et al.*	(SIEG, CERN, DORT, HEIDH)
BUNCE	76	PRL 36 1113	G.R.M. Bunce *et al.*	(WISC, MICH, RUTG)
ASTBURY	75	NP B99 30	P. Astbury *et al.*	(LOIC, CERN, ETH+)
CLAYTON	75	NP B95 130	E.F. Clayton *et al.*	(LOIC, RHEL)
ALTHOFF	73	PL 43B 237	K.H. Althoff *et al.*	(CERN, HEID)
ALTHOFF	73B	NP B66 29	K.H. Althoff *et al.*	(CERN, HEID)
KATZ	73	Thesis MDDP-TR-74-044	C.N. Katz	(UMD)
POULARD	73	PL 46B 135	G. Poulard, A. Givernaud, A.C. Borg	(SACL)
BAGGETT	72B	ZPHY 252 362	M.J. Baggett *et al.*	(HEID)
BAGGETT	72C	PL 42B 379	M.J. Baggett *et al.*	(HEID)
CLELAND	72	NP B40 221	W.E. Cleland *et al.*	(CERN, GEVA, LUND)
HYMAN	72	PR D5 1063	L.G. Hyman *et al.*	(ANL, CMU)
ALTHOFF	71	PL 37B 531	K.H. Althoff *et al.*	(CERN, HEID)
BALTAY	71B	PR D4 670	C. Baltay *et al.*	(COLU, BING)
BARONI	71	LNC 2 1256	G. Baroni, S. Petrera, G. Romano	(ROMA)
CANTER	71	PRL 26 868	J. Canter *et al.*	(STON, COLU)

CANTER	71B	PRL 27 59	J. Canter *et al.*	(STON, COLU)
DAHL-JENSEN	71	NC 3A 1	E. Dahl-Jensen *et al.*	(CERN, ANKA, LAUS+)
LINDQUIST	71	PRL 27 612	J. Lindquist *et al.*	(EFI, WUSL, OSU+)
OLSEN	70	PRL 24 843	S.L. Olsen *et al.*	(WISC, MICH)
DAUBER	69	PR 179 1262	P.M. Dauber *et al.*	(LRL)
DOYLE	69	Thesis UCRL 18139	J.C. Doyle	(LRL)
MALONEY	69	PRL 23 425	J.E. Maloney, B. Sechi-Zorn	(UMD)
GRIMM	68	NC 54A 187	H.J. Grimm	(HEID)
HEPP	68	ZPHY 214 71	V. Hepp, H. Schleich	(HEID)
BADIER	67	PL 25B 152	J. Badier *et al.*	(EPOL)
MAYEUR	67	U.Libr.Brux.Bul. 32	C. Mayeur, E. Tompa, J.H. Wickens	(BELG, LOUC)
OVERSETH	67	PRL 19 391	O.E. Overseth, R.F. Roth	(MICH, PRIN)
PDG	67	RMP 39 1	A.H. Rosenfeld *et al.*	(LRL, CERN, YALE)
BURAN	66	PL 20 318	T. Buran *et al.*	(OSLO)
CHIEN	66	PR 152 1171	C.Y. Chien *et al.*	(YALE, BNL)
ENGELMANN	66	NC 45A 1038	R. Engelmann *et al.*	(HEID, REHO)
GIBSON	66	NC 45A 882	W.M. Gibson, K. Green	(BRIS)
LONDON	66	PR 143 1034	G.W. London *et al.*	(BNL, SYRA)
SCHMIDT	65	PR 140B 1328	P. Schmidt	(COLU)
BAGLIN	64	NC 35 977	C. Baglin *et al.*	(EPOL, CERN, LOUC, RHEL+)
HUBBARD	64	PR 135B 183	J.R. Hubbard *et al.*	(LRL)
LIND	64	PR 135B 1483	V.G. Lind *et al.*	(WISC)
RONNE	64	PL 11 357	B.E. Ronne *et al.*	(CERN, EPOL, LOUC+)
SCHWARTZ	64	Thesis UCRL 11360	J.A. Schwartz	(LRL)
BHOWMIK	63	NC 28 1494	B. Bhowmik, D.P. Goyal	(DELH)
BLOCK	63	PR 130 766	M.M. Block *et al.*	(NWES, BGNA, SYRA+)
BROWN	63	PR 130 769	J.L. Brown *et al.*	(LRL, MICH)
CHRETIEN	63	PR 131 2208	M. Chretien *et al.*	(BRAN, BROW, HARV+)
CRONIN	63	PR 129 1795	J.W. Cronin, O.E. Overseth	(PRIN)
ELY	63	PR 131 868	R.P. Ely *et al.*	(LRL)
HUMPHREY	62	PR 127 1305	W.E. Humphrey, R.R. Ross	(LRL)
CORK	60	PR 120 1000	B. Cork *et al.*	(LRL, PRIN, BNL)
CRAWFORD	59B	PRL 2 266	F.S. Crawford *et al.*	(LRL)