Σ^-

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

We have omitted some results that have been superseded by later experiments.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

Σ^- MASS

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

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
1197.449±0.030 OUR FIT	Error includes scale factor of 1.2.				
1197.45 ±0.04 OUR AVERAGE	Error includes scale factor of 1.2.				
1197.417±0.040		GUREV	93	SPEC	Σ^- C atom, crystal diff.
1197.532±0.057		GALL	88	CNTR	Σ^- Pb, Σ^- W atoms
1197.43 ±0.08	3000	SCHMIDT	65	HBC	See note with Λ mass
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1197.24 ±0.15		[1] DUGAN	75	CNTR	Exotic atoms

[1] GALL 88 concludes that the DUGAN 75 mass needs to be reevaluated.

$m_{\Sigma^-} - m_{\Sigma^+}$

VALUE (MeV)	EVTS	DOCUMENT ID		TECN
8.08±0.08 OUR FIT	Error includes scale factor of 1.9.			
8.09±0.16 OUR AVERAGE				
7.91±0.23	86	BOHM	72	EMUL
8.25±0.25	2500	DOSCH	65	HBC
8.25±0.40	87	BARKAS	63	EMUL

$m_{\Sigma^-} - m_{\Lambda}$

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
81.766±0.030 OUR FIT	Error includes scale factor of 1.2.				
81.69 ±0.07 OUR AVERAGE					
81.64 ±0.09	2279	HEPP	68	HBC	
81.80 ±0.13	85	SCHMIDT	65	HBC	See note with Λ mass
81.70 ±0.19		BURNSTEIN	64	HBC	

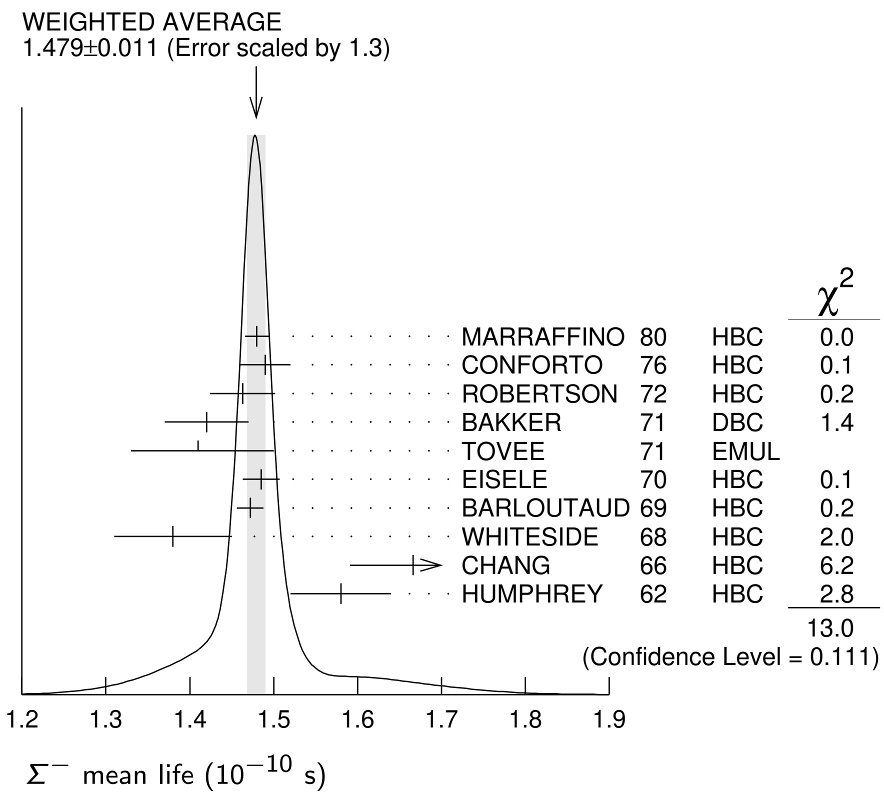
Σ^- MEAN LIFE

Measurements with an error $\geq 0.2 \times 10^{-10}$ s have been omitted.

VALUE (10^{-10} s)	EVTS	DOCUMENT ID		TECN	COMMENT
1.479±0.011 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.				
1.480±0.014	16k	MARRAFFINO	80	HBC	$K^- p$ 0.42–0.5 GeV/c
1.49 ±0.03	8437	CONFORTO	76	HBC	$K^- p$ 1–1.4 GeV/c
1.463±0.039	2400	ROBERTSON	72	HBC	$K^- p$ 0.25 GeV/c
1.42 ±0.05	1383	BAKKER	71	DBC	$K^- N \rightarrow \Sigma^- \pi\pi$
1.41 $^{+0.09}_{-0.08}$		TOVEE	71	EMUL	

1.485±0.022	100k	EISELE	70	HBC	$K^- p$ at rest
1.472±0.016	10k	BARLOUTAUD	69	HBC	$K^- p$ 0.4–1.2 GeV/c
1.38 ±0.07	506	WHITESIDE	68	HBC	$K^- p$ at rest
1.666±0.075	3267	[1] CHANG	66	HBC	$K^- p$ at rest
1.58 ±0.06	1208	HUMPHREY	62	HBC	$K^- p$ at rest

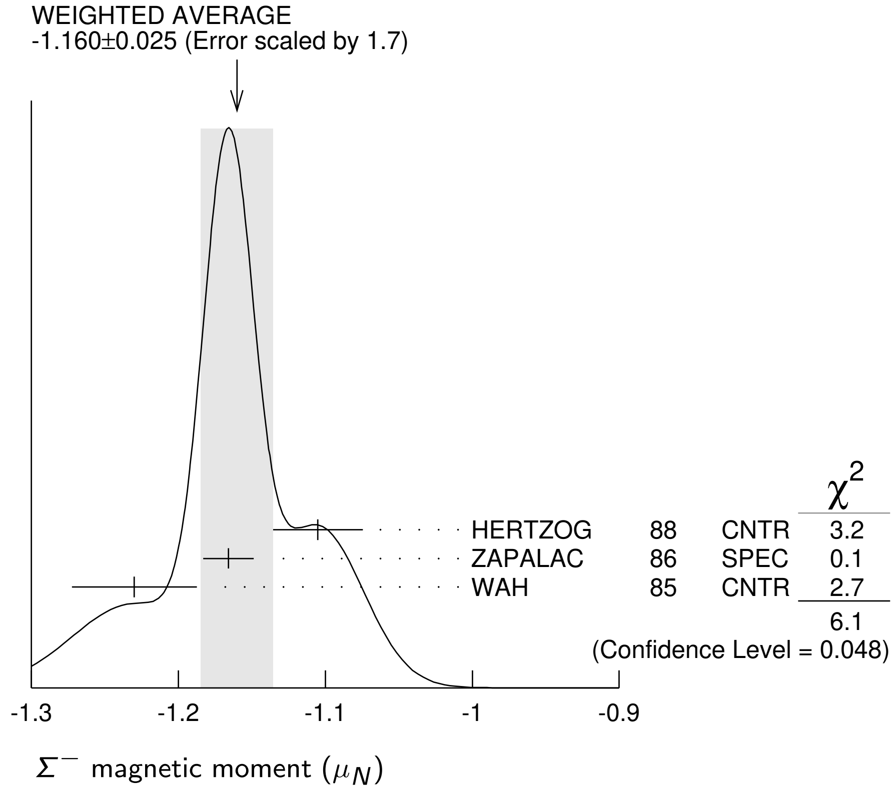
[1] We have increased the CHANG 66 error of 0.026; see our 1970 edition, Reviews of Modern Physics **42** 87 (1970).



Σ^- MAGNETIC MOMENT

See the "Quark Model" review. Measurements with an error $\geq 0.3\ \mu_N$ have been omitted.

VALUE (μ_N)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
−1.160±0.025 OUR AVERAGE	Error includes scale factor of 1.7. See the ideogram below.				
−1.105±0.029±0.010		HERTZOG	88	CNTR	Σ^- Pb, Σ^- W atoms
−1.166±0.014±0.010	671k	ZAPALAC	86	SPEC	$n e^- \nu$, $n \pi^-$ decays
−1.23 ±0.03 ±0.03		WAH	85	CNTR	pCu → Σ^- X
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.89 ±0.14	516k	DECK	83	SPEC	pBe → Σ^- X



Σ^- CHARGE RADIUS

VALUE (fm)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.780±0.080±0.060	[1] ESCHRICH	01	SELX	$\Sigma^- e \rightarrow \Sigma^- e$

[1] ESCHRICH 01 actually gives $\langle r^2 \rangle = (0.61 \pm 0.12 \pm 0.09)$ fm^2.

Σ^- DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	$n\pi^-$		(99.848±0.005) %	
Γ_2	$n\pi^-\gamma$	[a]	(4.6 ±0.6) $\times 10^{-4}$	
Γ_3	$ne^-\overline{\nu}_e$		(1.017±0.034) $\times 10^{-3}$	
Γ_4	$n\mu^-\overline{\nu}_\mu$		(4.5 ±0.4) $\times 10^{-4}$	
Γ_5	$\Lambda e^-\overline{\nu}_e$		(5.73 ±0.27) $\times 10^{-5}$	
Γ_6	$\Sigma^+ X$		$<$ 1.2 $\times 10^{-4}$	90%
	Lepton number (L) violating modes			
Γ_7	pe^-e^-	L	$<$ 6.7 $\times 10^{-5}$	90%

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

CONSTRAINED FIT INFORMATION

An overall fit to 3 branching ratios uses 16 measurements and one constraint to determine 4 parameters. The overall fit has a $\chi^2 =$ 8.7 for 13 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, $x_i \equiv \Gamma_i/\Gamma_{\rm total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_3	−64		
x_4	−77	0	
x_5	−5	0	0
	x_1	x_3	x_4

Σ^- BRANCHING RATIOS

$\Gamma(n\pi^-\gamma)/\Gamma(n\pi^-)$ — Γ_2/Γ_1

The π^+ momentum cuts differ, so we do not average the results but simply use the latest value for the Summary Table.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.46±0.06	292	EBENHOH	73	HBC	$\pi^+ < 150$ MeV/c
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.10±0.02	23	ANG	69B	HBC	$\pi^- < 110$ MeV/c
$\sim$ 1.1		BAZIN	65B	HBC	$\pi^- < 166$ MeV/c

$\Gamma(ne^-\overline{\nu}_e)/\Gamma(n\pi^-)$ — Γ_3/Γ_1

Measurements with an error $\geq 0.2 \times 10^{-3}$ have been omitted.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.019±0.035 OUR FIT					
$1.019^{+0.031}_{-0.040}$ OUR AVERAGE					
0.96 ±0.05	2847	BOURQUIN	83C	SPEC	SPS hyperon beam
$1.09\ ^{+0.06}_{-0.08}$	601	[1] EBENHOH	74	HBC	$K^- p$ at rest
$1.05\ ^{+0.07}_{-0.13}$	455	[1] SECHI-ZORN	73	HBC	$K^- p$ at rest
0.97 ±0.15	57	COLE	71	HBC	$K^- p$ at rest
1.11 ±0.09	180	BIERMAN	68	HBC	

[1] An additional negative systematic error is included for internal radiative corrections and latest form factors; see BOURQUIN 83C.

$\Gamma(n\mu^-\overline{\nu}_\mu)/\Gamma(n\pi^-)$ — Γ_4/Γ_1

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.45±0.04 OUR FIT					
0.45±0.04 OUR AVERAGE					
0.38±0.11	13	COLE	71	HBC	$K^- p$ at rest

0.43±0.06	72	ANG	69	HBC	K^-p at rest
0.43±0.09	56	BAGGETT	69	HBC	K^-p at rest
0.56±0.20	11	BAZIN	65B	HBC	K^-p at rest
0.66±0.15	22	COURANT	64	HBC	

$\Gamma(\Lambda e^- \overline{\nu}_e)/\Gamma(n\pi^-)$ — Γ_5/Γ_1

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
0.574±0.027 OUR FIT					
0.574±0.027 OUR AVERAGE					
0.561±0.031	1620	[1] BOURQUIN	82	SPEC	SPS hyperon beam
0.63 ±0.11	114	THOMPSON	80	ASPK	Hyperon beam
0.52 ±0.09	31	BALTAY	69	HBC	K^-p at rest
0.69 ±0.12	31	EISELE	69	HBC	K^-p at rest
0.64 ±0.12	35	BARASH	67	HBC	K^-p at rest
0.75 ±0.28	11	COURANT	64	HBC	K^-p at rest

[1] The value is from BOURQUIN 83B, and includes radiation corrections and new acceptance.

$\Gamma(\Sigma^+ X)/\Gamma_{total}$ — Γ_6/Γ

Here mode X can be any particle combination.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<1.2 × 10^{-4}	90	ABLIKIM	21F	BES	1,311 M J/ψ decays

Lepton number (*L*) violating modes

$\Gamma(pe^-e^-)/\Gamma_{total}$ — Γ_7/Γ

This decay violates lepton number conservation with $\Delta Q = \Delta L = 2$.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<6.7 × 10^{-5}	90	ABLIKIM	21F	BES	1,311 M J/ψ decays

Σ^- DECAY PARAMETERS

See the "Note on Baryon Decay Parameters" in the neutron Listings. Older, outdated results have been omitted.

α_- FOR $\Sigma^- \to n\pi^-$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.068±0.008 OUR AVERAGE					
−0.062±0.024	28k	HANSL	78	HBC	$K^-p \to \Sigma^-\pi^+$
−0.067±0.011	60k	BOGERT	70	HBC	K^-p 0.4 GeV/c
−0.071±0.012	51k	BANGERTER	69	HBC	K^-p 0.4 GeV/c

ϕ ANGLE FOR $\Sigma^- \to n\pi^-$ — $(\tan\phi = \beta\ /\ \gamma)$

VALUE (°)	EVTS	DOCUMENT ID		TECN	COMMENT
10±15 OUR AVERAGE					
+ 5±23	1092	[1] BERLEY	70B	HBC	n rescattering
14±19	1385	BANGERTER	69B	HBC	K^-p 0.4 GeV/c

[1] BERLEY 70B changed from −5 to +5° to agree with our sign convention.

g_A/g_V FOR $\Sigma^- \rightarrow ne^-\overline{\nu}_e$

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. What is actually listed is $|g_1/f_1 - 0.237 g_2/f_1|$. This reduces to $g_A/g_V \equiv g_1(0)/f_1(0)$ on making the usual assumption that $g_2 = 0$. See also the note on HSUEH 88.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.340±0.017 OUR AVERAGE					
+0.327±0.007±0.019	50k	[1] HSUEH	88	SPEC	Σ^- 250 GeV
+0.34 ±0.05	4456	[2] BOURQUIN	83C	SPEC	SPS hyperon beam
0.385±0.037	3507	[3] TANENBAUM	74	ASPK	

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.29 ±0.07	25k	HSUEH	85	SPEC	See HSUEH 88
$0.17\ ^{+0.07}_{-0.09}$	519	DECAMP	77	ELEC	Hyperon beam

[1] The sign is, *with our conventions*, unambiguously positive. The value assumes, as usual, that $g_2 = 0$. If g_2 is included in the fit, than (with our sign convention) $g_2 = -0.56 \pm 0.37$, with a corresponding reduction of g_A/g_V to $+0.20 \pm 0.08$.

[2] BOURQUIN 83C favors the positive sign by at least 2.6 standard deviations.

[3] TANENBAUM 74 gives 0.435 ± 0.035, assuming no q^2 dependence in g_A and g_V. The listed result allows q^2 dependence, and is taken from HSUEH 88.

$f_2(0)/f_1(0)$ FOR $\Sigma^- \rightarrow ne^-\overline{\nu}_e$

The signs have been changed to be in accord with our conventions, given in the "Note on Baryon Decay Parameters" in the neutron Listings.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.97±0.14 OUR AVERAGE					
+0.96±0.07±0.13	50k	HSUEH	88	SPEC	Σ^- 250 GeV
+1.02±0.34	4456	BOURQUIN	83C	SPEC	SPS hyperon beam

TRIPLE CORRELATION COEFFICIENT D for $\Sigma^- \rightarrow ne^-\overline{\nu}_e$

The coefficient D of the term $D\ \mathbf{P}\cdot(\hat{\mathbf{p}}_e\times\hat{\mathbf{p}}_\nu)$ in the $\Sigma^- \rightarrow ne^-\overline{\nu}$ decay angular distribution. A nonzero value would indicate a violation of time-reversal invariance.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.11±0.10	50k	HSUEH	88	SPEC	Σ^- 250 GeV

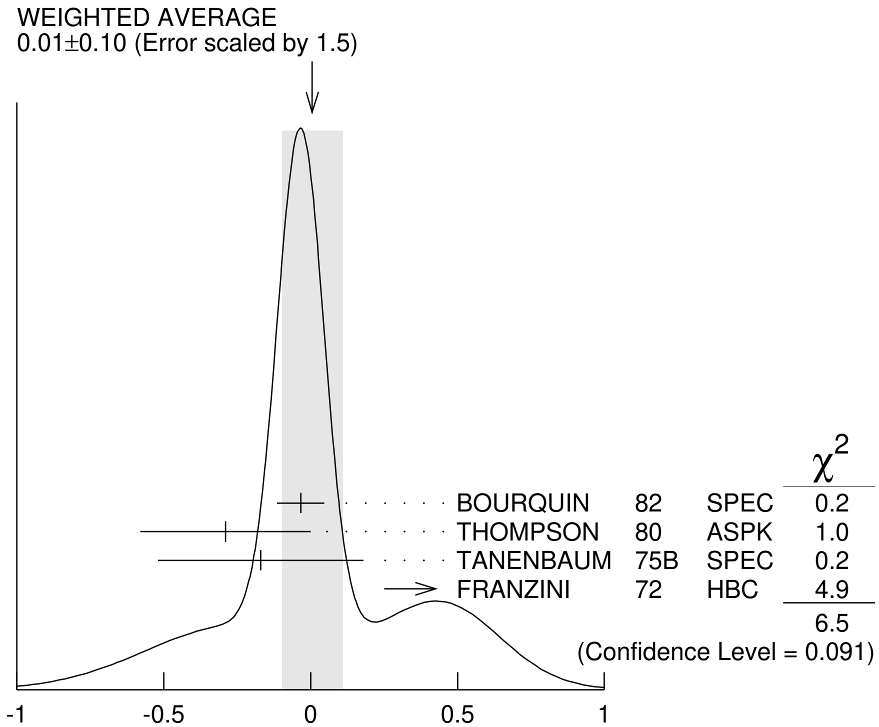
g_V/g_A FOR $\Sigma^- \rightarrow \Lambda e^-\overline{\nu}_e$

For the sign convention, see the "Note on Baryon Decay Parameters" in the neutron Listings. The value is predicted to be zero by conserved vector current theory. The values averaged assume CVC-SU(3) weak magnetism term.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.01 ±0.10 OUR AVERAGE Error includes scale factor of 1.5. See the ideogram below.					
−0.034±0.080	1620	[1] BOURQUIN	82	SPEC	SPS hyperon beam
−0.29 ±0.29	114	THOMPSON	80	ASPK	BNL hyperon beam
−0.17 ±0.35	55	TANENBAUM	75B	SPEC	BNL hyperon beam

+0.45 ±0.20	186	[1,2] FRANZINI	72	HBC

[1] The sign has been changed to agree with our convention.
[2] The FRANZINI 72 value includes the events of earlier papers. par



g_V/g_A for $\Sigma^- \rightarrow \Lambda e^- \overline{\nu}_e$

g_{WM}/g_A FOR $\Sigma^- \rightarrow \Lambda e^- \overline{\nu}_e$

The values quoted assume the CVC prediction $g_V = 0$.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.4 ±1.7 OUR AVERAGE					
1.75±3.5	114	THOMPSON	80	ASPK	BNL hyperon beam
3.5 ±4.5	55	TANENBAUM	75B	SPEC	BNL hyperon beam
2.4 ±2.1	186	FRANZINI	72	HBC	

Σ^- REFERENCES

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

ABLIKIM	21F	PR D103 052011	M. Ablikim *et al.*	(BESIII Collab.)
ESCHRICH	01	PL B522 233	I. Eschrich *et al.*	(FNAL SELEX Collab.)
GUREV	93	JETPL 57 400	M.P. Gurev *et al.*	(PNPI)
		Translated from ZETFP 57 389.		
GALL	88	PRL 60 186	K.P. Gall *et al.*	(BOST, MIT, WILL, CIT+)
HERTZOG	88	PR D37 1142	D.W. Hertzog *et al.*	(WILL, BOST, MIT+)
HSUEH	88	PR D38 2056	S.Y. Hsueh *et al.*	(CHIC, ELMT, FNAL+)
ZAPALAC	86	PRL 57 1526	G. Zapalac *et al.*	(EFI, ELMT, FNAL+)
HSUEH	85	PRL 54 2399	S.Y. Hsueh *et al.*	(CHIC, ELMT, FNAL+)
WAH	85	PRL 55 2551	Y.W. Wah *et al.*	(FNAL, IOWA, ISU)
BOURQUIN	83B	ZPHY C21 27	M.H. Bourquin *et al.*	(BRIS, GEVA, HEIDP+)
BOURQUIN	83C	ZPHY C21 17	M.H. Bourquin *et al.*	(BRIS, GEVA, HEIDP+)
DECK	83	PR D28 1	L. Deck *et al.*	(RUTG, WISC, MICH, MINN)
BOURQUIN	82	ZPHY C12 307	M.H. Bourquin *et al.*	(BRIS, GEVA, HEIDP+)

MARRAFFINO	80	PR D21 2501	J. Marraffino *et al.*	(VAND, MPIM)
THOMPSON	80	PR D21 25	J.A. Thompson *et al.*	(PITT, BNL)
HANSL	78	NP B132 45	T. Hansl *et al.*	(MPIM, VAND)
DECAMP	77	PL 66B 295	D. Decamp *et al.*	(LALO, EPOL)
CONFORTO	76	NP B105 189	B. Conforto *et al.*	(RHEL, LOIC)
DUGAN	75	NP A254 396	G. Dugan *et al.*	(COLU, YALE)
TANENBAUM	75B	PR D12 1871	W. Tanenbaum *et al.*	(YALE, FNAL, BNL)
EBENHOH	74	ZPHY 266 367	H. Ebenhoh *et al.*	(HEIDT)
TANENBAUM	74	PRL 33 175	W. Tanenbaum *et al.*	(YALE, FNAL, BNL)
EBENHOH	73	ZPHY 264 413	W. Ebenhoh *et al.*	(HEIDT)
SECHI-ZORN	73	PR D8 12	B. Sechi-Zorn, G.A. Snow	(UMD)
BOHM	72	NP B48 1	G. Bohm *et al.*	(BERL, KIDR, BRUX, IASD+)
FRANZINI	72	PR D6 2417	P. Franzini *et al.*	(COLU, HEID, UMD+)
ROBERTSON	72	Thesis UMI 78-00877	R.M. Robertson	(IIT)
BAKKER	71	LNC 1 37	A.M. Bakker *et al.*	(SABRE Collab.)
COLE	71	PR D4 631	J. Cole *et al.*	(STON, COLU)
Also		Thesis Nevis 175	H. Norton	(COLU)
TOVEE	71	NP B33 493	D.N. Tovee *et al.*	(LOUC, KIDR, BERL+)
BERLEY	70B	PR D1 2015	D. Berley *et al.*	(BNL, MASA, YALE)
BOGERT	70	PR D2 6	D.V. Bogert *et al.*	(BNL, MASA, YALE)
EISELE	70	ZPHY 238 372	F. Eisele *et al.*	(HEID)
PDG	70	RMP 42 87	A. Barbaro-Galtieri *et al.*	(LRL, BRAN+)
ANG	69	ZPHY 223 103	G. Ang *et al.*	(HEID)
ANG	69B	ZPHY 228 151	G. Ang *et al.*	(HEID)
BAGGETT	69	PRL 23 249	N.V. Baggett, B. Kehoe, G.A. Snow	(UMD)
BALTAY	69	PRL 22 615	C. Baltay *et al.*	(COLU, STON)
BANGERTER	69	Thesis UCRL 19244	R.O. Bangerter	(LRL)
BANGERTER	69B	PR 187 1821	R.O. Bangerter *et al.*	(LRL)
BARLOUTAUD	69	NP B14 153	R. Barloutaud *et al.*	(SACL, CERN, HEID)
EISELE	69	ZPHY 221 1	F. Eisele *et al.*	(HEID)
BIERMAN	68	PRL 20 1459	E. Bierman *et al.*	(PRIN)
HEPP	68	ZPHY 214 71	V. Hepp, H. Schleich	(HEID)
WHITESIDE	68	NC 54A 537	H. Whiteside, J. Gollub	(OBER)
BARASH	67	PRL 19 181	N. Barash *et al.*	(UMD)
CHANG	66	PR 151 1081	C.Y. Chang	(COLU)
BAZIN	65B	PR 140 B1358	M. Bazin *et al.*	(PRIN, RUTG, COLU)
DOSCH	65	PL 14 239	H.C. Dosch *et al.*	(HEID)
Also		PR 151 1081	C.Y. Chang	(COLU)
SCHMIDT	65	PR 140 B1328	P. Schmidt	(COLU)
BURNSTEIN	64	PRL 13 66	R.A. Burnstein *et al.*	(UMD)
COURANT	64	PR 136 B1791	H. Courant *et al.*	(CERN, HEID, UMD+)
BARKAS	63	PRL 11 26	W.H. Barkas, J.N. Dyer, H.H. Heckman	(LRL)
HUMPHREY	62	PR 127 1305	W.E. Humphrey, R.R. Ross	(LRL)