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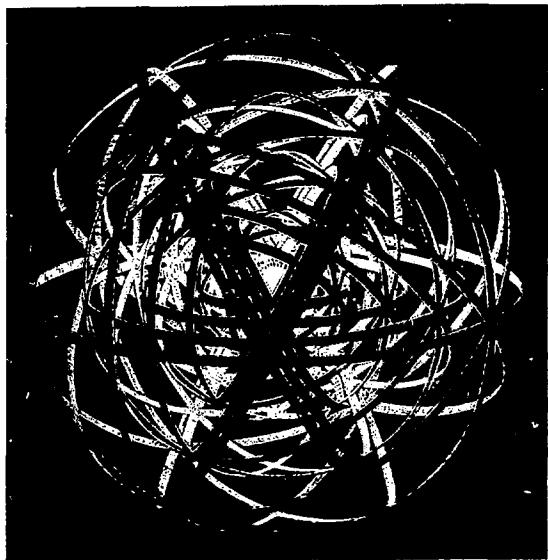
Production inclusive de Λ et de Λ̄ dans les annihilations

e^+e^- à 29 GeV.

par Christian de la Vaissière

LABORATOIRE DE PHYSIQUE NUCLEAIRE ET DES HAUTES ENERGIES

ERRATUM

Avant-propos, $3^{\text{ème}}$ paragraphe : lire 2.0 GeV/c au lieu de 0.5 GeV/c.

AVANT-PROPOS

Le travail qui suit étant à l'origine un rapport interne de l'expérience
MARK II, destiné à fournir les bases d'une publication , il est apparu
nécessaire de le faire précéder d'un avant propos explicatif.

Les laboratoires impliqués dans l'expérience sont SLAC, le Lawrence Berkeley
Laboratory et Harward. Cette collaboration prend actuellement des données
sur les anneaux de collision e^+e^- PEP du SLAC. L'énergie des collisions est
de 29 GeV.

Le sujet de l'étude est la production inclusive des Λ et $\bar{\Lambda}$ dans les
annihilations $e^+e^- \rightarrow$ hadrons. Son intérêt est de fournir des données sur
les conditions dans lesquelles les baryons sont produits dans le processus
d'hadronisation de la paire $q\bar{q}$ primaire. Ce phénomène reste mal connu.
L'hyperon Λ possède l'avantage sur le proton de pouvoir être identifié
pratiquement sans ambiguité, grâce à sa désintégration, pratiquement dans tout
le domaine d'impulsion (MARK II n'identifie les protons par temps de vol qu'en
dessous de 0.5 GeV/c). Les Λ (et $\bar{\Lambda}$) constituent donc des particules idéales pour sonder
la production de baryons dans les jets hadroniques.

De tous les détecteurs actuellement en place sur PETRA et PEP, MARK II est
le mieux placé pour une telle étude. Son atout principal est une chambre à
dérive de haute précision (appelée "Vertex chamber" (VC)) installée
depuis décembre 1981. Ce détecteur de vertexs secondaires qui voit la zone
la plus proche du point d'interaction s'est avéré un outil remarquable pour la
mesure de très courtes vies moyennes (τ, D^o, b) et la reconnaissance de K^o et
de Λ^os. Par ailleurs la campagne de prises de données 1982/83 a coïncidé avec
un fonctionnement remarquable de la machine PEP permettant d'accumuler 4 fois
plus de données que lors du cycle précédent. La luminosité totale ainsi obtenue

(133.6 evt/eb, soit pour une section efficace hadronique de 0.4 nb, environ 53000 évènements) donne à l'expérience MARK II l'avantage d'une statistique supérieure à celles d'autres groupes.

Les premières données concernant la production de Λ ont été fournies par TASSO à PETRA. Le nombre de Λ et $\bar{\Lambda}$ sur lequel est basé cette étude est grosso modo le double de celui de TASSO, mais l'avantage décisif provient de ce que le détecteur de vertex permet de disposer d'un lot de $\Lambda/\bar{\Lambda}$ beaucoup moins contaminés.

Ce rapport utilisant quelques notations propres à l'expérience et faisant référence à des documents internes difficilement accessibles, des notes explicatives ont été ajoutées, ainsi que deux annexes donnant une description sommaire du détecteur et un extrait d'un rapport précédent introduisant la notion de qualité d'un V°.

TG 374

To: PEP-5 Collaboration

From: Ch. de la Vaissiere, Drew Baden

Subject: Status report on Λ analysis

Introduction

A large amount of data has been accumulated since the early report writ-
ten in march 1983[1]. The large statistics now available allow one to go
beyond the measurement of inclusive cross-sections. Unfortunately , the
in-eficiencies of the drift chamber during the last cycle are not yet well
understood, and so a large fraction of the data cannot be fully used.

Data sample

This survey is based on an integrated luminosity of 133.6 pb^{-1}. It
includes the data accumulated with the vertex chamber during the 1981/1982
cycle (VCSUM SUMMARY)[x] and the 1982/1983 cycle (runs 9939-11472). The 15
pb^{-1} of data without the vertex chamber (29GEV SUMMARY) have not been used
for this analysis. The gain in statistical accuracy has become marginal
compared to the inconveniencies due to the handling of data taken with a
different apparatus. Furthermore, the Λ signal/background ratio is poor
compared to the one obtained with the vertex chamber.

Among the 114.3 pb^{-1} accumulated during the last cycle, 88.4 have suf-
fered from the drift chamber problems[xx] The remaining 25.7 pb^{-1} (runs
11107-11472) , corresponding to the period where oxygen has been added to
the drift chamber gas, have been compared with the data of the previous
cycle(VCSUM). The raw number of Λ⁰s / pb^{-1} have been found to be 9.3 ± 0.9
and 8.5 ± 0.8 respectively. If one divides · the momentum spectrum in 7
intervals, the two samples normalized to luminosities agrees with a x^2 of 6
for 7 degrees of freedom. Therefore, we have added VCSUM and OXYGEN into a
"good data" sample of 45.2 pb^{-1}.

We have also compared the rest of the data to this reference sample.
The ratio of the Λ yields is found to be 0.776 ± 0.050, significantly lower
than 1. A comparison made at the level of the Λ momentum distributions
indicates that the inneficiency does not vary in first approximation with
P_Λ: taking into account a global 0.776 ratio, the x^2 is 7.8/6.

The determination of the cross-sections has been based on the good data
sample. For the other topics the whole sample has been considered.

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[x] VCSUM SUMMARY est le nom du fichier contenant les données prises en 1981/1982
    (13.8/pb-1) première année de fonctionnement de la chambre de haute précision;
    29 GeV SUMMARY celui des données prises sans cette chambre, non utilisées pour
    cette étude.
    Pendant une partie de l'année 1982/83 la chambre à dérive principale de MARK II
    a fonctionné avec une efficacité réduite. Le fichier OXYGEN correspond à la période
    durant laquelle l'efficacité a été égale à celle de l'année précédente.

Event and Λ selection

The selection of hadronic events[*] is:

     NCHARG   > 5
     ECODE   > 3
     |ZVT| < 5 cm

   The selection of the Λ and $\bar{\Lambda}$ has been detailed in previous reports[1,2].

     1)First the vee finder package VFINDP[3] is used to select and recon-
struct candidates K^o and Λ^os. The Λ and $\bar{\Lambda}$ cuts are: [**]
     Distance of closest approach to the interaction point,
                    π   > 2mm
                    p   > 1mm
                    Λ   < 5mm
     Match in z of secondaries at secondary vertex[***] < 5 cm
     Distance of closest approach in z of secondaries < 10 cm
     cτ(Λ)   >4 mm
     x^2 of V geometrical fit (1-c)   <10.
     Fitted mass of V   [1.092,1.1140]GeV

   This set of cuts is soft,and optimized to remove background at the cost
of a minimum loss of signal.

   2)A large fraction of the remaining background is removed through a qual-
ity cut. This Λ quality has been defined in a previous note[2]. We use the
standard cut:QUALDW(Λ)=-1.50. The removal of background due to the quality
cut appears very clean on fig. 1.b. [****]

   3)In order to remove regions of low acceptance, we required finally
that:
                    | cos(θ(Λ)) | < 0.75
                       cτ(Λ)   > 1 cm.
The final Λ/$\bar{\Lambda}$ sample is shown Fig.1. It contains around 955 Λ or $\bar{\Lambda}$ in
the mass range [1.102,1.126] with a signal/background ratio of = 5.5.   In
the following the term Λ will refer to both Λ and $\bar{\Lambda}$. The sub traction of
the background below the Λ is made by a peak minus wing sub_traction.

mass resolution

   The statistics allows us to measure the variation of the mass resolution
with momentum.   The resolution increases from = 3MeV for slow Λ^os to above
7 MeV for fast Λ^os.   This variation agrees with the Monte-Carlo pre-
dictions(Fig.2)

(*)   Il s'agit d'une sélection standard d'événements hadroniques
(**) VFINDF est décrit sommairement en annexe
(***) La reconstruction des traces en z (le long de l'axe du faisceau)
      est beaucoup plus imprécise que dans le plan x,y perpendiculaire à cet axe.
(****) Voir annexe.

Inclusive cross-sections

The limited sample of 45.2 pb^{-1} has been used for this study. 13678 events
pass the hadronic cuts. The raw number of $\Lambda/\bar{\Lambda}$ is 404 ± 24. The efficiency
is calculated from the Monte-Carlo events that use BQCD as a generator.
The efficiency is 0 below 0.5 GeV/c. It reaches a maximum of 12% at 1.5
GeV/c and decreases slowly to around 7% at 7 GeV/c.   The inclusive cross
section corrected for acceptance is shown in Fig.3-a. This estimation is
based on the luminosity coming out of Bhabha events. Radiative corrections
have not been applied. It can be seen that the Λ^0s are sensibly softer in
the BQCD model than in the data. Λ production is also overestimated by
40%. In the Fig.3.b the invariant cross-section s/B $d\sigma/dx_\Lambda$ is compared to
previous results by TASSO[5] and JADE[6].   JADE is able to explore slow Λ^0s ,
while TASSO has access to a momentum range similar to ours. Both experi-
ments are well below our present statistical accuracy.

   The inclusive Λ cross section agrees in shape and magnitude with the
early measurements, except maybe in the range of high x values where both
statistical and systematical errors are large. In the Fig.4 ,we have added
data coming from the sample with drift chamber inefficiencies, giving them
a weight 1/0.776 independent of momentum.

   The total cross-section in the range $P_\Lambda > 0.5$ GeV/c is
              87.6 ± 5.2 ± 6.0 pb .
The correction for Λ below 0.5 GeV/c is estimated to 3%, and the corrected
value is
              $\sigma_\Lambda = 90.2 ± 5.4 ± 6.0$ pb

   Most of the systematical error comes from the uncertainty in the lumi-
nosity. The ratio R_Λ of the cross-section to $\sigma_{\mu\mu}$ is 0.87 ± 0.05 ± 0.06 and
the number of Λ and $\bar{\Lambda}$ per hadronic event is 0.22 ± 0.013.   This should be
compared to the value of R_Λ given by TASSO at 33 Gev,1.12 ± 0.15 ± 0.17 and
to our early measurement of 1981[4], .80 ± 0.24

   If instead of normalizing the number of Λ^0s to the Bhabha luminosity,
the total number of hadronic events is used, the Λ cross-section is found
to be 81. ± 5.0 pb.

Baryon-antibaryon correlations

   Baryon-antibaryon correlations are interesting since they can shed some
light to poorly understood features: How baryons are produced in jets? Is
the baryon number conserved locally ? Do some jets carry leading diquarks?
The advantage of using Λ^0s is that they can be detected over a fairly broad
range of momentum.   Protons and antiprotons rely on the time-of-flight and
can be identified only below 2 Gev/c.

$\Lambda-\bar{\Lambda}$ correlations

   11 $\Lambda\bar{\Lambda}$ events were found after quality cuts compared to 5 compatible with
$\Lambda\Lambda$ or $\bar{\Lambda}\bar{\Lambda}$.   The 2-dimensional mass plot of $\Lambda\bar{\Lambda}$ events suggests that these

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(*) Il n'existe pas de modèle satisfaisant pour la production de baryons, celle-
ci est introduite empiriquement, sous forme de probabilités de production de
diquarks,dans le processus d'hadronisation. BQCD est une version du programme
IMLL, Pietarinen et Nilrodt avec une hadronisation à la Feynman et Field.
BQCD est principalement utilisé ici pour calculer l'acceptance.

events are genuine associated production(fig.5).   The low statistics allow
only a classification between pairs belonging to the same or opposite jet.
This gives:

	same jet	opposite jet
ΛΛ̄	6	5
ΛΛ + cc.	4	1

An individual display of these few events shows than none of the 5 ΛΛ̄ pairs
in opposite jets are compatible with a hypothesis of a leading diquark.
Most of them are soft

Λ-p̄ and Λ̄-p correlations:

p and p̄ were defined by the conditions: [*]

P	< 2.0 GeV
WPR	>0.70
TQUAL	=1 or 2

The cosine of the angle between a Λ and a p̄ (or a Λ̄ and a p) is plotted in
Fig.6-a.   The same angle when both particles have the same baryonic number
is plotted on Fig.6-b.   B=2 or B=-2 pairs come from events with 2 baryon-
antibaryon pairs. We estimate the contribution of single baryon-antibaryon
pairs by sub tracting the │ B │ =2 from the B=0 contribution.   (fig.7-a)
This sub traction indicates that associated baryon-antibaryon pairs belong
by a large margin(70/14) to the same jet.   Using the same method, it is
also meaningful to consider the difference in rapidity along the jet axis
between the Λ and the p̄(fig.7-b).   The average ΔY is 0.83 ± 0.05, signifi-
cantly less than for the uncorrelated B=2 pairs(1.62 ± 0.12).   This sug-
gests a dominant local conservation.   The Fig.7-c shows Δφ,the difference
in azimuthal angle in the plane perpendicular to the sphericity axis. Here
we observe a rather flat distribution which does not show a pronounced peak
at 180⁰. This agrees with a recent result of TASSO[7] on pp̄ correlation and
disagrees with a claim made by JADE[8] .   We do not observe an angular anti-
correlation as predicted for example by the Mayer model[9].

Jet analysis

It was suggested by TASSO[9] that gluon jets fragment more into baryons
than do quark jets.   We have investigated how Λ/Λ̄ behave inside jets.   We
have defined the jet axis with sphericity from JETCAL.   Particles used in
the jet definition are:1)the charged particles; 2) γs with $E_γ$ above 250
MeV;3)Λ⁰s and K⁰s.   If Λ⁰s prefer gluons, there should be a difference in
sphericity and aplanarity when a Λ is required or not required in the
event. The sphericity and aplanarity distributions appears fully compatible
between the two types of events(fig.8).   Comparing now Λ⁰s and charged
hadrons in Λ events, it turns out that the Λ⁰s get significantely more P_t^2
(Fig.9):   The average value is 0.83 ± 0.04 against 0.57 ± 0.01 for charged

hadrons.   This is expected from qq+g topologies.   When massive particles
belong to a jet emitted at a non-zero angle with the primary axis, they
will have more transverse momentum than light particles.

We have investigated if ,in 3-jets events, Λ⁰s prefer the softer jet
which, according to a simulation made by TASSO, is most likely to be the
gluon jet(51%)[±].   We have followed the TASSO selection of 3 jet events
(this calculation uses the reduced momentum x of the primary partons
instead of the observed jet energies).   We require in particular that the
reduced momentum of the most energetic jet is <0.9 and that the sum of the
momenta in each jet is over 1.5 GeV/c. Among the 103 Λ⁰s that fell in the
3-jet category, 40 were found to belong to the most energetic jet, 35 to
the median jet, and 28 to the softer jet. These results are not acceptance
corrected and require further studies.   However, there is no striking evi-
dence of a strong relation between Λ⁰s and gluon jets.

Fast Λ⁰s

Fast Λ⁰s suffer from a poor mass resolution due to the fact that they
include high momentum baryons and that they often decay beyond the vertex
chamber inner layers.   But on the other hand, they are practically back-
ground free.   Some events containing fast Λ/Λ̄ have interesting features.
The fast Λ⁰s were required to have P_Λ > 6.Gev/c. We replaced the condition
that the mass belongs to the peak region, by the requirement that the qual-
ity is well above the standard quality cut.

In one event (10848/1866), the Λ̄ is practically alone in one jet(Fig.9).
A second event (1077/13186)presents similar features. In some other events
the multiplicity is low not only in the fast Λ jet but also in the opposite
one.

Ξ Production

A practical application of Λ detection is a search for Ξ particles.
Using 117 pb⁻¹ of data, (runs 8068 thru 11472, not including FALL82) a pre-
liminary study does show a signal (fig 11). The cuts used are similar to
those of TASSO:

        1) require Λ mass to be in Λ peak region [1.106,1.126] Gev
        2) require Ξ decay distance be > 1.5 cm
        3) construct E = exp(-d/(dperp) where d = Ξ decay distance (meas-
        ured) and dperp = $\bar{L}$ * γ * cr * sin(θ)) (of Ξ)
        4) require 0.1<E<0.8
        5) require $|Z(\pi\Xi)-Z(\Lambda)|$ < 5 cm

The resultant signal and background (signal = Λπ⁻,Λ̄π+ and background =
Λπ+,Λ̄π⁻) plots are competitive with the TASSO group , and further   study
is planned.

Conclusions

1)The large amount of data accumulated and the opportunities offered by the vertex chamber, give us over the other groups the advantage of a much larger and clean Λ sample.   This should allow us to probe the production of baryons in e⁺e⁻ annihilations.
2)Results on cross-sections agrees with TASSO.
3)The baryon number seems predominantly conserved locally, inside one jet.
4)A preliminary jet analysis does not suggest a strong preference of gluon jets for Λs.

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$$M(p \ \pi^-) \ + \ M(p \ \pi^+)$$
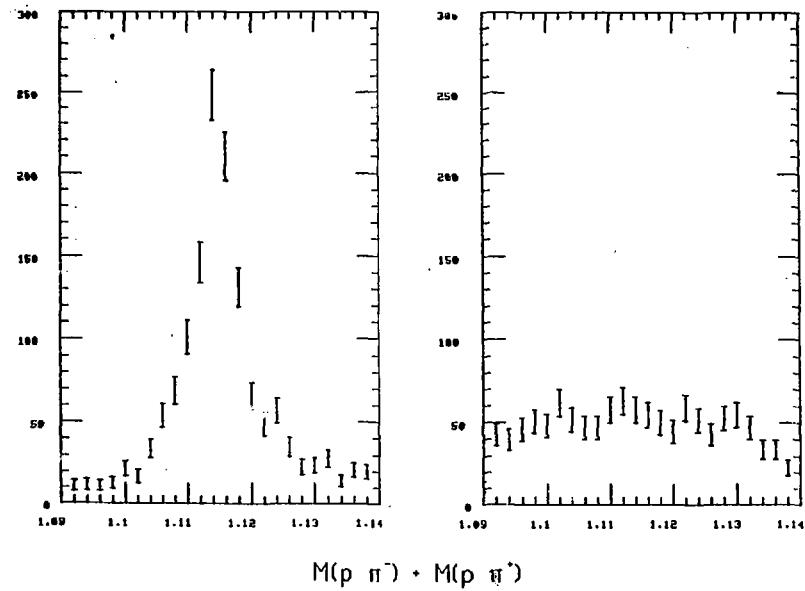
Fig.1:   a)M(p π⁻) and M(p̄ π+) coming out of the geometrical fit to a secondary vertex : a)after all cuts; b)combinations rejected by the standard quality cut.
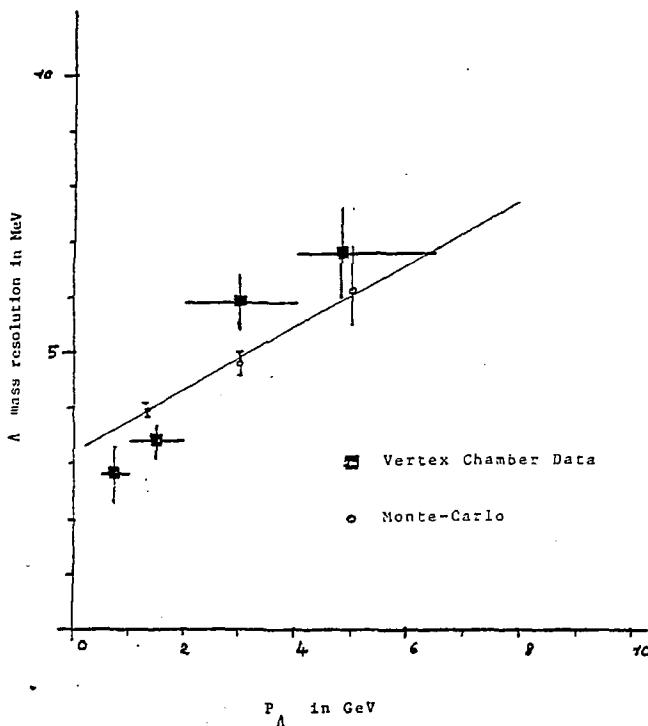
Fig.2:Variation of the Λ resolution (defined as σ_m) with momentum.
Data agrees with Monte-Carlo simulation.
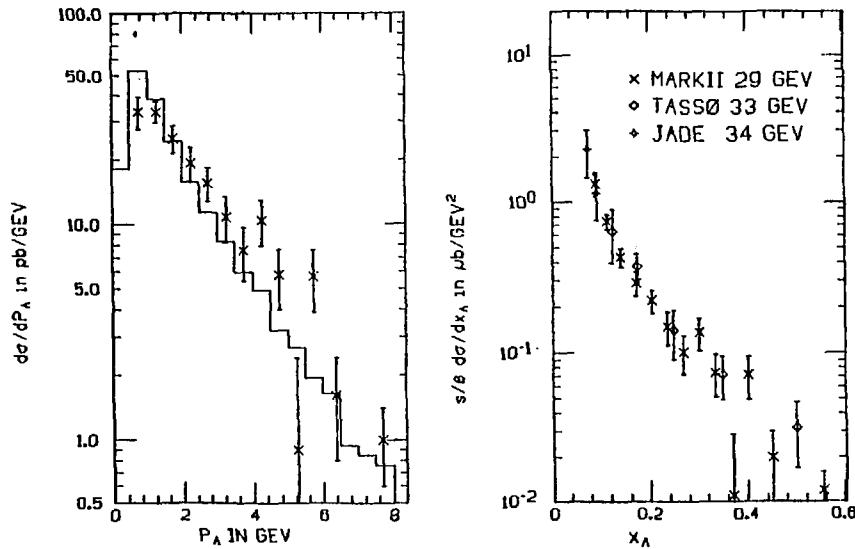
Fig.3: a)Differential cross-section dσ/dP_A corrected for acceptance (the errors are statistical only). Comparison with the cross-section predicted by the BQCD generator(full histogram). The model has been normalized to the data by a reduction of 1.39. b)invariant cross-section s/β dσ/dx and comparison with results of TASSO and JADE. Only the data coming from the sample without drift chamber problems have been used.
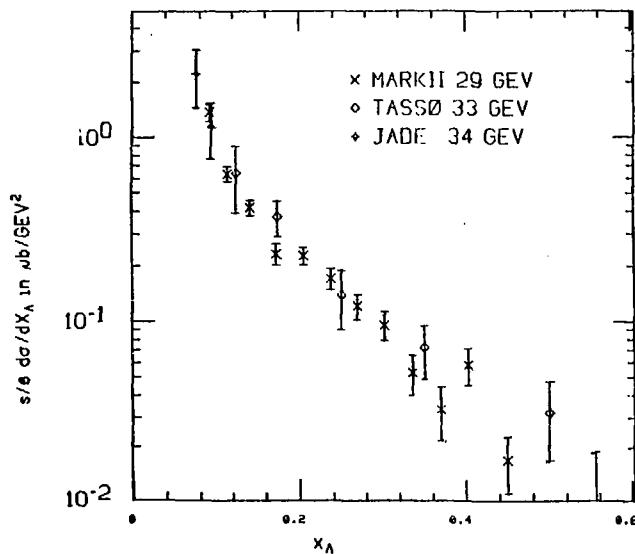
Fig.4; Same as Fig.3-b but the whole sample have been used. The events coming from the 88 pb⁻¹ with drift chamber problems have been given a weight 1/0.776 to compensate for the inefficiency.

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ID= 263   CPD962    M(YEE) VERSUS M(YEE) +LAM ALAM +CC EVENTS

Z.E 0     J    1    2    3    4    5    6    7    8    9   10   11   12   13   14

          Y   UN01.0921.0961.1001.1041.1081.1121.1161.1201.1241.1201.1321.136  OVR=E  0
    .I   . X   +----+----+----+----+----+----+----+----+----+----+----+----+----+----+ YTOT.E  0
    1  UN0 I                                                                          I     0
    2 1.092 I                                                                         I     0
    3 1.096 I                                                                         I     0
    4 1.1   Z                                                                         I     0
    5 1.104 I                                                                         I     0
    6 1.108 I                                                                         I     6
    7 1.112 I                              2    2    1         1                      I     4
    8 1.116 I                                   2    1    1                           I     2
    9 1.120 I                                        2                                I     0
   10 1.124 I                                                                         I     1
   11 1.128 I                                                      1                  I     0
   12 1.132 I                                                                         I     0
   13 1.136 I                                                                         I     0
   14  OVR I                                                                          I     0
    E  0   +----+----+----+----+----+----+----+----+----+----+----+----+----+----+
 XTOT.E  0    0    0    0    0    0    2    4    4    1    1    0    1    0    0        13

    STATS FROM BINS, #CALLS=      9, NTS= 13.000
    <X>= 1.1177    +- .127E-02, SD= .45640E-02+- .895E-03  FOR  1.09   < X <  1.14    (EXTREME X
    <Y>= 1.1177    +- .177E-02, SD= .63657E-02+- .125E-02  FOR  1.09   < Y <  1.14    (EXTREME Y
    COR.COEF=  .6746
    COVARIANCE ELLIPSE : SEMI AXES=   .2957E-02 AND   .7253E-02, ANGLE= 2.589   RAD
```

Fig.5:   2-dimensional mass plot of $\Lambda\bar{\Lambda}$ candidates showing a clear associated production.

	Same jet	Opposite jet
$\Lambda\bar{p} + \bar{\Lambda}p$	92	56
$\Lambda p + \bar{\Lambda}\bar{p}$	22	42
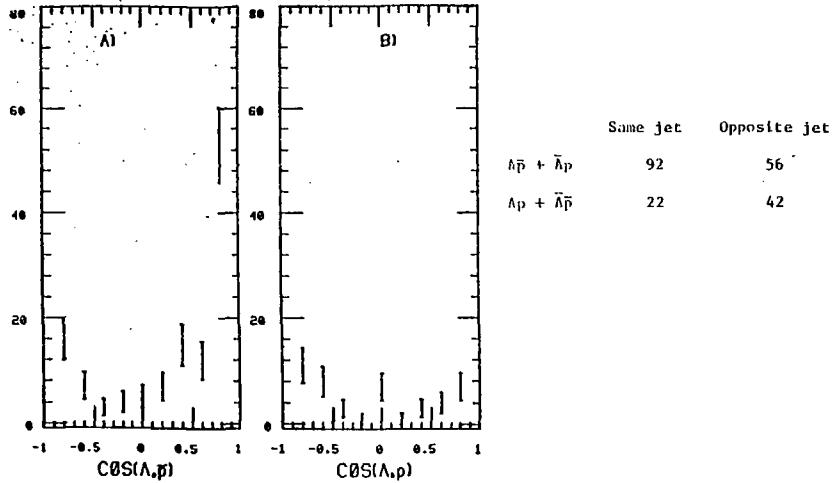
Fig.6: a)Cosine of the angle between Λ and $\bar{p}$ (or $\bar{\Lambda}$ and p);
b)$\cos\Theta(\Lambda,p)$ and its charge conjugate.
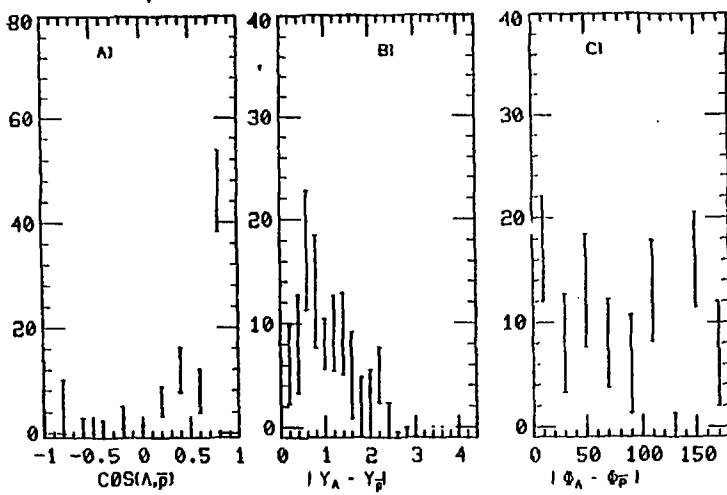
Fig.7: a)Cos θ(Λ,p̄) and its charge conjugate after sub-traction of the contribution due to 2 baryon-antibaryon pairs. b)difference of rapidity along the sphericity axis between a Λ and a p̄(or the charged conjugate) after sub-traction of the double pair contribution. c)Difference of azimuthal angles of Λ and p̄ (+c.c), measured in the plane perpendicular to the sphericity axis. Same sub-traction method.
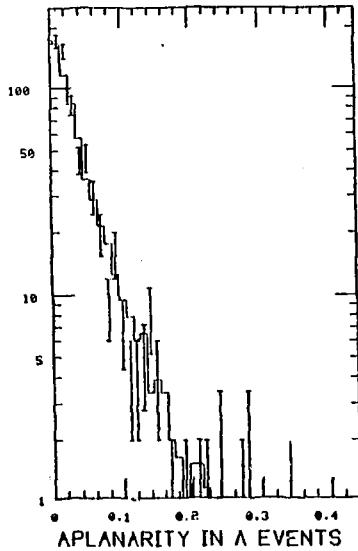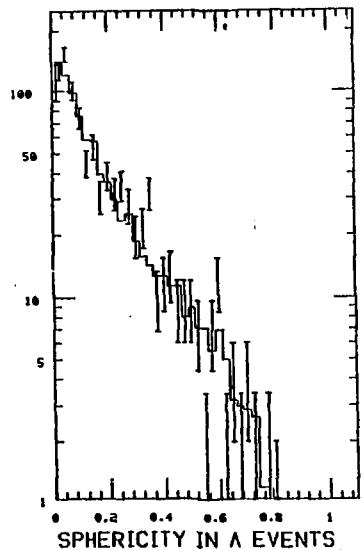
Fig.8:Sphericity and aplanarity distributions when a Λ(Λ̄) is required or not required(full histogram) in the event. The number of entries of the full histograms have been normalized to the number of Λ⁰s.
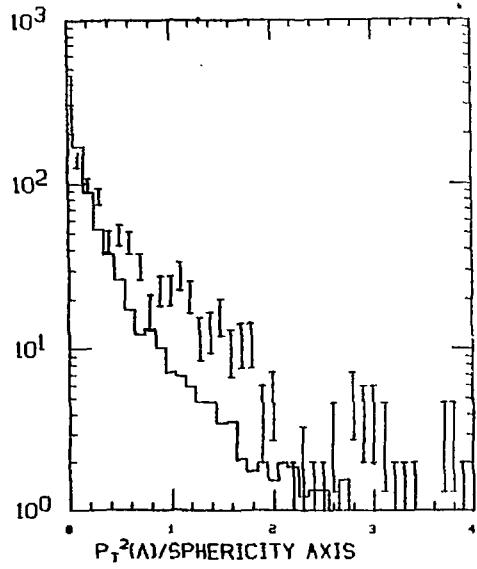
Fig.9: Comparison of the P_t^2 of Λ^0s and charged hadrons relatively to the sphericity axis in events containing Λ^0s. The charged distribution(full histogram) has been normalized to the number of Λ^0s.

TRK	P	EL	TOT	ID
1	3.4	0.		PI·
2	0.0	0		P·
3	0.8			PI·
4	0.9	0.2		PI·
5	0.3	0.3		PI·
6	3.0	0.0		PI·
7		0.4		G
8		0.7		G
9		0.4		G
10		0.5		G
11		0.3		G
12		0.3		G
13		0.5		G
14		0.5		G
15		0.5		G
16		0.3		G
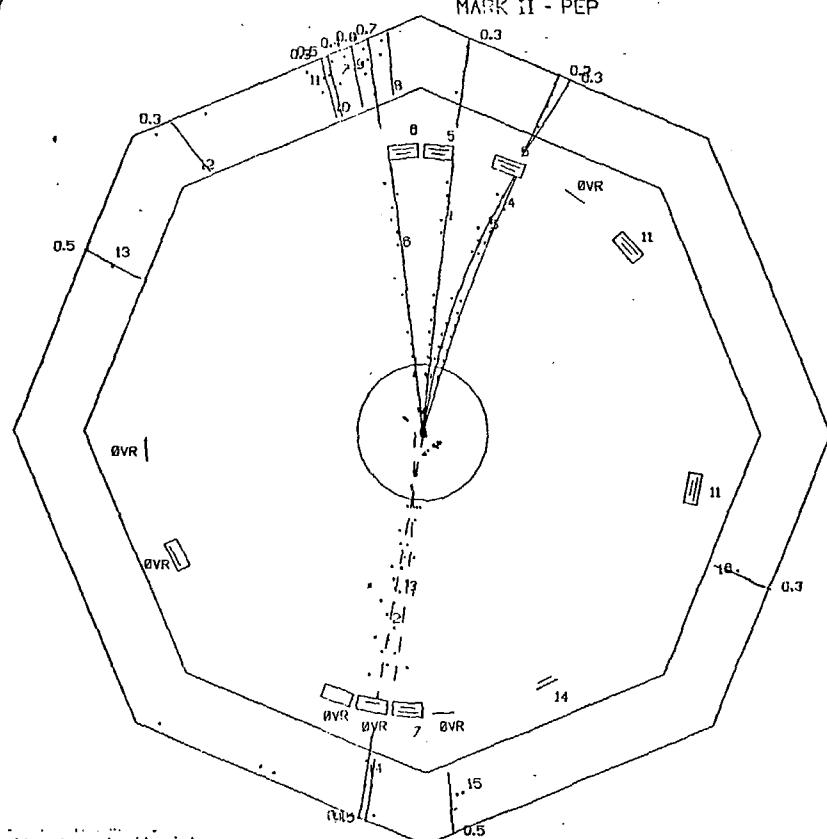
Fig.10: Example of a fast $\bar{\Lambda}$ practically alone in its jet.

TASSO

Fig.11; Cascade mass plots of MARK2 and TASSO   MARK2

DR > 1.5 cm
$0.1 < exp(-\rho_w(\beta \gamma c \tau \sin\theta))_{\perp} \times 8$
$|z(\pi) - z(\Lambda)| < 5 cm$

$M(\Lambda\pi^-, \bar{\Lambda}\pi^+)$

$M(\Lambda\pi^-, \bar{\Lambda}\pi^+)$

$M(\Lambda\pi^+, \bar{\Lambda}\pi^-)$

$M(\Lambda\pi^+, \bar{\Lambda}\pi^-)$

MARK II

LOCATION
PEP e^+e^- storage ring
SLAC, Stanford, CA, USA

MAGNET
4.6 kG Al coil solenoid, 1.5 m radius (currently running at 2.3 kG)

TRACKING
Central drift chamber:
  Active length = 2.64 m, inner radius = 0.41 m, outer radius = 1.45 m
  6 axial layers, 10 stereo layers ($\pm 3°$)
  50% ethane, 50% argon
  $\sigma \simeq 200\ \mu$
Vertex drift chamber:
  Cylindrical drift chamber, 1.2 m long, inner radius = 10 cm, outer radius = 35 cm
  Only axial wire layers (4 near $r = 12$ cm, 3 near $r = 30$ cm)
  $\sigma \simeq 100\ \mu$
  Be beam pipe ($0.006X_0$)
  Combined $(\Delta p/p)^2 = (0.015)^2 + (0.01p)^2$
  Tracks extrapolated to interaction point within 100 μ

SHOWER COUNTERS
8 modules of Pb-liquid argon ($15X_0$ each), arranged in octagon outside coil
Covers 64% of 4π
2 mm Pb sheets separated by 3 mm liquid argon gaps
37 layers ($0.4X_0$ sampling) are ganged to provide 5 samples in depth
Readout in 3.8 cm wide strips in ϕ, θ, u directions
$\Delta E/E \simeq 13\%/\sqrt{E}$

TIME OF FLIGHT
48 scintillation counters read out at both ends
Cover 75% of 4π
1.50 m flight path at $\theta = 90°$; $\sigma = 340$ ps
K,π separation up to 1.35 GeV/c at 1σ level

END CAPS
2 layers Pb-proportional chamber ($5X_0$) with 4 successive cathode strip readouts
  (θ, ϕ, R-spiral, L-spiral)
50% argon, 50% ethane

MUON DETECTION
Proportional tubes interleaved with steel absorber (4 layers each for total thickness of 1 m)
covering 55% of 4π

SMALL ANGLE TAGGING
LUMINOSITY
MONITOR
6 planar drift chambers followed by shower counters
Octagonal shower counters cover 22 mrad $< \theta <$ 80 mrad contain
18 layers 1/4'' Pb and 1/2'' scintillator, read out with BBQ wave shifter, front 5 layers
  separately from back 13
$\Delta E/E = 15.5\%/\sqrt{E}$
3 sets of scintillation counters

REFERENCES

1. G.S. Abrams et al., Phys Rev. Lett. 43 (1979) 477, and ibid 481.
2. W. Davies White et al., Nucl. Instr. & Meth. 160 (1979) 227.
3. G.S. Abrams et al., IEEE Trans. Nucl. Sci. NS 25 (1978) 1, ibid 309, and NS 27 (1980) 59.
4. J.A. Jaros, Proc. Int. Conf. on Instrumentation for Colliding Beam Physics, SLAC-250 (1982).

MARK II

Vacuum Chamber
Vertex Detector
Drift Chamber
Time of Flight Counters
Solenoid Coil
Liquid Argon Shower Counter
Iron Flux Return and Hadron Absorber
Muon Proportional Tubes

1 m

Flux Return
Drift Chamber
Vacuum Chamber
Shower Counter
End Cap

Muon Detectors
Shower Counters
Coil

Time of Flight Scintillation Counters
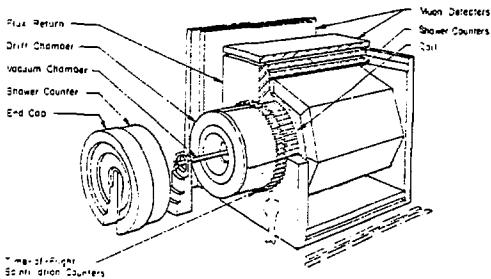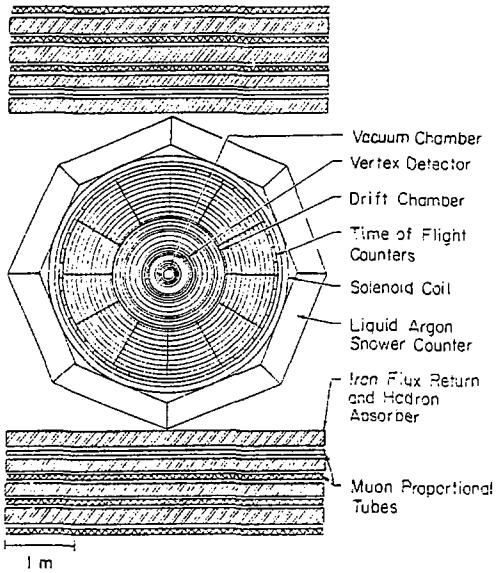
1) distance d'approche maximum
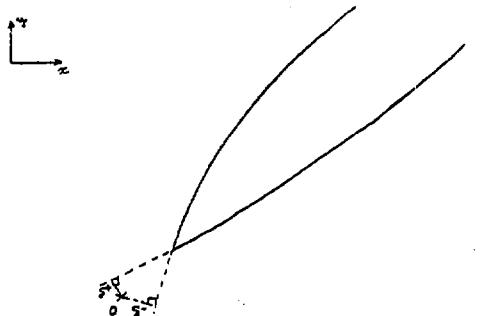
$$S^+ > DCPR = 2 \text{ mm}$$
$$S^- > DCPI = 1 \text{ mm}$$

2) Point de rencontre dans l'espace
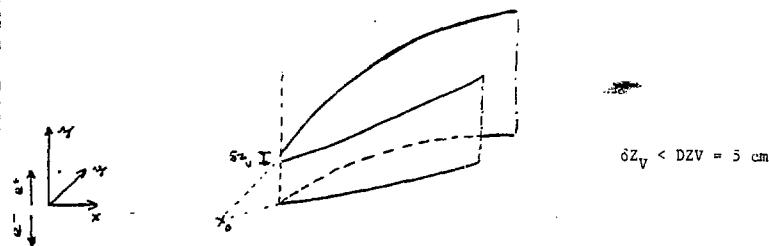
$$\delta Z_V < DZV = 5 \text{ cm}$$

3) Alignement du V_o

$$\delta_{V_a} = \ell_{xy} \sin \varepsilon < RSNV = 5 \text{ mm}$$

$$c\tau = \frac{\ell_{xy}}{\beta\gamma\cos\theta} > CTLM = 4 \text{ mm}$$
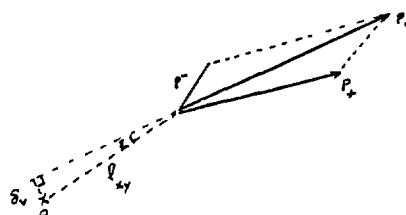
Illustration des critères géométriques de sélection des Λ

ANNEXE 2

VFINDP : VFINDP est un ensemble de programmes destiné, comme son nom
l'indique, à reconnaître des vertexs secondaires du type V_o. VFINDP fonctionne
comme une boîte noire. Al'entrée un "menu" d'options et de critères de sélec-
tion, à la sortie des candidats V_o satisfaisant ces critères.

Essentiellement VFINDP associe toutes les paires de traces positives et
négatives satisfaisant un certain nombre de ces critères. Des hypothèses de
masses sont alors assignées aux 2 traces. Celles-ci sont ajustées à un vertex
secondaire qui doit satisfaire à d'autres critères pour être retenu comme V_o.

Les critères choisis pour cette étude suivent de près la définition d'un V^o.

1) Les deux traces doivent manquer le point d'interaction primaire. Le test
est effectué sur la projection perpendiculaire à l'axe du faisceau qui est la
plus précise. On mesure la "distance d'approche maximum" δ des traces au point
d'interaction. Cette opération nécessite une extrapolation. Grâce à la chambre
de haute précision, cette extrapolation est très précise : 100 μ .

2) Les deux traces doivent se rencontrer dans l'espace. Malheureusement l'im-
précision le long de l'axe du faisceau ne permet pas d'être sélectif.

3) Les 2 traces sont ajustées à provenir d'un même vertex secondaire. Le
test de l'ajustement doit être positif.

4) La ligne de vol du V_o et la somme des impulsions sont assujettis à être
alignés.

5) Les très courts parcours sont éliminés. Plutôt que sur le parcours, le test
est effectué sur le temps de vol propre $c\tau = \ell/\beta\gamma$.

6) La masse du V doit être compatible avec celle d'un K^o, Λ ou $\bar{\Lambda}$.

Qualité d'un V_o

De façon à améliorer la pureté de l'échantillon de K_o, Λ, $\bar{\Lambda}$, nous avons introduit la notion de qualité d'un V_o, ce qui permet ensuite de faire une coupure sur cette qualité.

La Fig. 1 du rapport montre la présence d'un fond sous le signal du $\Lambda/\bar{\Lambda}$. Ce fond est du à des paires de traces qui simulent un V^o où à un K^o mal iden- tifié.

La séparation du signal et du fond est basée sur l'analyse multi-dimensionnelle Si l'on considère les quelques caractéristiques d'un V^o sur lesquelles est basée la sélection, le comportement en paraît souvent sensiblement différent entre le fond et le signal, pas assez cependant pour permettre une séparation très propre.

Le principe de la méthode est de combiner toutes ces caractéristiques à l'in- térieur d'une variable unique, la qualité, dont le pouvoir de séparation est plus fort. Dans la qualité, nous avons introduit l'information sur l'identi- fication des secondaires par "temps de vol". Cette information étant souvent insuffisante et pas toujours disponible n'avait pas été utilisée au niveau de VFINDP.

L'extrait ci-dessus de la Réf. 2, détaille le calcul de la qualité d'un V_o.

Definition of K^o and $\bar{\Lambda}$ quality.

3 types of ingredients enter in determining the V quality.
-Time of flight compatibility of secondaries. The time of flight prob- ability , which is mainly useful for slow Λs, reflects the discrepancy between the measured time of flight (when available or significant) and expected time of flight.
-Geometrical quantities: DSV(Match in z of the 2 secondaries at the XY intersection), RSNV(distance of closest approach of the V line of flight), SUMDCA ($\sqrt{}$(sum of distance of cl. appr. of secondaries squared)), COSTAR (Cos. of the decay angle/line of flight in the V frame). For these factors, we estimated the probability from the histograms of these quantities PK(I) and WI(I) in the peak and wings regions. (This histo- grams are entered numerically in the function PROZV) The probability factor is essentially PK(I)/WI(I) normalized to a convenient factor. The fig.1 shows these distributions for VC data. They are found gener- ally independent from the type of data or V.
-Penalties and bonuses. Penalties and bonuses occurs when secondaries of a V that decays outside the VC inner layer have unwanted (or no) hits in these layers.A penalty is also given to a Λ candidate when a secondary is labelled electron in the liquid argon (Function IDGA).This allows to kill pair contamination. Penalties and bonuses are empirical.

SVQUAL is actually the logarithm of the product all these probability fac- tors. The Fig.2 and 3 show the cumulated distribution of the quality of candidates K^o, Λ^o in the peak and wings regions. The standard probability cuts (QUALOW and UPQUAL in the common VSELEC), divide the quality distribu- tion in 3 zones: 1)The low quality region that is mostly background; 2)The high quality region with low background; 3)The upper quality region virtu- ally background free but with some loss of signal.
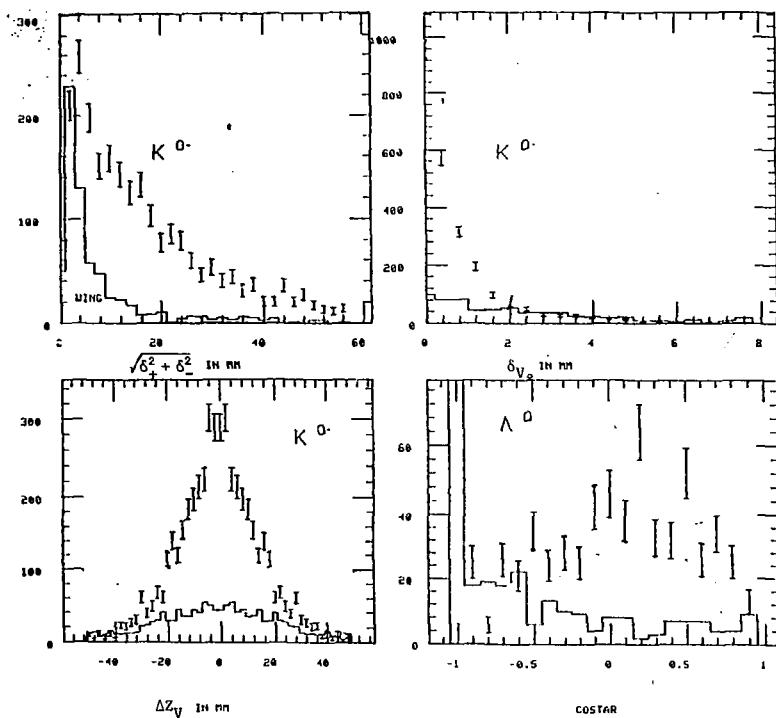
Fig.1:Distributions of the geometrical or dynamical variables. These dis-
tributions are shown for the V peak and wings regions (full histogram).
The peak contribution is estimated through a linear peak minus wings sub-
straction.   Whenever the distribution differs significantly between K[0] and
Λ[0] or data type,it may be entered seperately in the function PROZV.
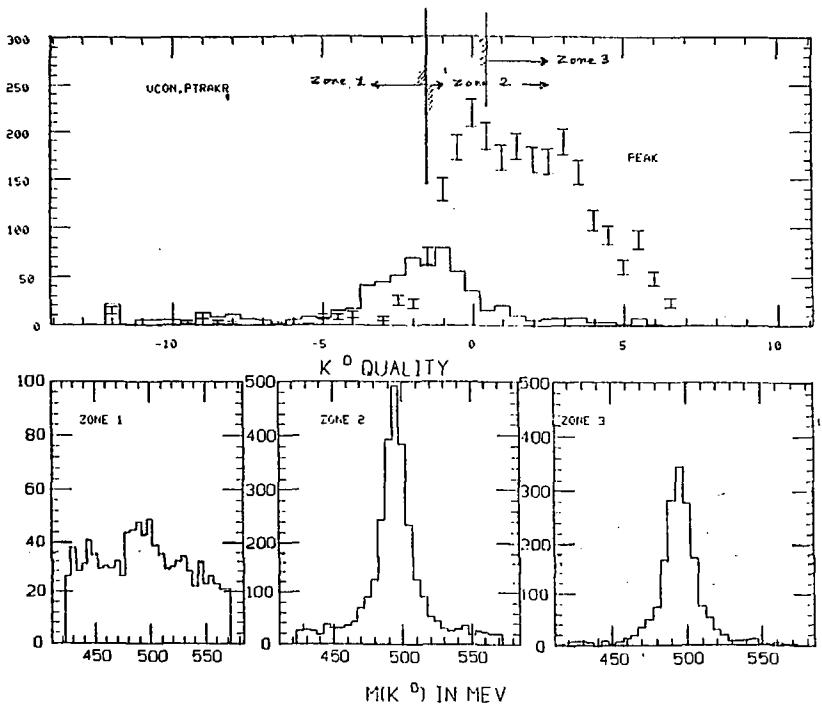
Fig.2:K⁰ probability distribution for vertex chamber data. in the peak
and wings regions. The default probability cuts QUALON and UPQUAL are
indicated, and the lower part of the figure shows the K⁰ mass spectrum in
the 3 zones that can be defined. Solid histograms are combinations of low
VQUAL that are cut.

Fig.3:Same as Fig.2 but for Λ⁰ s.