Ξ^-

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

The parity has not actually been measured, but + is of course expected.

We have omitted some results that have been superseded by later experiments. The omitted results may be found in our 1986 edition (Physics Letters **170B**) or in earlier editions.

Ξ^- MASS

The fit uses the Ξ^-, $\overline{\Xi}^+$, and Ξ^0 mass and mass difference measurements. It assumes the Ξ^- and $\overline{\Xi}^+$ masses are the same.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1321.32±0.13 OUR FIT					
1321.34±0.14 OUR AVERAGE					
1321.46±0.34	632	DIBIANCA	75	DBC	4.9 GeV/c $K^- d$
1321.12±0.41	268	WILQUET	72	HLBC	
1321.87±0.51	195	[1] GOLDWASSER	70	HBC	5.5 GeV/c $K^- p$
1321.67±0.52	6	CHIEN	66	HBC	6.9 GeV/c $\overline{p}p$
1321.4 ±1.1	299	LONDON	66	HBC	
1321.3 ±0.4	149	PJERROU	65B	HBC	
1321.1 ±0.3	241	[2] BADIER	64	HBC	
1321.4 ±0.4	517	[2] JAUNEAU	63D	FBC	
1321.1 ±0.65	62	[2] SCHNEIDER	63	HBC	

[1] GOLDWASSER 70 uses $m_\Lambda = 1115.58$ MeV.
[2] These masses have been increased 0.09 MeV because the Λ mass increased.

$\overline{\Xi}^+$ MASS

The fit uses the Ξ^-, $\overline{\Xi}^+$, and Ξ^0 mass and mass difference measurements. It assumes the Ξ^- and $\overline{\Xi}^+$ masses are the same.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1321.32±0.13 OUR FIT					
1321.20±0.33 OUR AVERAGE					
1321.6 ±0.8	35	VOTRUBA	72	HBC	10 GeV/c $K^+ p$
1321.2 ±0.4	34	STONE	70	HBC	
1320.69±0.93	5	CHIEN	66	HBC	6.9 GeV/c $\overline{p}p$

$(m_{\Xi^-} - m_{\overline{\Xi}^+}) \,/\, m_{\text{average}}$

A test of *CPT* invariance. We calculate it from the *average* Ξ^- and $\overline{\Xi}^+$ masses above.

VALUE	*DOCUMENT ID*
(1.1±2.7) × 10^{-4} OUR EVALUATION	

Ξ^- MEAN LIFE

Measurements with an error $> 0.2 \times 10^{-10}$ s or with systematic errors not included have been omitted.

VALUE (10^{-10} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.639±0.015 OUR AVERAGE					
1.652±0.051	32k	BOURQUIN	84	SPEC	Hyperon beam
1.665±0.065	41k	BOURQUIN	79	SPEC	Hyperon beam
1.609±0.028	4286	HEMINGWAY	78	HBC	4.2 GeV/c $K^- p$
1.67 ±0.08		DIBIANCA	75	DBC	4.9 GeV/c $K^- d$
1.63 ±0.03	4303	BALTAY	74	HBC	1.75 GeV/c $K^- p$
1.73 $^{+0.08}_{-0.07}$	680	MAYEUR	72	HLBC	2.1 GeV/c K^-
1.61 ±0.04	2610	DAUBER	69	HBC	
1.80 ±0.16	299	LONDON	66	HBC	
1.70 ±0.12	246	PJERROU	65B	HBC	
1.69 ±0.07	794	HUBBARD	64	HBC	
1.86 $^{+0.15}_{-0.14}$	517	JAUNEAU	63D	FBC	

$\overline{\Xi}^+$ MEAN LIFE

VALUE (10^{-10} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.6 ±0.3	34	STONE	70	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.55^{+0.35}_{-0.20}$	35	[3] VOTRUBA	72	HBC	10 GeV/c $K^+ p$
$1.9\ ^{+0.7}_{-0.5}$	12	[3] SHEN	67	HBC	
1.51±0.55	5	[3] CHIEN	66	HBC	6.9 GeV/c $\overline{p}p$

[3] The error is statistical only.

$(\tau_{\Xi^-} - \tau_{\overline{\Xi}^+})\ /\ \tau_{\text{average}}$

A test of CPT invariance. Calculated from the Ξ^- and $\overline{\Xi}^+$ mean lives, above.

VALUE	*DOCUMENT ID*
0.02±0.18 OUR EVALUATION	

Ξ^- MAGNETIC MOMENT

See the Note on Baryon Magnetic Moments in the Λ Listings.

VALUE (μ_N)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
−0.6507±0.0025 OUR AVERAGE					
−0.6505±0.0025	4.36M	DURYEA	92	SPEC	800 GeV p Be
−0.661 ±0.036 ±0.036	44k	TROST	89	SPEC	Ξ^- ∼ 250 GeV
−0.69 ±0.04	218k	RAMEIKA	84	SPEC	400 GeV pBe
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−0.674 ±0.021 ±0.020	122k	HO	90	SPEC	See DURYEA 92
−2.1 ±0.8	2436	COOL	74	OSPK	1.8 GeV/c $K^- p$
−0.1 ±2.1	2724	BINGHAM	70B	OSPK	1.8 GeV/c $K^- p$

$\overline{\Xi}^+$ MAGNETIC MOMENT

See the Note on Baryon Magnetic Moments in the Λ Listings.

VALUE (μ_N)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
+0.657±0.028±0.020	70k	HO	90	SPEC	800 GeV pBe

Ξ^- DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\Lambda\pi^-$		(99.887±0.035) %	
Γ_2	$\Sigma^-\gamma$		(1.27 ±0.23) × 10^{-4}	
Γ_3	$\Lambda e^- \overline{\nu}_e$		(5.63 ±0.31) × 10^{-4}	
Γ_4	$\Lambda\mu^- \overline{\nu}_\mu$		($3.5\ ^{+3.5}_{-2.2}$) × 10^{-4}	
Γ_5	$\Sigma^0 e^- \overline{\nu}_e$		(8.7 ±1.7) × 10^{-5}	
Γ_6	$\Sigma^0 \mu^- \overline{\nu}_\mu$		< 8 × 10^{-4}	90%
Γ_7	$\Xi^0 e^- \overline{\nu}_e$		< 2.3 × 10^{-3}	90%
	$\Delta S = 2$ forbidden ($S2$) modes			
Γ_8	$n\pi^-$	$S2$	< 1.9 × 10^{-5}	90%
Γ_9	$n e^- \overline{\nu}_e$	$S2$	< 3.2 × 10^{-3}	90%
Γ_{10}	$n\mu^- \overline{\nu}_\mu$	$S2$	< 1.5 %	90%
Γ_{11}	$p\pi^-\pi^-$	$S2$	< 4 × 10^{-4}	90%
Γ_{12}	$p\pi^- e^- \overline{\nu}_e$	$S2$	< 4 × 10^{-4}	90%
Γ_{13}	$p\pi^- \mu^- \overline{\nu}_\mu$	$S2$	< 4 × 10^{-4}	90%
Γ_{14}	$p\mu^-\mu^-$	L	< 4 × 10^{-4}	90%

CONSTRAINED FIT INFORMATION

An overall fit to 4 branching ratios uses 5 measurements and one constraint to determine 5 parameters. The overall fit has a χ^2 = 1.0 for 1 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_1	x_2	x_3	x_4
x_2	−6			
x_3	−8	0		
x_4	−99	0	−1	
x_5	−5	0	0	0

Ξ^- BRANCHING RATIOS

A number of early results have been omitted.

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

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
1.27±0.24 OUR FIT					
1.27±0.23 OUR AVERAGE					
1.22±0.23±0.06	211	[4] DUBBS	94	E761	Ξ^- 375 GeV
2.27±1.02	9	BIAGI	87B	SPEC	SPS hyperon beam

[4] DUBBS 94 also finds weak evidence that the asymmetry parameter α_γ is positive (α_γ = 1.0 ± 1.3).

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

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.564±0.031 OUR FIT					
0.564±0.031	2857	BOURQUIN	83	SPEC	SPS hyperon beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.30 ±0.13	11	THOMPSON	80	ASPK	Hyperon beam

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

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$0.35^{+0.35}_{-0.22}$ OUR FIT						
0.35±0.35		1	YEH	74	HBC	Effective denom.=2859
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 2.3	90	0	THOMPSON	80	ASPK	Effective denom.=1017
< 1.3			DAUBER	69	HBC	
<12			BERGE	66	HBC	

$\Gamma(\Sigma^0 e^-\overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ — Γ_5/Γ_1

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.087±0.017 OUR FIT					
0.087±0.017	154	BOURQUIN	83	SPEC	SPS hyperon beam

$\Gamma(\Sigma^0\mu^-\overline{\nu}_\mu)/\Gamma(\Lambda\pi^-)$ — Γ_6/Γ_1

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<0.76	90	0	YEH	74	HBC	Effective denom.=3026
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<5			BERGE	66	HBC	

$\left[\Gamma(\Lambda e^- \overline{\nu}_e) + \Gamma(\Sigma^0 e^- \overline{\nu}_e)\right]/\Gamma(\Lambda\pi^-)$ — $(\Gamma_3+\Gamma_5)/\Gamma_1$

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.651±0.031	3011	[5] BOURQUIN	83	SPEC	SPS hyperon beam
0.68 ±0.22	17	[6] DUCLOS	71	OSPK	

[5] See the separate BOURQUIN 83 values for $\Gamma(\Lambda e^- \overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ and $\Gamma(\Sigma^0 e^- \overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ above.

[6] DUCLOS 71 cannot distinguish Σ^0's from Λ's. The Cabibbo theory predicts the Σ^0 rate is about a factor 6 smaller than the Λ rate.

$\Gamma(\Xi^0 e^- \overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ — Γ_7/Γ_1

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<2.3	90	0	YEH	74	HBC	Effective denom.=1000

$\Gamma(n\pi^-)/\Gamma(\Lambda\pi^-)$ — Γ_8/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<0.019	90		BIAGI	82B	SPEC	SPS hyperon beam
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<3.0	90	0	YEH	74	HBC	Effective denom.=760
<1.1			DAUBER	69	HBC	
<5.0			FERRO-LUZZI	63	HBC	

$\Gamma(n e^- \overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ — Γ_9/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 3.2	90	0	YEH	74	HBC	Effective denom.=715
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<10	90		BINGHAM	65	RVUE	

$\Gamma(n\mu^- \overline{\nu}_\mu)/\Gamma(\Lambda\pi^-)$ — Γ_{10}/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-3})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<15.3	90	0	YEH	74	HBC	Effective denom.=150

$\Gamma(p\pi^-\pi^-)/\Gamma(\Lambda\pi^-)$ — Γ_{11}/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<3.7	90	0	YEH	74	HBC	Effective denom.=6200

$\Gamma(p\pi^- e^- \overline{\nu}_e)/\Gamma(\Lambda\pi^-)$ — Γ_{12}/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<3.7	90	0	YEH	74	HBC	Effective denom.=6200

$\Gamma(p\pi^- \mu^- \overline{\nu}_\mu)/\Gamma(\Lambda\pi^-)$ — Γ_{13}/Γ_1

ΔS=2. Forbidden in first-order weak interaction.

VALUE (units 10^{-4})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<3.7	90	0	YEH	74	HBC	Effective denom.=6200

$\Gamma(p\mu^-\mu^-)/\Gamma(\Lambda\pi^-)$ — Γ_{14}/Γ_1

A ΔL=2 decay, forbidden by total lepton number conservation.

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<3.7	90	[7] LITTENBERG	92B	HBC	Uses YEH 74 data

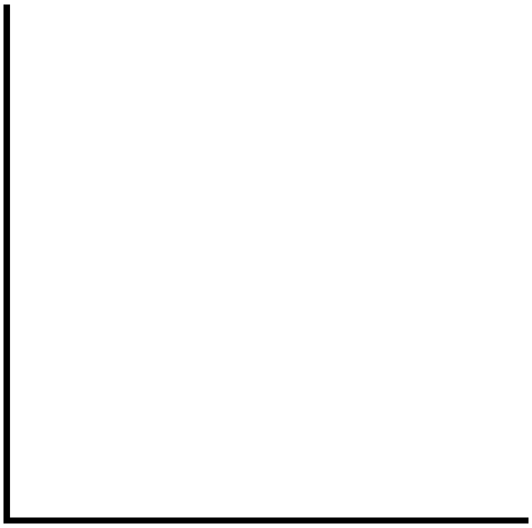
[7] This LITTENBERG 92B limit and the identical YEH 74 limits for the preceding three modes all result from nonobservance of any 3-prong decays of the Ξ^-. One could as well apply the limit to the *sum* of the four modes.

Ξ^- DECAY PARAMETERS

See the Note on Baryon Decay Parameters in the neutron Listings.

$\alpha(\Xi^-)\alpha_-(\Lambda)$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.293±0.007 OUR AVERAGE	Error includes scale factor of 1.8. See the ideogram below.				
−0.303±0.004±0.004	192k	RAMEIKA	86	SPEC	400 GeV pBe
−0.257±0.020	11k	ASTON	85B	LASS	11 GeV/c $K^- p$
−0.260±0.017	21k	BENSINGER	85	MPS	5 GeV/c $K^- p$
−0.299±0.007	150k	BIAGI	82	SPEC	SPS hyperon beam
−0.315±0.026	9046	CLELAND	80C	ASPK	BNL hyperon beam
−0.239±0.021	6599	HEMINGWAY	78	HBC	4.2 GeV/c $K^- p$
−0.243±0.025	4303	BALTAY	74	HBC	1.75 GeV/c $K^- p$
−0.252±0.032	2436	COOL	74	OSPK	1.8 GeV/c $K^- p$
−0.253±0.028	2781	DAUBER	69	HBC	



$\alpha(\Xi^-)\alpha_-(\Lambda)$

α FOR $\Xi^- \rightarrow \Lambda\pi^-$

The above average, $\alpha(\Xi^-)\ \alpha_-(\Lambda) = -0.293 \pm 0.007$, where the error includes a scale factor of 1.8, divided by our current average $\alpha_-(\Lambda) = 0.642 \pm 0.013$, gives the following value for $\alpha(\Xi^-)$.

VALUE	DOCUMENT ID
−0.456±0.014 OUR EVALUATION	Error includes scale factor of 1.8.

ϕ ANGLE FOR $\Xi^- \rightarrow \Lambda\pi^-$ $(\tan\phi = \beta/\gamma)$

VALUE (°)	EVTS	DOCUMENT ID		TECN	COMMENT
4 ± 4 OUR AVERAGE					
5 ±10	11k	ASTON	85B	LASS	$K^- p$
14.7±16.0	21k	[8] BENSINGER	85	MPS	5 GeV/c $K^- p$
11 ± 9	4303	BALTAY	74	HBC	1.75 GeV/c $K^- p$
5 ±16	2436	COOL	74	OSPK	1.8 GeV/c $K^- p$
−26 ±30	2724	BINGHAM	70B	OSPK	
−14 ±11	2781	DAUBER	69	HBC	Uses $\alpha_\Lambda = 0.647\pm0.020$
0 ±12	1004	[9] BERGE	66	HBC	
0 ±20.4	364	[9] LONDON	66	HBC	Using $\alpha_\Lambda = 0.62$
54 ±30	356	[9] CARMONY	64B	HBC	

[8] BENSINGER 85 used $\alpha_\Lambda = 0.642 \pm 0.013$.

[9] The errors have been multiplied by 1.2 due to approximations used for the Ξ polarization; see DAUBER 69 for a discussion.

g_A / g_V FOR $\Xi^- \to \Lambda e^- \overline{\nu}_e$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
−0.25±0.05	1992	[10] BOURQUIN	83	SPEC	SPS hyperon beam

[10] BOURQUIN 83 assumes that $g_2 = 0$. Also, the sign has been changed to agree with our conventions, given in the Note on Baryon Decay Parameters in the neutron Listings.

Ξ^- REFERENCES

We have omitted some papers that have been superseded by later experiments. The omitted papers may be found in our 1986 edition (Physics Letters **170B**) or in earlier editions.

DUBBS	94	PRL 72 808	+Albuquerque, Bondar+	(FNAL E761 Collab.)
DURYEA	92	PRL 68 768	+Guglielmo, Heller+	(MINN, FNAL, MICH, RUTG)
LITTENBERG	92B	PR D46 R892	+Shrock	(BNL, STON)
HO	90	PRL 65 1713	+Longo, Nguyen, Luk+	(MICH, FNAL, MINN, RUTG)
Also	91	PR D44 3402	Ho, Longo, Nguyen, Luk+	(MICH, FNAL, MINN, RUTG)
TROST	89	PR D40 1703	+McCliment, Newsom, Hseuh, Mueller+	(FNAL-715 Collab.)
BIAGI	87B	ZPHY C35 143	+	(BRIS, CERN, GEVA, HEIDP, LAUS, LOQM, RAL)
RAMEIKA	86	PR D33 3172	+Beretvas, Deck+	(RUTG, MICH, WISC, MINN)
ASTON	85B	PR D32 2270	+Carnegie+	(SLAC, CARL, CNRC, CINC)
BENSINGER	85	NP B252 561	+	(CHIC, ELMT, FNAL, ISU, PNPI, MASD)
BOURQUIN	84	NP B241 1	+	(BRIS, GEVA, HEIDP, LALO, RAL, STRB)
RAMEIKA	84	PRL 52 581	+Beretvas, Deck+	(RUTG, MICH, WISC, MINN)
BOURQUIN	83	ZPHY C21 1	+Brown+	(BRIS, GEVA, HEIDP, LALO, RL, STRB)
BIAGI	82	PL 112B 265	+	(BRIS, CAVE, GEVA, HEIDP, LAUS, LOQM, RL)
BIAGI	82B	PL 112B 277	+	(LOQM, GEVA, RL, HEIDP, CAVE, LAUS, BRIS)
CLELAND	80C	PR D21 12	+Cooper, Dris, Engels, Herbert+	(PITT, BNL)
THOMPSON	80	PR D21 25	+Cleland, Cooper, Dris, Engels+	(PITT, BNL)
BOURQUIN	79	PL 87B 297	+	(BRIS, GEVA, HEIDP, ORSAY, RHEL, STRB)
HEMINGWAY	78	NP B142 205	+Armenteros+	(CERN, ZEEM, NIJM, OXF)
DIBIANCA	75	NP B98 137	+Endorf	(CMU)
BALTAY	74	PR D9 49	+Bridgewater, Cooper, Gershwin+	(COLU, BING) J
COOL	74	PR D10 792	+Giacomelli, Jenkins, Kycia, Leontic, Li+	(BNL)
Also	72	PRL 29 1630	Cool, Giacomelli, Jenkins, Kycia, Leontic+	(BNL)
YEH	74	PR D10 3545	+Gaigalas, Smith, Zendle, Baltay+	(BING, COLU)
MAYEUR	72	NP B47 333	+VanBinst, Wilquet+	(BRUX, CERN, TUFTS, LOUC)
VOTRUBA	72	NP B45 77	+Safder, Ratcliffe	(BIRM, EDIN)
WILQUET	72	PL 42B 372	+Fliagine, Guy+	(BRUX, CERN, TUFTS, LOUC)
DUCLOS	71	NP B32 493	+Freytag, Heintze, Heinzelmann, Jones+	(CERN)
BINGHAM	70B	PR D1 3010	+Cook, Humphrey, Sander+	(UCSD, WASH)
GOLDWASSER	70	PR D1 1960	+Schultz	(ILL)
STONE	70	PL 32B 515	+Berlinghieri, Bromberg, Cohen, Ferbel+	(ROCH)
DAUBER	69	PR 179 1262	+Berge, Hubbard, Merrill, Miller	(LRL) J
SHEN	67	PL 25B 443	+Firestone, Goldhaber	(UCB, LRL)
BERGE	66	PR 147 945	+Eberhard, Hubbard, Merrill+	(LRL)
CHIEN	66	PR 152 1171	+Lach, Sandweiss, Taft, Yeh, Oren+	(YALE, BNL)
LONDON	66	PR 143 1034	+Rau, Goldberg, Lichtman+	(BNL, SYRA)
BINGHAM	65	PRSL 285 202		(CERN)
PJERROU	65B	PRL 14 275	+Schlein, Slater, Smith, Stork, Ticho	(UCLA)
Also	65	Thesis	Pjerrou	(UCLA)
BADIER	64	Dubna Conf. 1 593	+Demoulin, Barloutaud+	(EPOL, SACL, ZEEM)
CARMONY	64B	PRL 12 482	+Pjerrou, Schlein, Slater, Stork+	(UCLA) J
HUBBARD	64	PR 135B 183	+Berge, Kalbfleisch, Shafer+	(LRL)
FERRO-LUZZI	63	PR 130 1568	+Alston-Garnjost, Rosenfeld, Wojcicki	(LRL)
JAUNEAU	63D	Siena Conf. 4	+	(EPOL, CERN, LOUC, RHEL, BERG)
Also	63B	PL 5 261	Jauneau+	(EPOL, CERN, LOUC, RHEL, BERG)
SCHNEIDER	63	PL 4 360		(CERN)

OTHER RELATED PAPERS

PONDROM 85 PRPL 122 57 (WISC)
Review of FNAL hyperon experiments.