EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN/TCC 73-35
T233
August, 1973

CERN Proposal

Georges W. London

Brookhaven National Laboratory

PURPOSES

1. To make a definitive statement concerning the possible I = 0 Z^* resonance by studying the reaction $K_L^o p \rightarrow K_S^o p$ as a function of c.m. energy from 1645 to 1860 MeV;
2. To begin a study of the I = 1 $\bar{K}^o p$ hyperon-producing reactions in the same interval.

EXPERIMENTAL SETUP

Similar to proposal #208 (1), (2) by the Bologna, Edinburgh, Glasgow, Pisa, RHEL (BEGPR) collaboration:

1. 5 p.s bunches (or more if possible).
2. Modified K8 beam at 1.21 - 1.46 BeV/c
3. 350 K pictures in 2-meter chamber.

STUDY OF $K_L^o p \rightleftarrows K_S^o p$ AND $\bar{K}^o p$ REACTIONS BETWEEN 1645 AND 1860 IN C.M.

I. INTRODUCTION

We would like to propose to study two distinct and important reactions as a function of c.m. energy:

a. $K_L^o p \rightarrow K_S^o p$ (to measure the I=0 KN elastic phase shifts in the region of the possible Z_o^* resonance); and

b. $\bar{K}^o p \rightarrow \Lambda$ or $\Sigma + n\ \pi$ (to study the formation of Y_1^* resonances in the important c.m. energy region 1645 - 1860 MeV).

The main point of this experiment is to give a definitive answer to the question, "Is there an I=0 Z^* resonance?"

The K_L beam would be produced by $\pi^- p$ interactions (producing $\Lambda^o K^o$ and $\Sigma^o K^o$) using the modified K8 beam between 1.21 and 1.46 GeV/c in an external hydrogen target similar to that of proposal #208[1]. The detection apparatus of the subsequent $K_L p$ interactions is the CERN 2-meter hydrogen bubble chamber. The number of pictures required is 350,000. Since the BEGPR collaboration has requested an additional 500K pictures[2] at a lower energy, we propose to run our experiment at the same time as their extension.

II. $K_L^o p \rightarrow K_S^o p$

A. Experimental situation for Z^* resonances.

The important but vexing problem of whether or not there are Z^* resonances with I=0 or I=1 has been with us since the discovery by Cool et al.[3] of peaks in the I=0 and I=1 total cross sections determined by K^+p and K^+d measurements. Since that time, a large study has been made of K^+p elastic scattering (differential cross sections[4] and polarizations[5]), K^+n charge exchange, and K^+n elastic scattering.[6] A polarization measurement in the charge exchange channel has been made at 600 MeV/c[7].

The I = 1 K^+p elastic scattering is characterized by the rapid increase in inelasticity in the P_3 wave near threshold for K^*N production. There is no preference for a resonance solution among the 4 preferred solutions.[8]

The I = 0 waves as studied in K^+n charge exchange and elastic scattering (which include both I = 0 and I = 1 waves) in the 0.6-1.5 GeV/c region give more tantalizing evidence of resonance structure in the P_1 wave. Starting with each of the four <u>fixed</u> I = 1 solutions, searches have been made for I = 0 solutions. Three I =0,1 combinations have been found called A, C, and D, with preferred probabilities. Solutions C and D exhibit classical resonance behavior in the P_1 wave (near an energy about 1800 MeV) while solution A does not appear to have a resonance interpretation.[9] See Fig. 1. Naturally, more scattering experiments would help understand the situation, but qualitatively new data is needed.

B. Proposed method to study KN phase shifts.

A detailed study of the reaction

$$K_L^o p \rightarrow K_S^o p \qquad (1)$$

would yield data of a qualitatively different character which does bear on this problem. Using the CP-conserving definition of K_L and K_S, the initial state can be expressed as eigenstates of strangeness indicated by superscript, and isospin indicated by $\binom{I}{I_Z}$:

$$|\,i> = |\,1/\sqrt{2}\,(K^o - \bar{K}^o)p> = 1/\sqrt{2}\,|\,1/\sqrt{2}\,\{\binom{1}{o}^+ + \binom{o}{o}^+\} - \binom{1}{1}^- > .$$

Similarly the final state is

$$|f> = 1/\sqrt{2}\ |\ 1/\sqrt{2}\ \{\binom{1}{0}^{+} + \binom{0}{0}^{-}\} + \binom{1}{1}^{-} >.$$

Since strangeness and isospin are conserved, the amplitude for the reaction is

$$T = \frac{1}{4}\ (Z_o + Z_1 - 2Y_1) \qquad (2)$$

where

Z_o = the I = 0, KN amplitude

Z_1 = the I = 1, KN amplitude

Y_1 = the I = 1, $\bar{K}$N amplitude.

Due to the fact that there is a highly elastic and relatively narrow resonance in the region of the possible Z_o resonance, the $Y_1^*(1765)$, the reaction is in fact very sensitive to the different Z_o solutions through interference with the rapidly varying Y_1 amplitude. The cross section (Fig. 2) and the differential cross section predictions (Fig. 3 and Fig. 4) are quite different. The data points come from Brody et al[10] and favor the resonant solutions C and D (see Appendix). These predictions have been calculated in the 600-1200 MeV/c region by using the appropriate Z_1 solutions,[4] Z_o solutions[9] and Y_1 solutions.[11] The parametrization was checked by recalculating the published amplitudes and differential cross sections. The error on the predicted cross sections comes only from the full error matrix for the Z_o parameters. The Z_1 parameters are left fixed in this calculation as in the K^+n analysis, which gave the solutions we wish to test, at the values given by the K^+p analysis. The introduction of Z_1 errors in the K^+n analysis would reduce the χ^2/degree of freedom, but its effect on the Z_o errors is not obvious. The errors on the C solution are quite small because its error matrix is highly correlated.

C. Projected results and sensitivity of proposed experiment.

We propose to use only events where the $K_S \to \pi^+ \pi^-$ decay is observed and where the proton has a length greater than 2 cm (i.e. $\cos \theta^*_p \geq 0.9$). We assume a scanning efficiency of 90%. Therefore we have a detection efficiency of 2/3 x 0.85 x 0.90 = 0.51.

We propose to determine our flux in two independent ways: via the known $\bar{K}^o p \to \Lambda \pi^+$ reaction and via K_L decays. Each method will provide a measurement to less than ± 10%.

We have tested the projected results, i.e. the measured differential cross sections, for each of the three Z_o solutions by assuming in turn that one is correct giving "experimental" numbers within statistical errors. We have performed 100 random experiments. For each momentum we normalized the predicted differential cross sections to the "experimental" one to compare the shapes. To this comparison, we added separately a comparison of the different cross section predictions assuming a 10% flux error. Fig. 5 shows the results for one random experiment at one momentum, assuming the D solution is correct. Table I gives the results for the median of 100 experiments. Note that the important comparison is between the resonant solutions (C or D) and the non-resonant solution (A).

TABLE I

Overall χ^2/DF=190

(Cross section contribution, DF=10)

"experimental solution" / test solution	A	C	D
A	0	5.9 (7.7)	6.7 (17.1)
C	1595 (46)	0	47 (5.8)
D	1.5 (11.3)	0.2 (2.4)	0

It is clear from this table that the resonant solutions can be separated from the non-resonant solution. The sensitivity of this proposed experiment is quite large, with contributions coming from both the shape of the differential cross section as well as the channel cross section. For example, if D is correct, the χ^2/DF for the A solution goes from 2.1 for the previous experiments[8] to 3.2, while that for the D solution goes from 1.8 to 1.4. Analysis of the "stretch functions" can be even more sensitive since they would show systematic effects.

III. BEGINNING STUDY OF $\bar{K}^o p$ REACTIONS

A. Experimental situation.

The center of mass energy region, 1645-1860 MeV, has proven to be very rich in Y_o^* and Y_1^* resonances. It has also proven rich in controversy. The following table lists the know or reasonably suspected Y^* resonances in the mass interval.

TABLE II

Y_o^*	Y_1^*
1670 ?	1660 ?
1690 ?	1680 ?
1815	1750 ?
1830 ?	1765

The resonances marked with a question mark have some questionable status which we now enumerate:

1. The $\Lambda\eta$ threshold effect at 1670[12] for which a p-wave scattering length fits the data as adequately as an s-wave resonance seems

to have been observed in $\Sigma\pi^{(13)}$ implying its resonant nature. This observation comes from the interference of this effect with the D_{03} resonance at 1690, whose width in the elastic channel differs greatly from the width in the $\Sigma\pi$ channel. If you consider that this result comes from disentangling the I = 0 and I = 1 partial waves and that there is the nearby Y_1^* (1660), both the Y_o^* (1670) and Y_o^* (1690) need work. In addition recent experiemnts(14) indicate that there is no bump in the $\Sigma\pi$ cross section as seen in Ref. 13.

2. The Y_o^* (1830) is only seen in partial wave analysis in the differential cross section as an interference effect. When you consider that the elasticity is about 5%, one must doubt the quantitative, if not qualitative, results of such an analysis at this time.

3. The 3/2 Y_1^* (1660) is well established except for its branching ratios. These vary so much, both in formation and production, that perhaps two resonances are at the same place. For example, in production, one finds an equal amount of $\Sigma\pi$ and Y_o^* (1405)π decay modes (15) while in formation there seems to be almost no signal in Y_o^* (1405)π as compared to $\Sigma\pi$ (16) and a reasonable $\Lambda\pi$ decay mode (about 20%).(17) In one experiment (18), the branching ratio, $\Sigma\pi/Y_o^*$ (1405), seems to be a function of the production angle suggesting at least two resonances. These results could be compatible if one Y_1^* (1660) resonance was elastic and the other not.

4. The Y_1^* (1680) (19) found in production decaying into $\Lambda\pi$ is not found in K^-p formation (17) but is found in $\bar{K}^o p$ experiments. (20). A crucial point in the production and formation experiments is the separation of Λ from Σ, and the branching ratios of the Y_1^* (1660) into $\Lambda\pi$ and $\Sigma\pi$.

5. The $\Sigma\eta$ threshold effect $^{(21)}$ at 1750 reminiscent of the $\Lambda\eta$ effect is far from established as a resonance. There is even disagreement as to the production dynamics $^{(22)}$ and production angular distribution near threshold.

The K^-p formation experiment in hydrogen has brought important information concerning Y_o^* and Y_1^* resonances. However, it has not exhausted the possible information derivable from $\bar{K}p$ formation experiments mainly because of the mixed isospin of most of the final states studied. It appears necessary to restudy this region either by having a unique isospin initial state or by isolating unique isospin final states.

B. Proposed method to study $\bar{K}N$ I = 1 phase shifts.

We propose to study $\bar{K}^op$ interactions whose initial state is pure I = 1, in the cm energy region of 1645-1860 MeV. It should be noted here that there is no such previous formation study. Experiments have been done with K^- in deuterium but the spectator proton problem has not been clearly solved. The BEGPR collaboration is making a study of $\bar{K}^op$ reaction in the region of cm energy 1540-1690 MeV, which conveniently overlaps our region.

The following reactions are to be studied:

3a/$\bar{K}^op \rightarrow \Lambda\pi+$

3b/$\bar{K}^op \rightarrow \Sigma^+\pi^o$

3c/$\bar{K}^op \rightarrow \Sigma^+\pi^o$

3d/$\bar{K}^op \rightarrow \Lambda\ \pi^+\pi^o$

3e/$\bar{K}^op \rightarrow \Sigma^+\pi^-\pi^+$

3f/$\bar{K}^op \rightarrow \Sigma^-\pi^+\pi^+$

3g/$\bar{K}^op \rightarrow \Sigma^+\eta$

We propose to use only events where the neutral hyperon (Λ or Σ) decays eventually via $\Lambda \rightarrow p\pi^-$ and where the charged hyperon ($\Sigma^{\pm}$) decays via the charged pion mode. A 90% scanning efficiency is assumed. Short charged decays have an additional correction (90%). The detection efficiencies therefore for the different reactions are:

Reactions a/, b/, d/: $2/3 \times 0.9 \times 0.9 = 0.54$

Reactions c/, e/, g/: $1/2 \times 0.9 \times 0.9 = 0.41$

Reactions f/: $0.9 \times 0.9 = 0.81$

Figure 6 gives the cross sections for reactions a/ - g/ as a function of K momentum. These cross sections give the numbers of events per channel per momentum found in Table III

TABLE III

E^*	$\Lambda\pi$	$\Sigma^0\pi^+$	$\Sigma^+\pi^0$ (a)	$\Lambda\pi^+\pi^0$	$\Sigma^+\pi^-\pi^+$	$\Sigma^-\pi^+\pi^+$	$\Sigma^+\eta$ (a)
1644	485	230	175	195	20	75	-
1671	525	200	150	240	20	75	-
1704	555	160	120	275	25	95	-
1723	1690	435	330	935	100	395	-
1747	1810	410	310	1135	145	545	110
1775	1780	350	265	1050	190	655	220
1794	1690	335	255	1095	175	635	175
1817	970	195	150	775	155	610	145
1840	775	175	135	775	145	670	120
1859	390	175	135	745	135	415	90

(a) It is quite possible that the $\Sigma^+\pi^0$ events will be hard to scan and fit, as well as the $\Sigma^+\eta$ events except for the $\eta \to \pi^+\pi^-\pi^0$ and $\pi^+\pi^-\gamma$ decay modes (30%).

It is obvious from this table that we will be able to make a reasonable first study of the entire region for some channels and only for $E^* \geq 1723$ for others.

Combined with the BEGPR study, $\bar{K}^o p$ reactions will have been studied from 1540-1860 MeV in cm energy.

C. Background

The main background will be the 1C fit categories which fit other production reactions (e.g. $\Lambda\pi^+\pi^o$ which fits $\Sigma\pi^+$). In addition we have the problem of the dienergetic beam.

We have studied the 1C vs 2C ambigiuty and conclude that there will be little problem. The probability for a $\Lambda\pi\pi$ hypothesis to fit a $\Sigma\pi$ event is about 10% for either beam component. The reverse is considerably less. Thus any event which fits $\Sigma\pi$ is accepted as such.

The dienergic beam may present great problems for the $\Sigma^+\pi^o$ final state if we find that we have little information for the Σ momentum or even from the 0C decay fit. This is true also for the $\Sigma^+\eta$ case except for the charged η decay modes.

IV EXPERIMENTAL ARRANGEMENT

We summarize the experimental set up as described in proposal # 208.(1)

A. Pi beam

Using 5 p.s. bunches (or more) at 24 GeV/c, the K8 beam line (30m long) will produce a separated π^- beam in 7 momentum intervals between 1.21 and 1.46 GeV/c. (Proposal #208 has momentum intervals between 1.0 and 1.18 GeV/c). The π^- will pass through a 60 cm long hydrogen target about 7 meters from the chamber. We propose to increase the momentum bite of the π beam if possible from $\pm$ 1.3% (proposal #208) to about $\pm$ 2%, thus increasing the K^o flux by about 1.5. However, our yield estimates are based on the $\pm$ 1.3% bite used by BEGPR in its October 1972 run. The resulting increased K^o momentum bite will not hurt us in the important K_S regeneration channel of this experiment which has 3 constraints <u>without</u> the K_L^o momentum, but the increased flux will definitely help.

B. K^o beam and flux

The K_L^o will be produced at 6^o. The angular divergence of the beam is ∿ ± 6 mr at the chamber window. The October 1972 run by the BEGPR collaboration has been analyzed for the K_L^o flux. At the highest π^- momentum, 1.18 GeV/c the number of K_L^o/ picture, determined by K_L^odecays, was about 2.(2) Using this figure, we have calculated the flux at higher π momenta by considering as a function of π momentum:

1. The production of π^- by 24 GeV/c protons at 0^o
2. The decay of π^-.
3. The production of K^o.
4. The decay of K_L^o.

By coincidence these factors cancel so that the number of K_L^o entering the chamber is ∿ 2 independent of energy. The events/mb per K^o momentum is calculated using 50K pictures at each of 7 π momenta, 2 K_L^o/ pictures, and a 150 cm fiducial length, and is shown in Table IV.

TABLE IV

$P\pi$	P_K	events/mb
1.21	680	180
1.25	740	180
1.30	810	180
1.21, 1.32	850	540
1.25, 1.36	900	540
1.30, 1.42	960	540
1.32, 1.46	1000	540
1.36	1050	360
1.42	1100	360
1.46	1140	360
		3780

C. Background

The collimation of the beam, the removal of charged particles and the reduction of the photon component will be similar to the October 1972 run since that run was quite successful as to background.(2) The neutron component should actually be reduced since neutron-producing cross sections (e.g. $\pi^- p \rightarrow n\pi^o$ and $n\pi^+\pi^-$) are falling rapidly and, in the case of $n\pi^+\pi^-$, becoming more peripheral due to ρ production.

V. DATA ANALYSIS

In the 350,000 pictures we will have to measure about 5K ($K_L p \rightarrow K_S p$) events, 30K ($\bar{K}^o p \rightarrow$ hyperon) events, and 10-25K (K_L decay) events, giving a total of 45-60K events or 1 event every 6 to 8 pictures. We believe that we can scan and measure these events in one year, using about 10-15% of the group's capacity.

VI. CONCLUSION

We have shown that we can give a definitive answer to the question, "Is there an $I = o$ Z^* resonance ?" At the same time, we have shown that we can contribute important information concerning Y_1^* resonances by making a study of $\bar{K}^o p$ hyperon-producing reactions.

REFERENCES

1. "Proposal to Measure Parameters of the τ and Semi-leptonic Decays of K_L^o, TCC 71-18", Rutherford High Energy Laboratory.
2. "Extension of Proposal 208 (K_L^o Decays and Interactions)", TCC 73-18, Bologna, Edinburgh, Glasgow, Pisa, RHEL Collaboration; and G. Gopal, private communication.
3. R.L. Cool et al., Phys. Rev. Letters 17, 102 (1966).
4. G. Giacomelli et al., Nucl. Physics B20, 301 (1970).
5. R.D. Ehrlich et al., Phys. Rev. Letters 24, 160 (1970).
6. G. Giacomelli et al., Nucl. Physics B42, 437 (1972); B.C. Wilson et al., Nucl. Physics B42, 445 (1972).
7. A.K. Ray et al., Phys. Review 183, 1183 (1969).
8. J.D. Dowell, reported at Batavia Conference, p. 40, Vol. 1 (1972).
9. R. Jennings, presented at the Purdue Conference on Baryon Resonances, (1973) and private communication.
10. A.D. Brody et al., Phys. Rev. Letters 26 1050 (1971); and J. Matthews, private communication.
11. R. Armenteros et al., Nucl. Physics B 195 (1968).
12. D. Berley et al., Phys. Rev. Letters , 645 (1965).
13. R. Armenteros et al., Physics Letters 24B, 198 (1967).
14. R.Y.L. Chu et al., Purdue Conference (1973); and D. Baxter et al., Purdue Conference (1973).
15. e.g. G. W. London et al., Phys. Review 143, 1043 (1966).
16. R. Armenteros et al., Nucl. Physics B 223 (1968).
17. R. Armenteros et al., Nucl. Physics B 223 (1968).
18. P. Eberhard, LBL-2012 (1973).
19. M. Derrick et al., Phys. Rev. Letters 18, 226 (1967).
20. B. J. Blumenfeld et al., Physics Letters 9B, 41 (1967).
21. D. Cline et al., Physics Letters 25B, 41 (1967).
22. W. Delaney et al., Nuovo Cimento Letters 1 497 (1969).

APPENDEX

Submitted to PHYSICS LETTERS, Aug. 1973

The Reaction $K_L^o p \to K_S^o p$ and the Possible Existence of Z^* Resonances[*]

Georges W. London

Brookhaven National Laboratory

The vexing problem of whether there are Z^* resonances (with $I = 0$ or $I = 1$) or not has been with us since the discovery of Cool *et al.*[1] of peaks in the $I = 0$ and $I = 1$ total cross sections in K^+p and K^+d measurements. Since that time, the effects have been confirmed[2] and a large study has been made of K^+p elastic scattering (differential cross sections[3] and polarizations[4]), K^+n charge exchange, and K^+n elastic scattering.[5]

The $I = 1$ K^+p elastic scattering is characterized by the rapid increase in inelasticity in the P_3 wave near the threshold for K^*N production. There are 4 preferred solutions which are similar. An extensive analysis of the inelastic channels showed no need for a resonance interpretation.

The $I = 0$ waves as studied in K^+n charge exchange and elastic scattering (which include both $I = 0$ and $I = 1$ waves) give more tantalizing evidence of resonance structure in the P_1 wave. Starting with each of the four $I = 1$ solutions a search was made for $I = 0$ solutions. Three solutions are found, called A($\sim$E), C and D. Solutions C and D exhibit classical resonance behavior in the P_1 wave (near an energy $\sim$ 1800 MeV) while solution A does not appear to have a resonance interpretation. Naturally more experiments of the same type would help understand the situation. Qualitatively new data such as more polarization information is needed. (A polarization measurement in the charge exchange channel at 600 MeV/c [8] favors solutions C and D.)

---

[*] Work supported by the U.S. Atomic Energy Commission.

However, it has not been noticed apparently that there is published data of a qualitatively different character which bears on this problem. While the statistical weight of this data is not high in comparison to the many differential cross section points, it is quite suggestive.

The reaction

$$K_L^o p \rightarrow K_S^o p \qquad (1)$$

has been measured[10] from 600 MeV/c through the interesting region in 200-MeV/c steps. Using the CP-conserving definition of K_L and K_S and isospin conservation, one can easily show that the amplitude for this reaction is

$$T = 1/4(Z_o + Z_1 - 2Y_1) \qquad (2)$$

where

Z_o = the I = 0, KN amplitude

Z_1 = the I = 1, KN amplitude

Y_1 = the I = 1, $\bar{K}N$ amplitude.

Y_1 is known in the 600- to 1200-MeV/c region.[11] Due to the fact that there is a highly elastic and relatively narrow resonance in this region, the $Y_1^*(1765)$, the reaction is very sensitive to the different Z_o solutions. Using the appropriate Z_1 solutions,[3] Z_o solutions[8] and Y_1 solutions,[11] we have calculated the cross section for reaction 1 in 3 intervals. These are given in Table 1. The error on the predicted cross section comes from the full error matrix for the Z_o parameters for the amplitudes.[12] The very small errors for the C solution are due to the highly correlated nature of its error matrix. In fact, if the parametrization is correct, the C solution can be omitted due to its pathological error matrix.

These results give some support to the resonant solution since the probabilities that the three data agree with the D, C and A solutions are 27%, 4% and 4.4×10^{-4} respectively.

FIGURE CAPTIONS

Figure 1. The p_1 Argand plots for the three Z_o solutions, D,C,A, (see text).

Figure 2. The predicted cross section for $K_L^o p \to K_S^o p$ for the three Z_o solutions, D, C and A (see text) as a function of K_L^o laboratory momentum. The shaded regions indicate the one standard deviation theoretical error. The three experimental points are indicated.

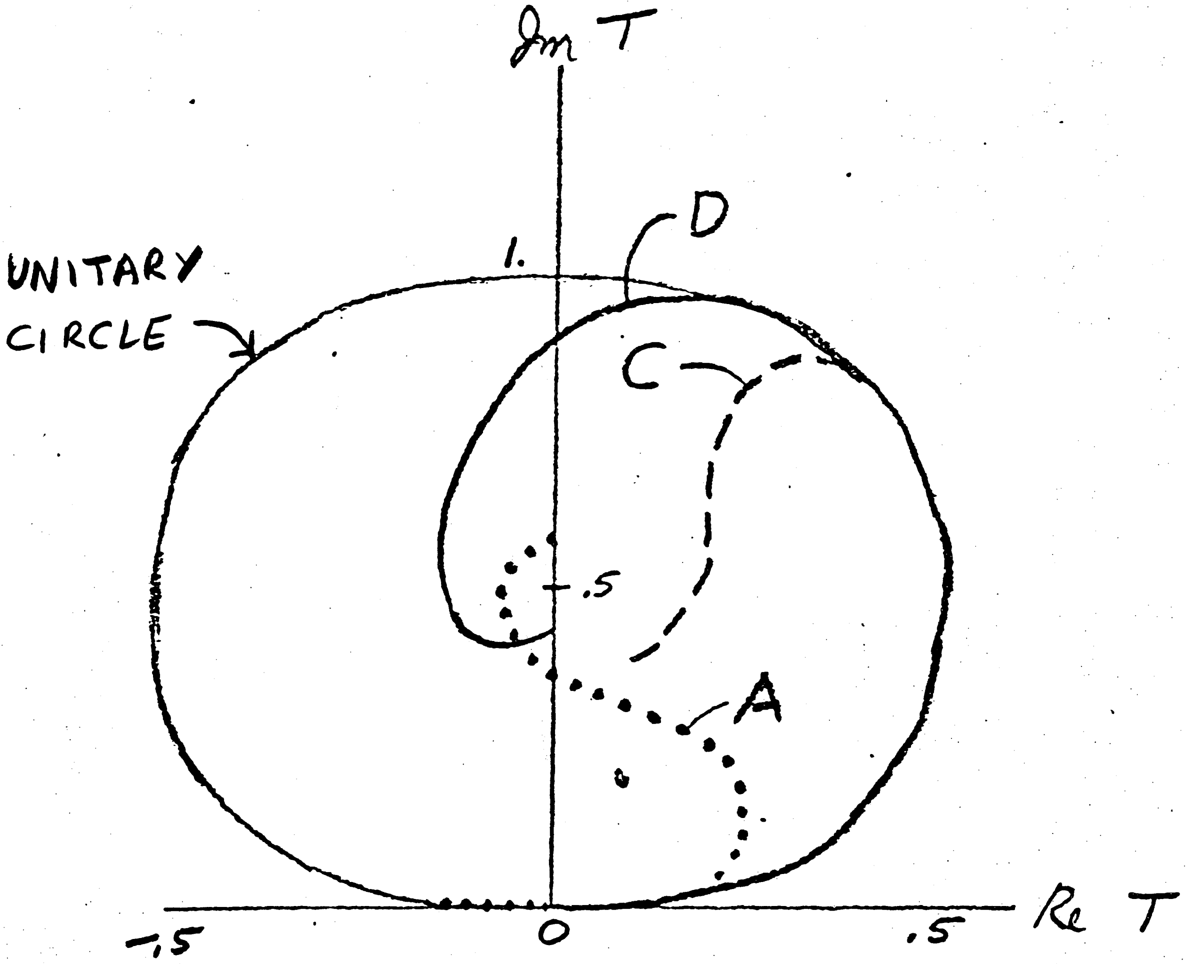
Figure 3. The differential cross sections for $K_L^o p \to K_S^o p$ at a/p_K = 860 MeV/c, b/p_K = 960 MeV/c and c/ p_K = 1060 MeV/c, for the three Z_o solutions, D, C and A (see text). The ordinate was obtained by assuming an experiment equal in statistics to 1000 events/millibarn/momentum. The center of mass scattering angle is that of the proton.

Figure 4. The predicted $A_1 - A_4$ coefficients as a function of cm energy, E^*, for the three Z_o solutions, D, C, A (see text). The A_n coefficients are defined as

$$\frac{d\sigma}{d\Omega}\,(E^*,\theta^*) = \bar{\lambda}^2 \Sigma A_n\,(E^*) P_n\,(\theta^*)$$

Figure 5. The "experimental" differential cross section for a random experiment at p_K = 960 MeV/c assuming that the D solution is correct, as compared to the three Z_o solutions, D, C, A (see text).

Figure 6. The cross section for reactions 3 (see text) as a function of cm energy.



P_1 ARGAND PLOT
I=0 KN

FIG. 1

References

1. R.L. Cool et al., PRL 17, 102 (1966).
2. D.V. Bugg et al., PR 168, 1466 (1968).
3. G. Giacomelli et al., NP B20, 301 (1970).
4. R.D. Ehrlich et al., PRL 24 160 (1970).
5. G. Giacomelli et al., NP B42, 437 (1972); B.C. Wilson et al., NP B42, 445 (1972).
6. J.D. Dowell, reported at Batavia Conference, p. 40, Vol. 1 (1972).
7. R. Bland et al., UCRL-18758 (1969).
8. R. Jennings, Purdue Conference (1973) and private communication.
9. A.K. Ray et al., PR 183, 1183 (1969).
10. A.D. Brody et al., PRL 26, 1050 and J. Matthews, private communication.
11. R. Armenteros et al., B8, 195 (1968); C. Bricman et al., PL 31B, 152 (1970).
12. We note that the Z_1 parameters are left fixed in this analysis as in the K^+n analysis at the values given by K^+p analysis, though these parameters should be introduced with their full error matrix.
13. G.W. London, proposal to CERN(1973).

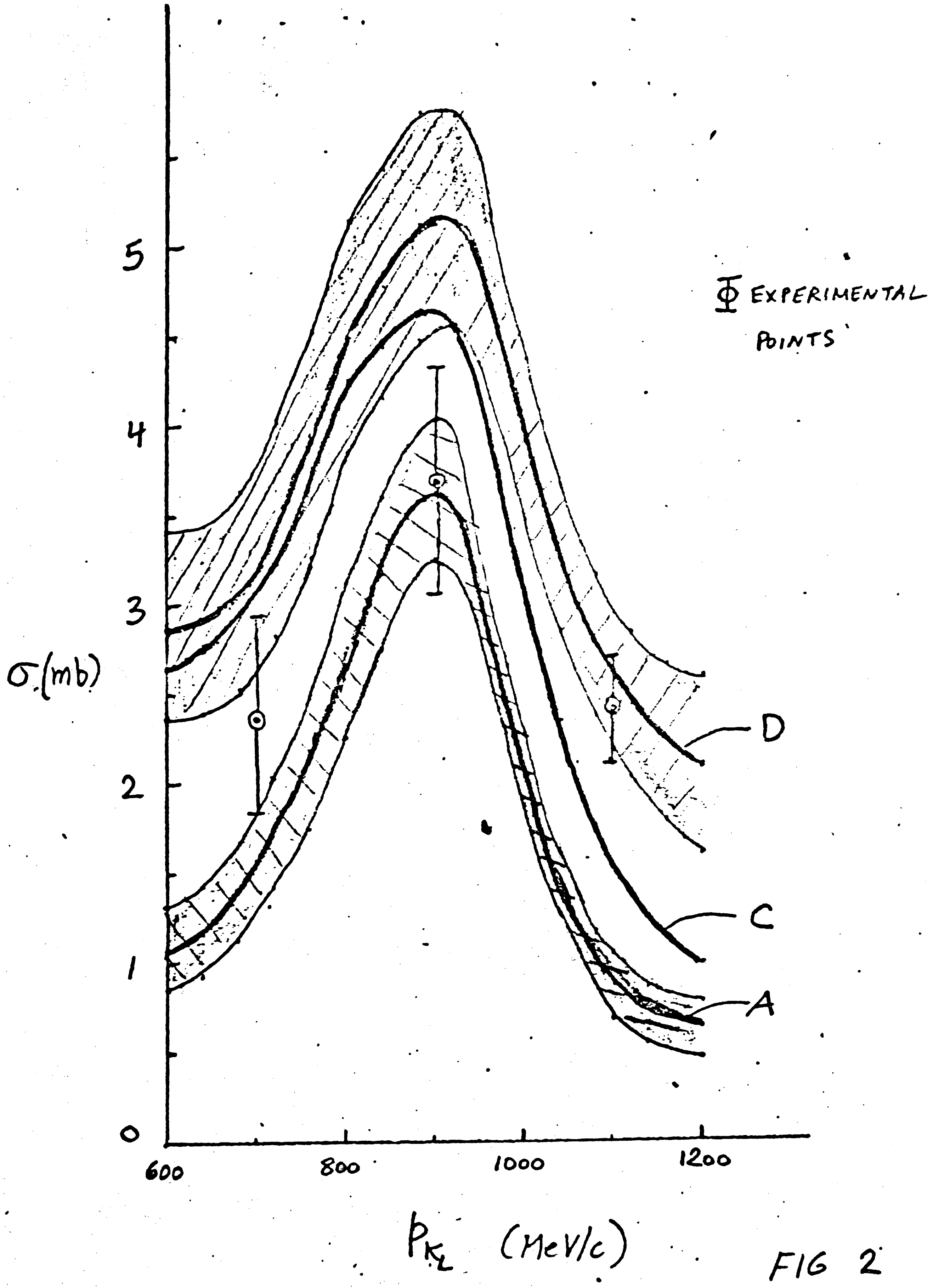

σ (mb)
0
1
2
3
4
5
600
800
1000
1200
P_{K_L} (MeV/c)
EXPERIMENTAL POINTS
D
C
A

FIG 2

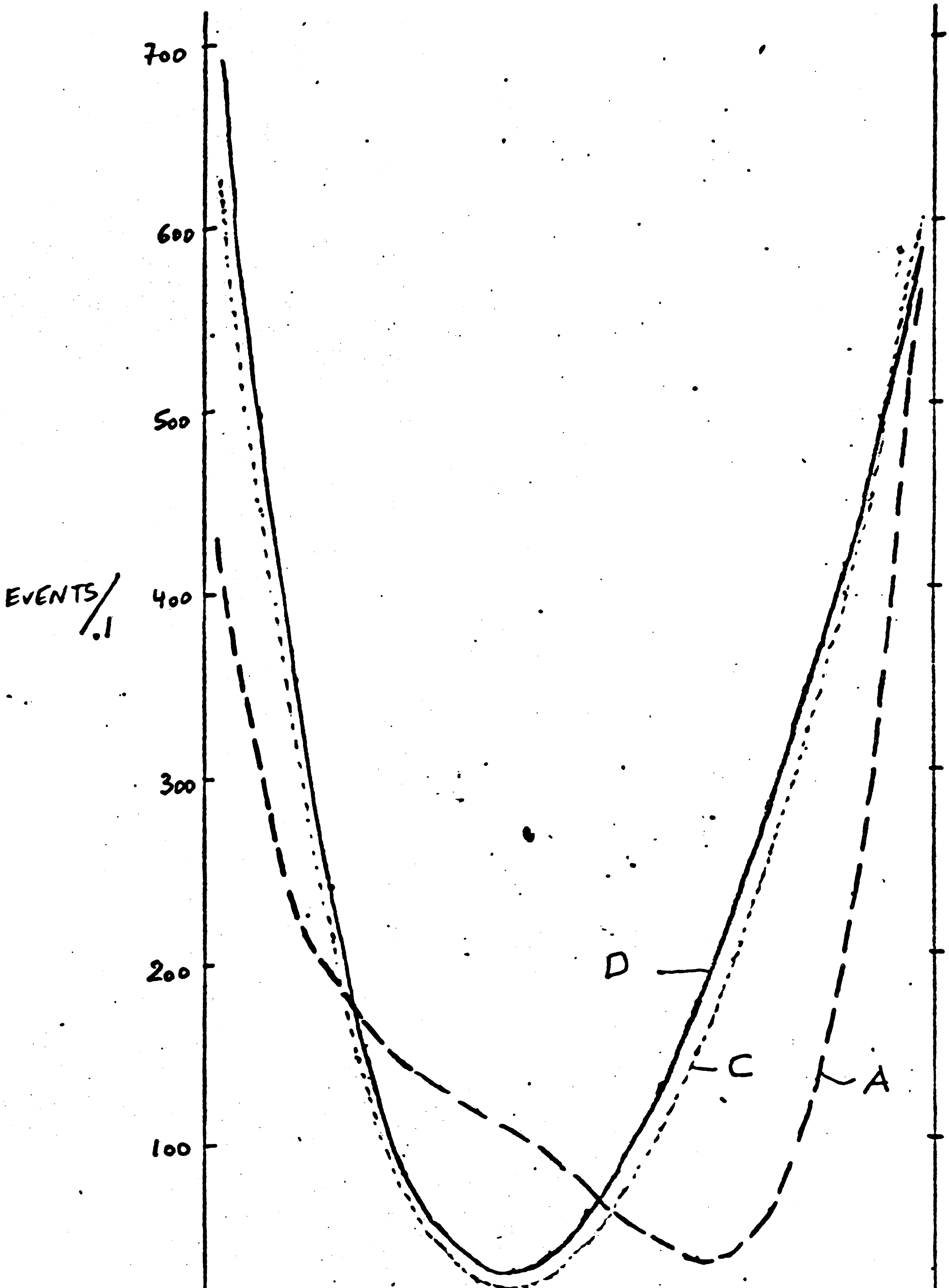


FIG 3a

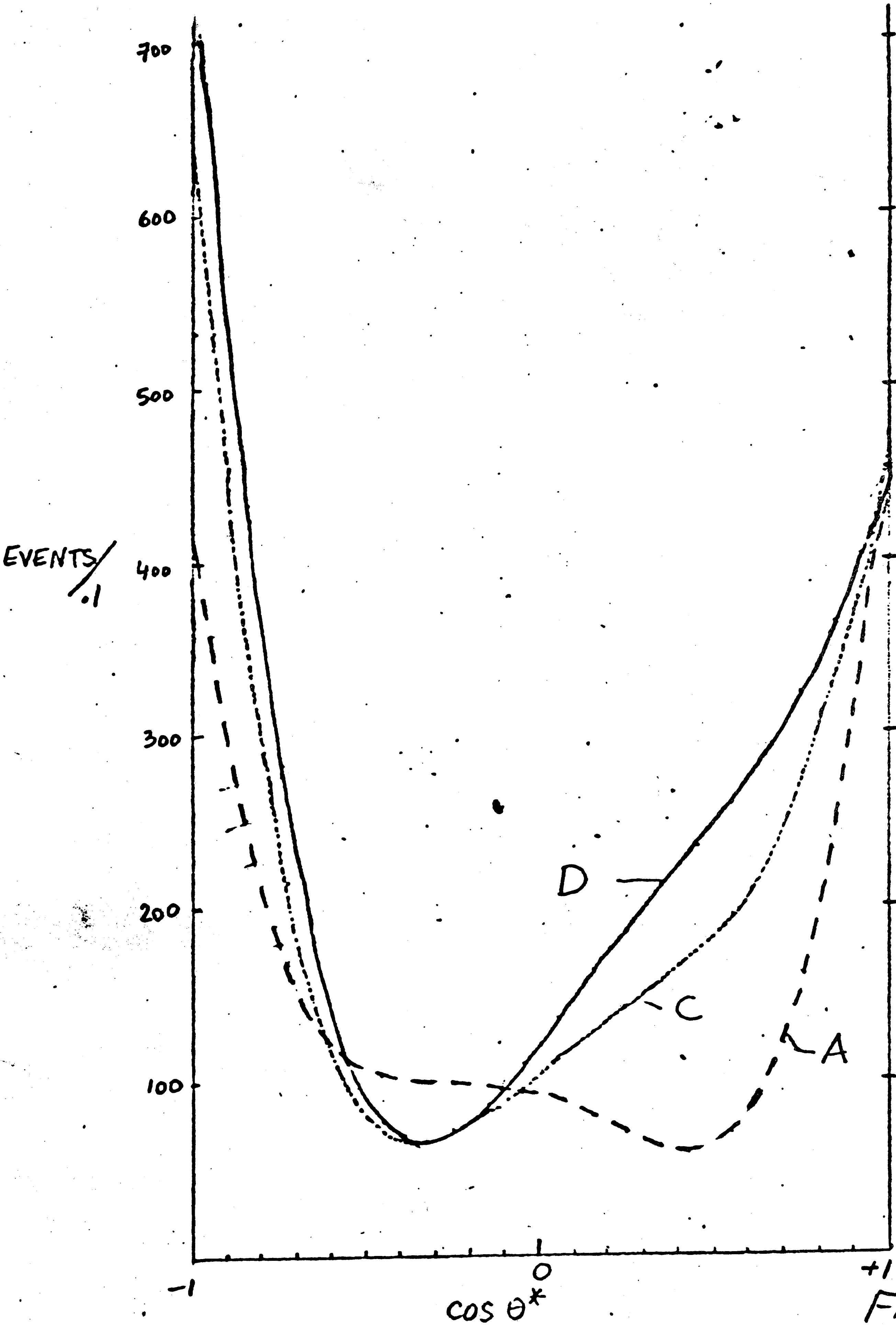


FIG 3b

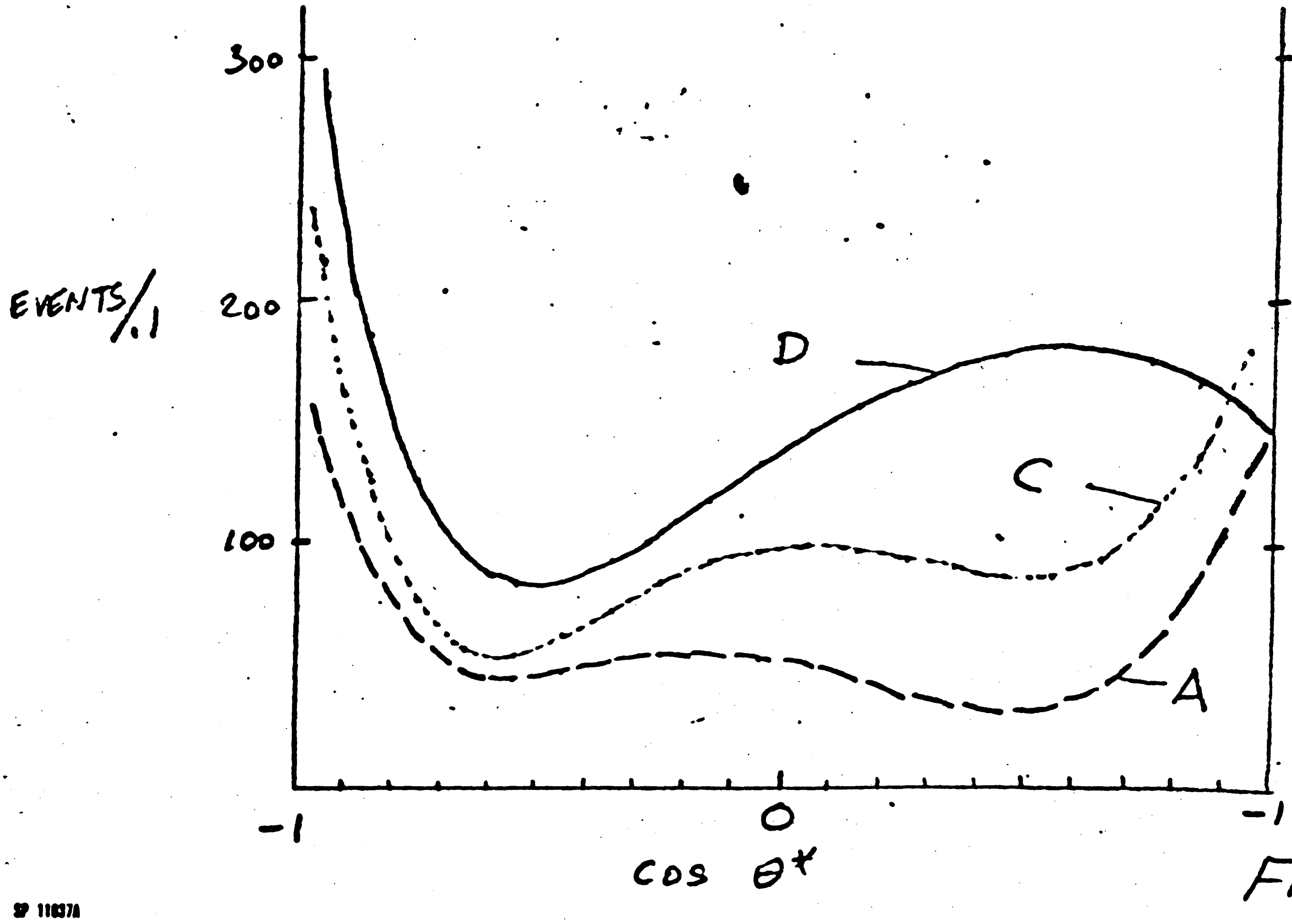


FIG 3C

SP 11037A

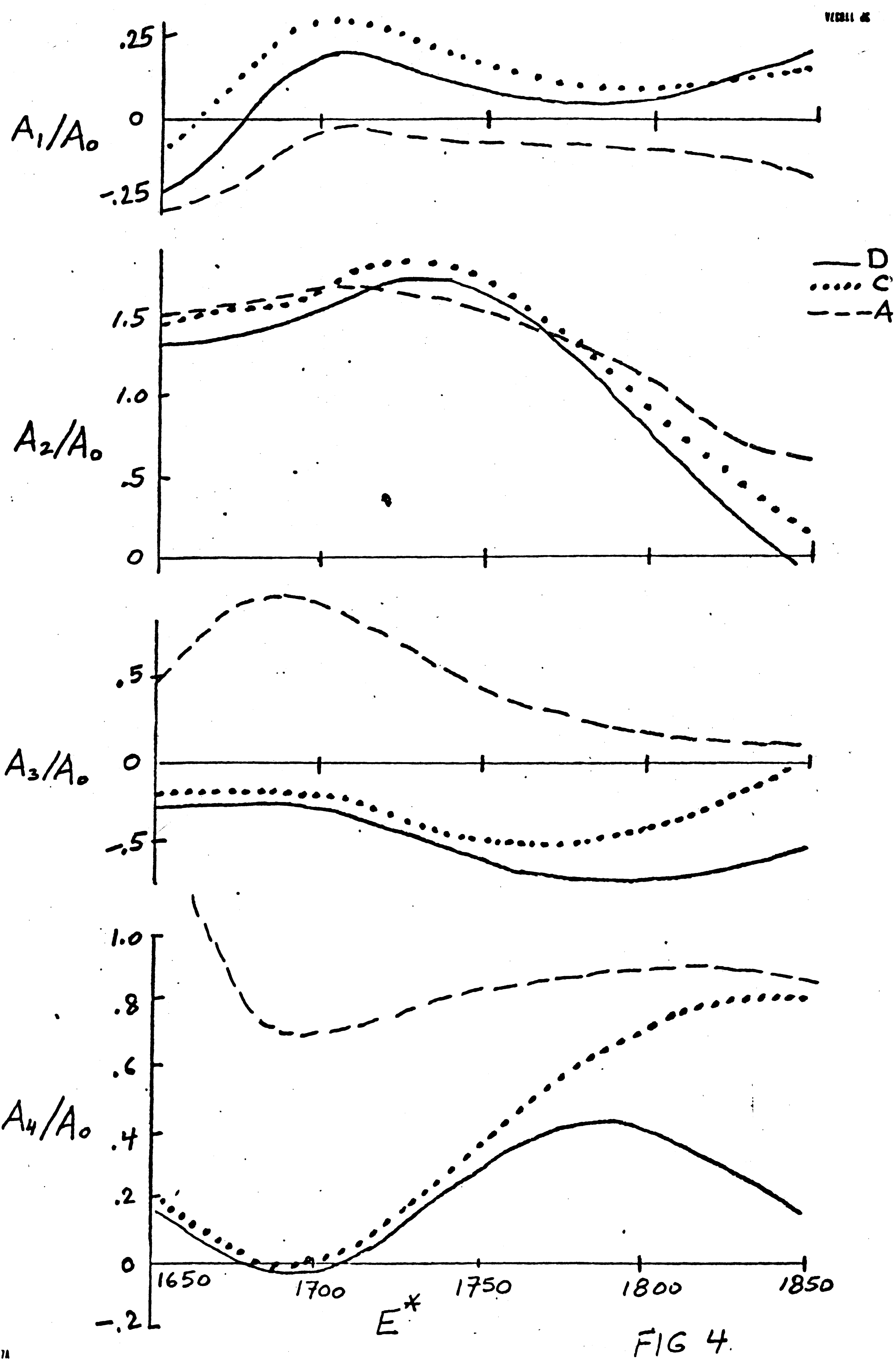

.25
0
-.25
A₁/A₀
1.5
1.0
.5
0
A₂/A₀
D
C
A
.5
0
-.5
A₃/A₀
1.0
.8
.6
.4
.2
0
-.2
A₄/A₀
1650
1700
1750
1800
1850
E*

FIG 4

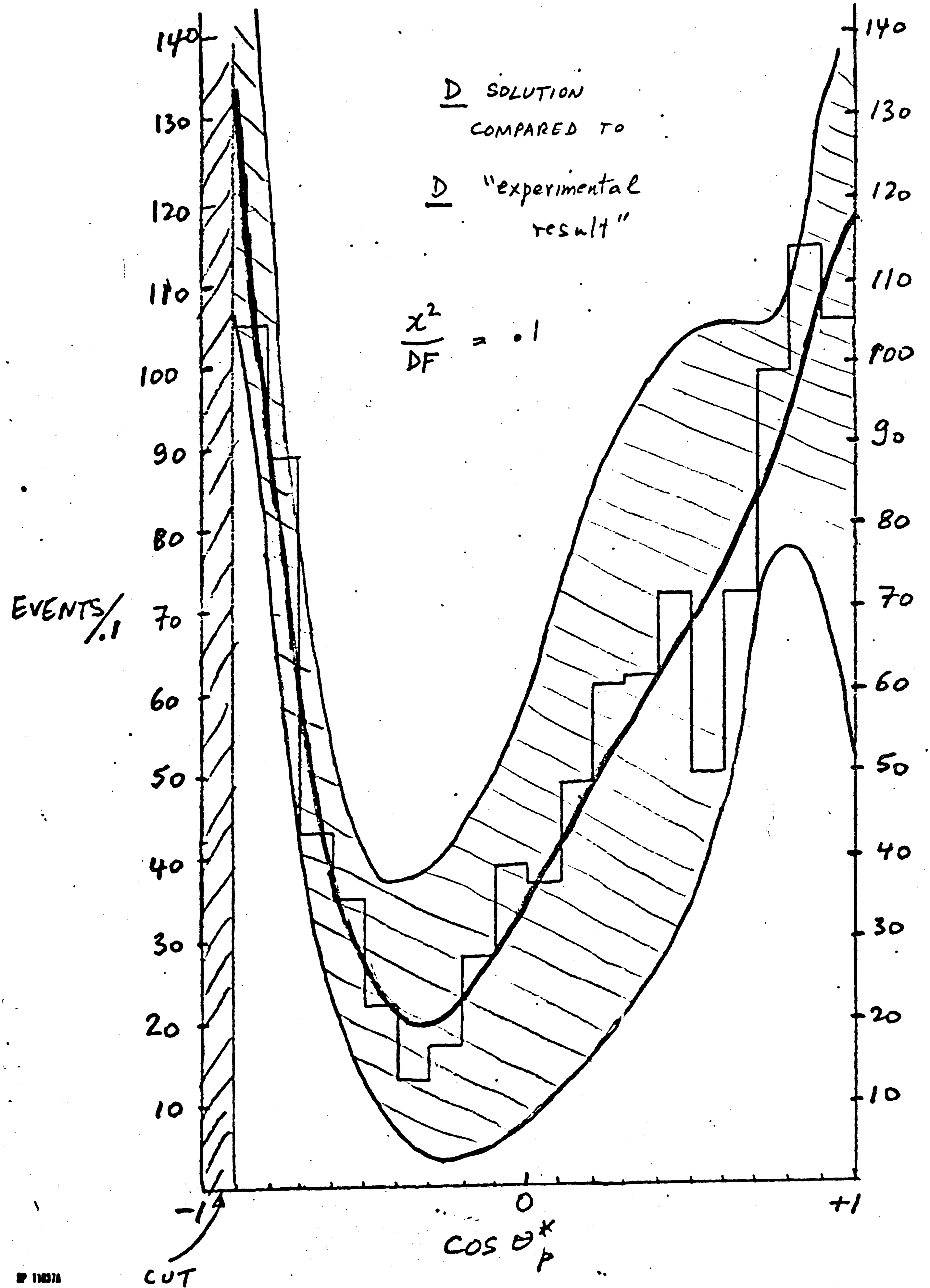

D SOLUTION
COMPARED TO
D "experimental result"
$\frac{\chi^2}{DF} = .1$
EVENTS/.1
140
130
120
110
100
90
80
70
60
50
40
30
20
10
-1
0
+1
$\cos\theta_p^*$
CUT

FIG 5a.

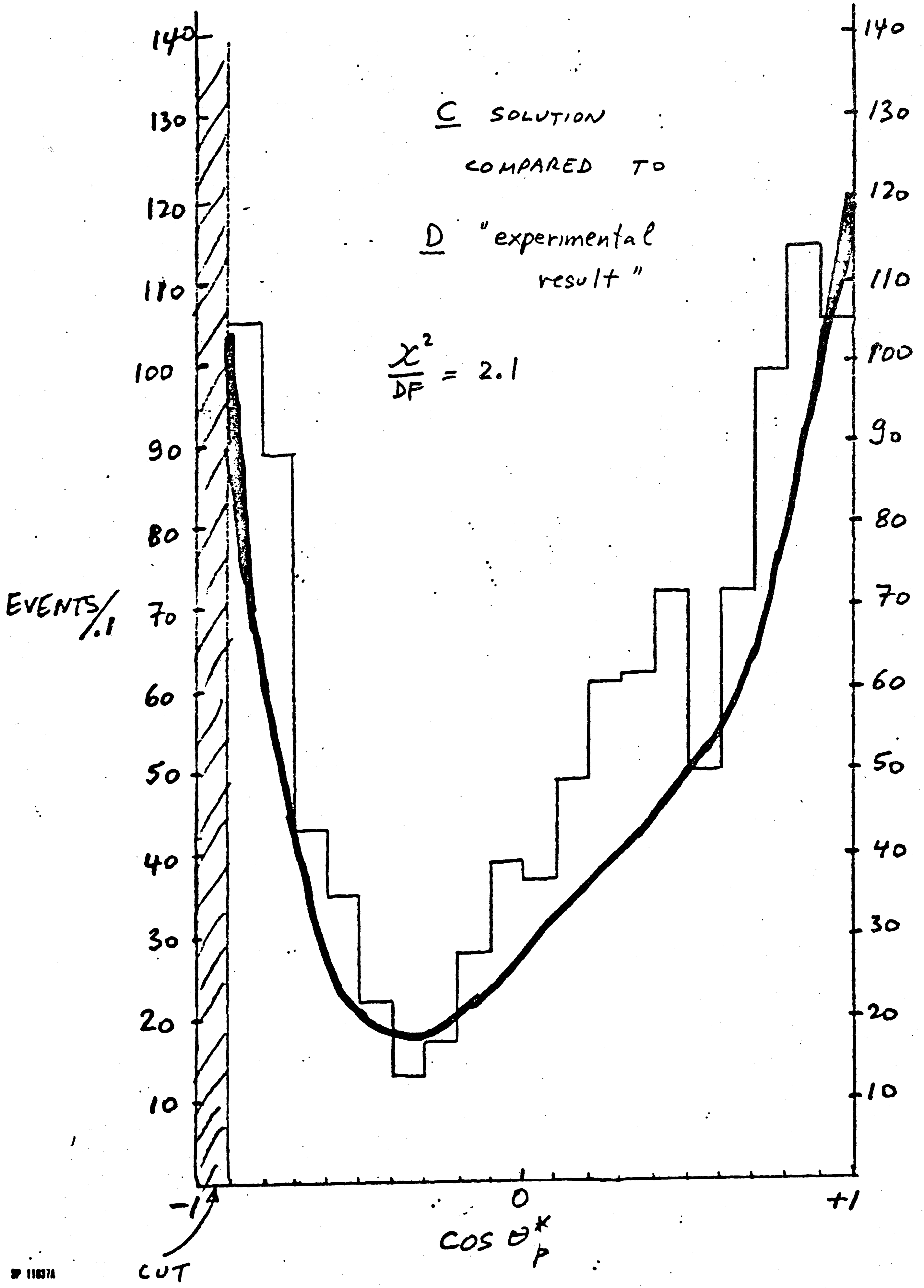

C SOLUTION
COMPARED TO
D "experimental result"
$\frac{\chi^2}{DF} = 2.1$
EVENTS/.1
140
130
120
110
100
90
80
70
60
50
40
30
20
10
140
130
120
110
100
90
80
70
60
50
40
30
20
10
−1
0
+1
$\cos\theta_p^*$
CUT

FIG 5b

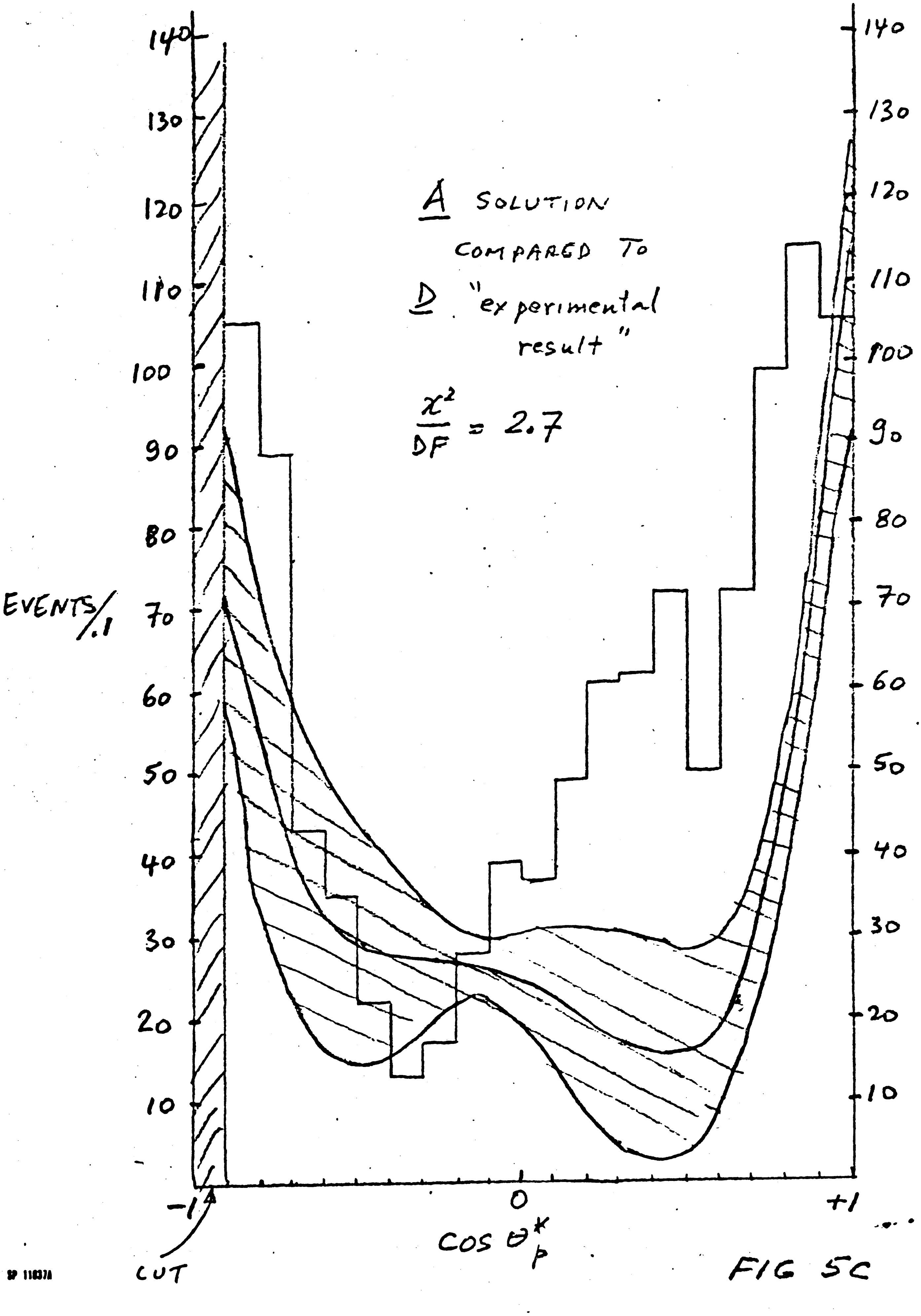
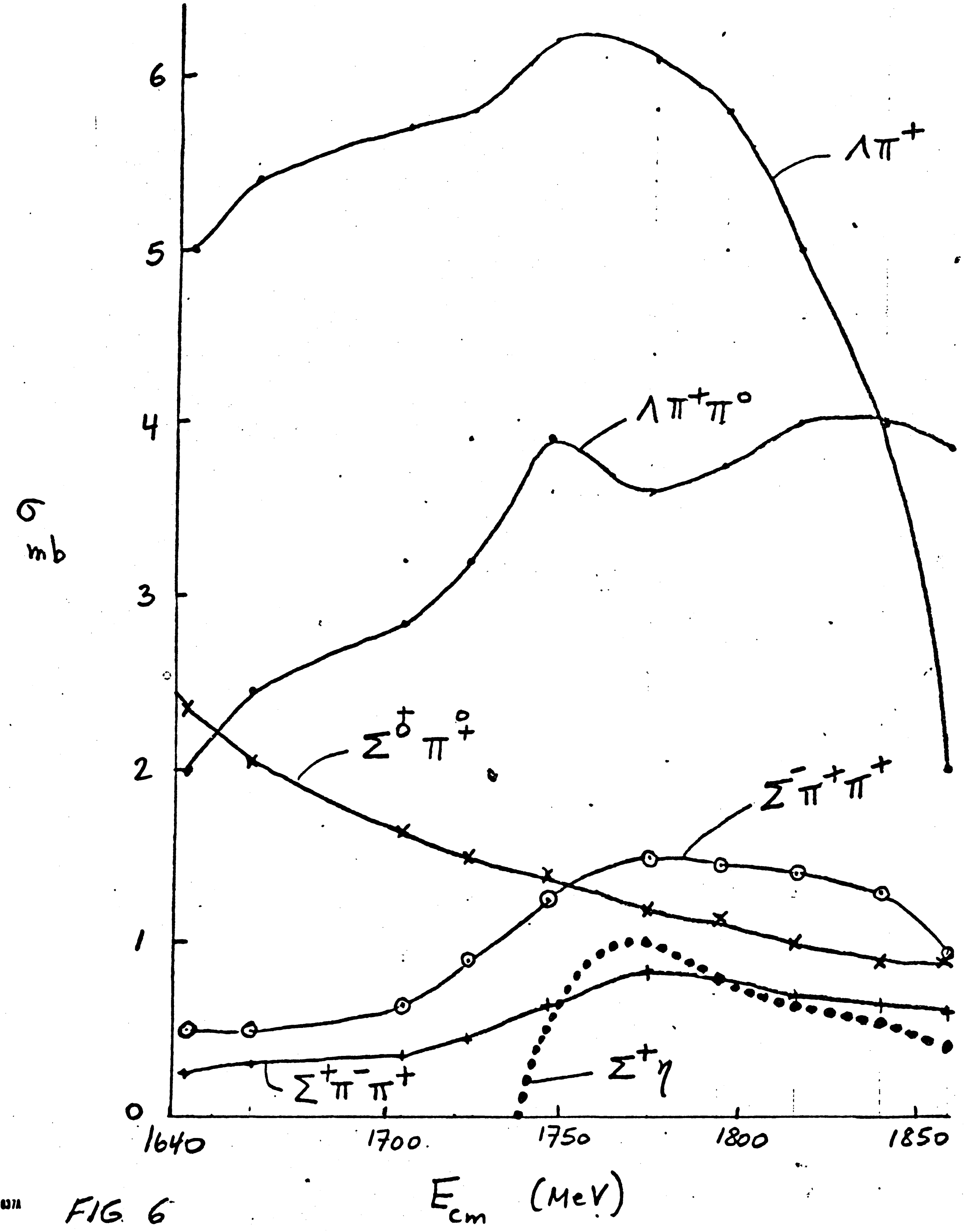


FIG 5C

SP 11837A



SP 11637A

FIG. 6

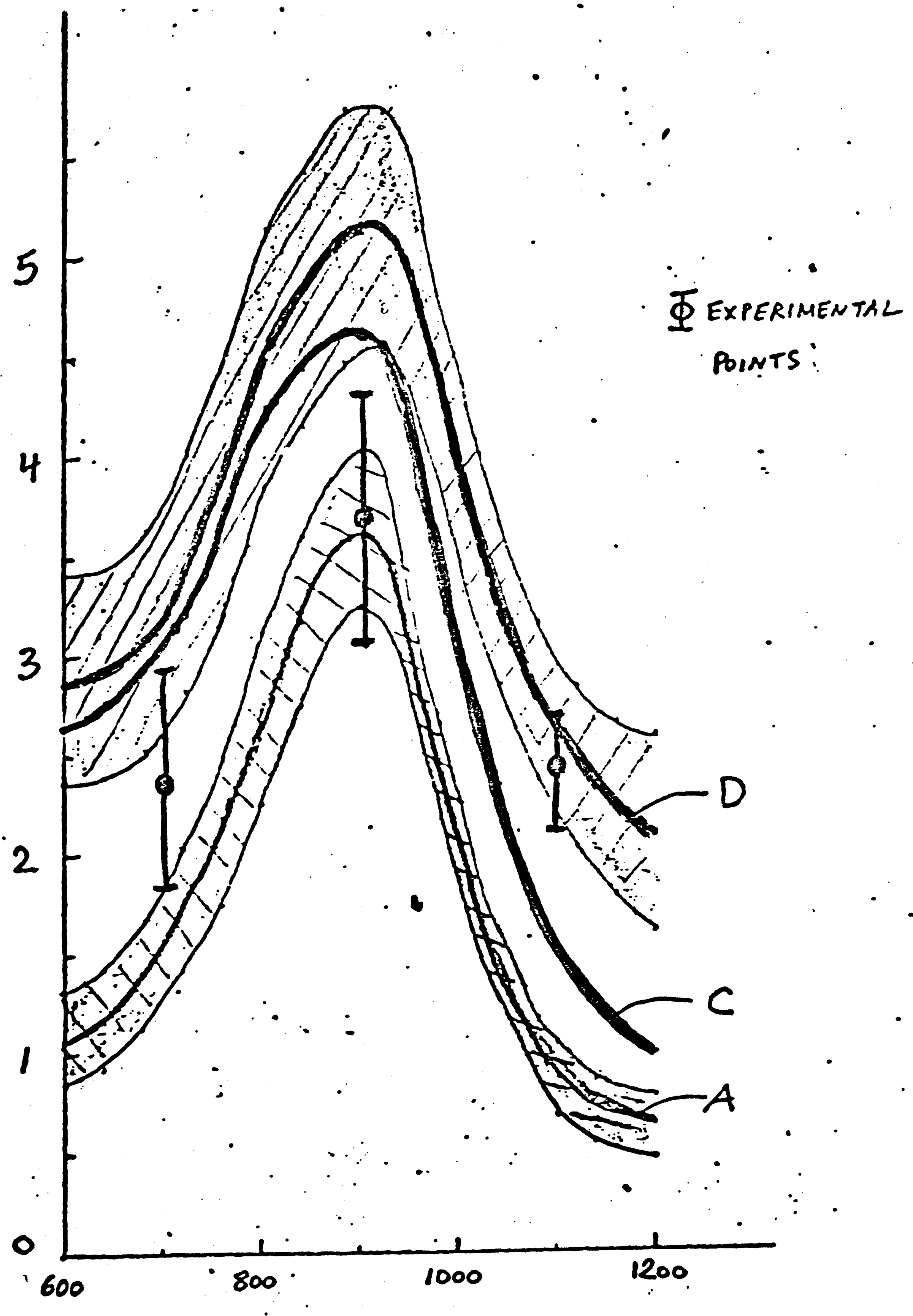

5
4
3
2
1
0
σ (mb)
600
800
1000
1200
p_{K_L} (MeV/c)
Φ EXPERIMENTAL POINTS
D
C
A

FIG 1

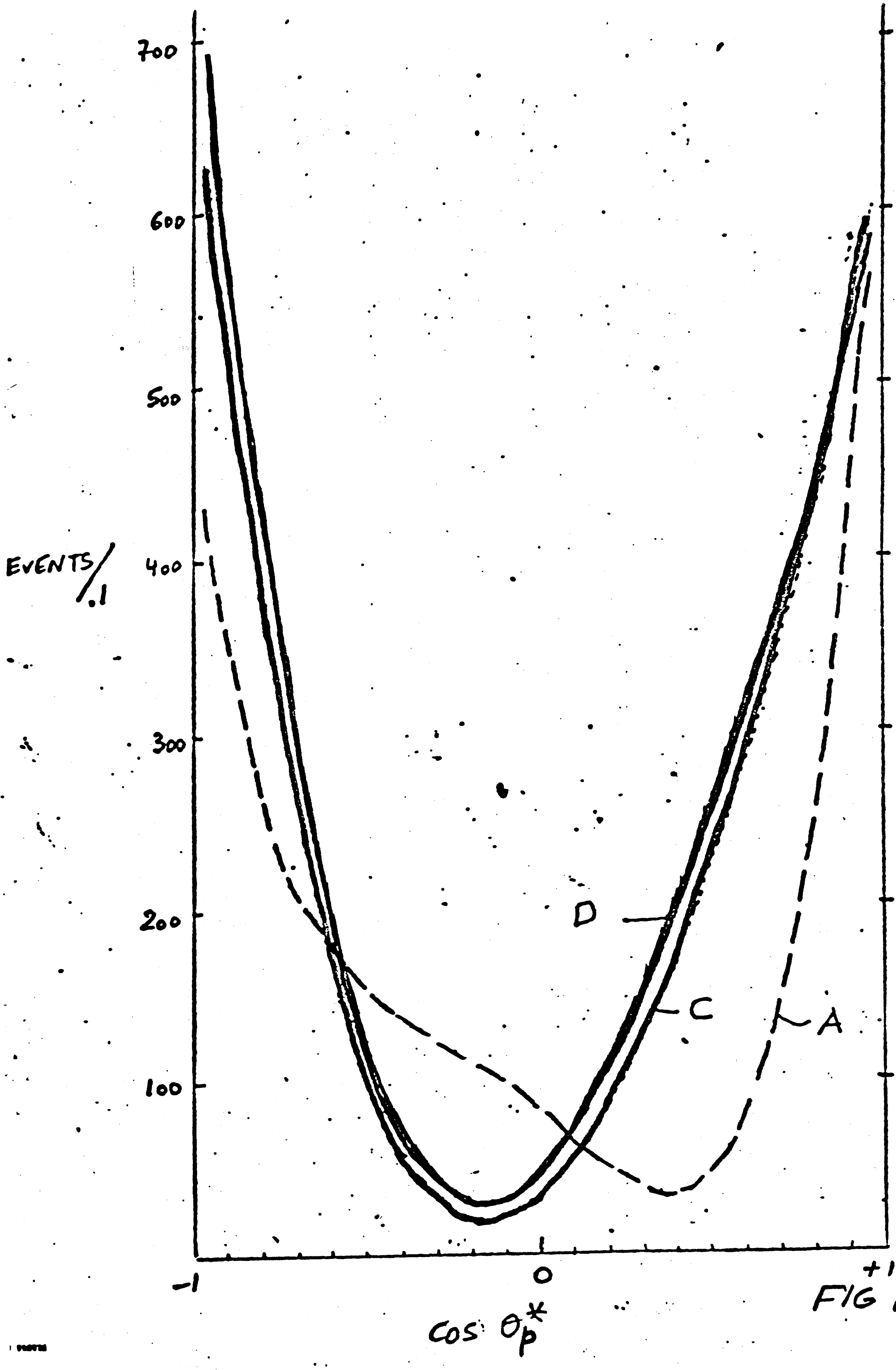


FIG 2a

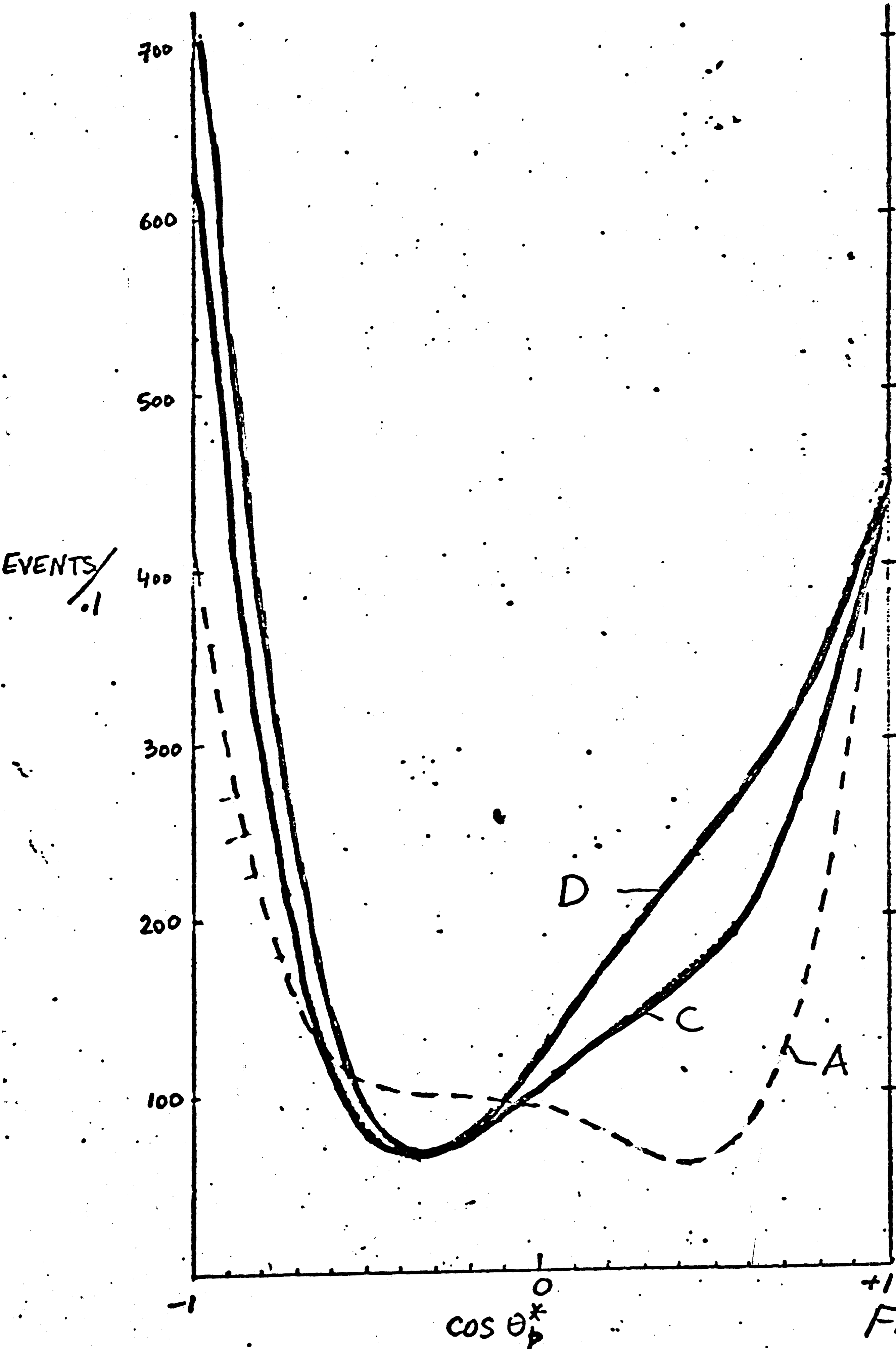


FIG 2b

P 11078

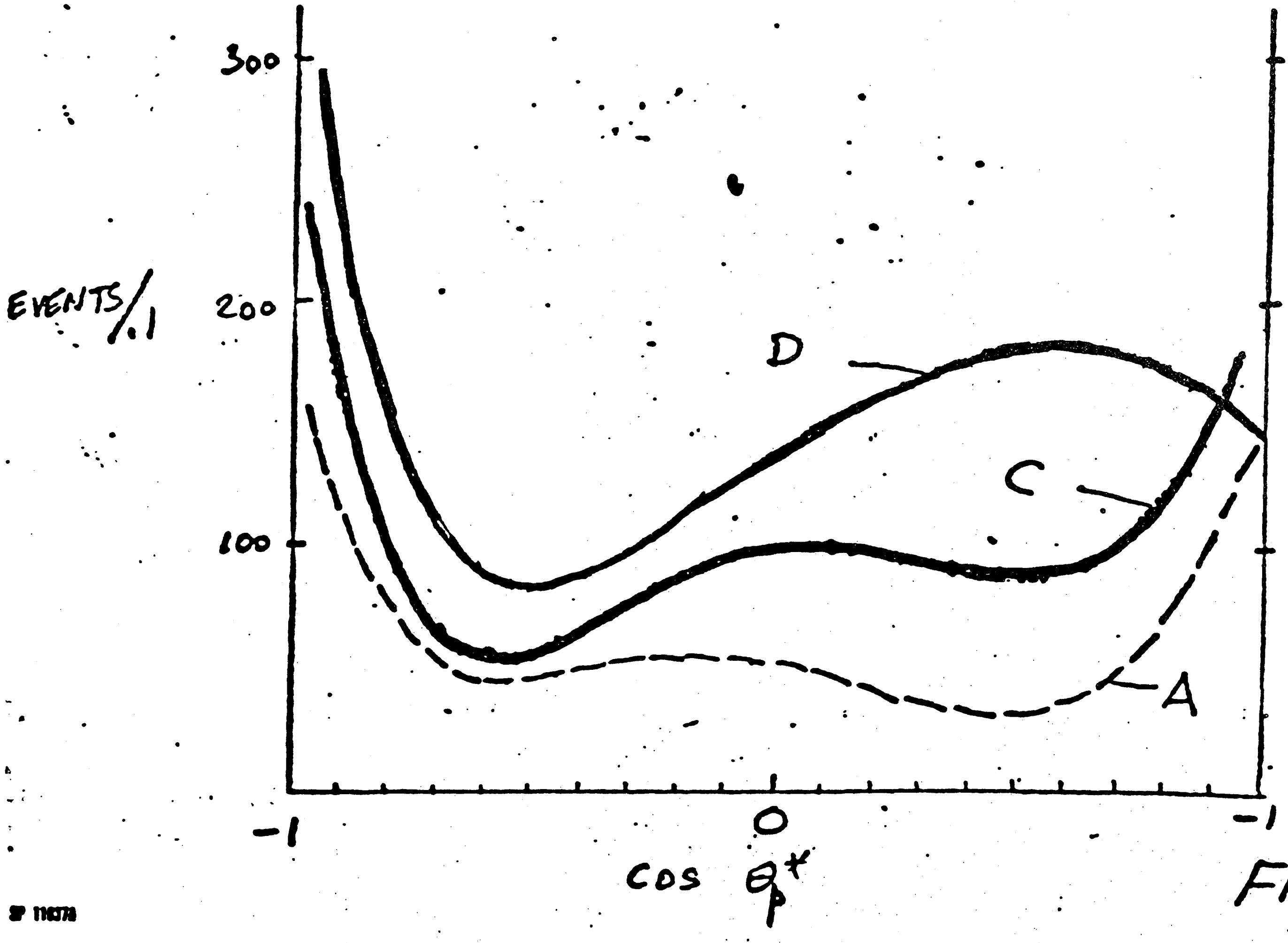


FIG 2C