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Λ transverse polarization

Introduction

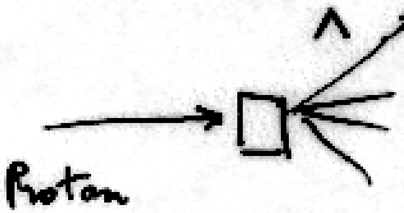
* Perturbative QCD does not predict any large polarization effect in hard scattering processes.

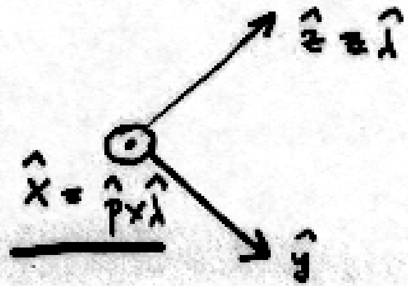
* Λ produced in e.g. fixed target experiments, p-p collisions, deep inelastic muon scattering, etc. show significant transverse polarization.

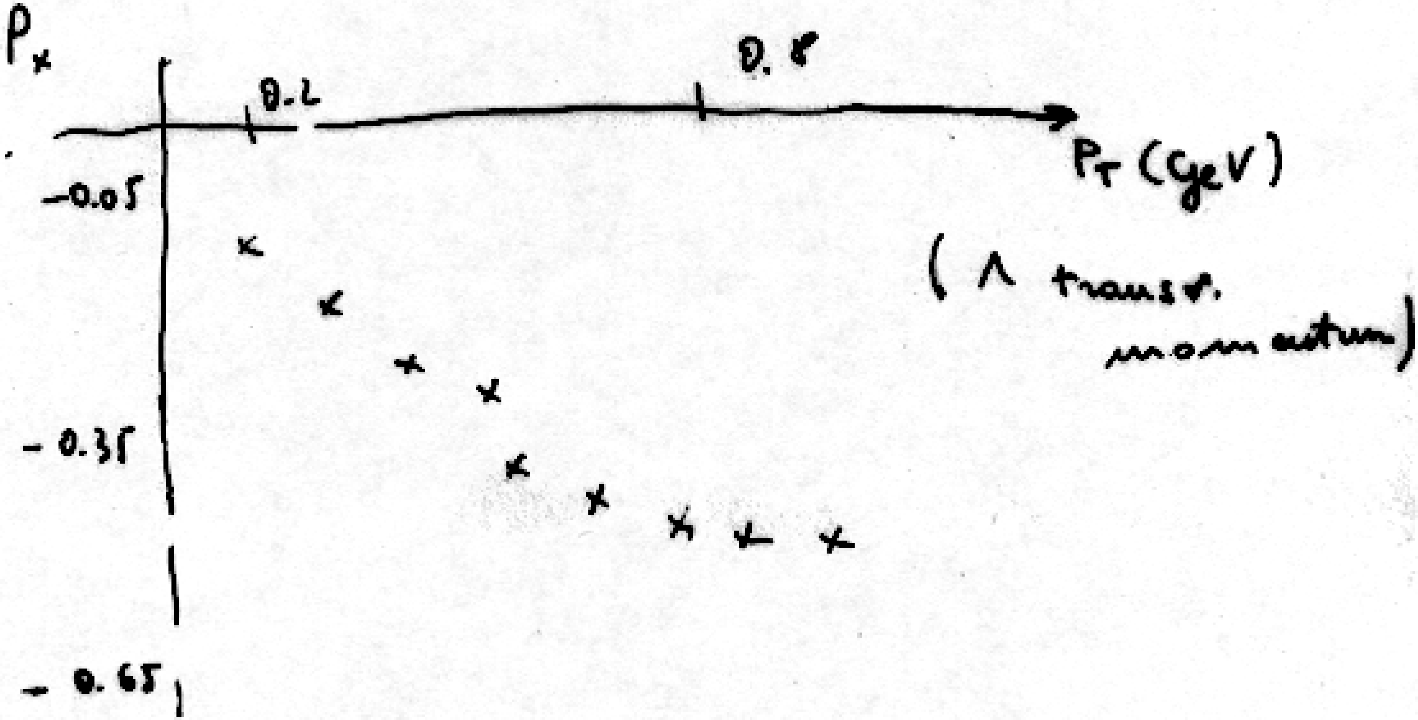
* Existing models do not account for experimental findings.

* One can ask what happens in e^+e^- collisions.

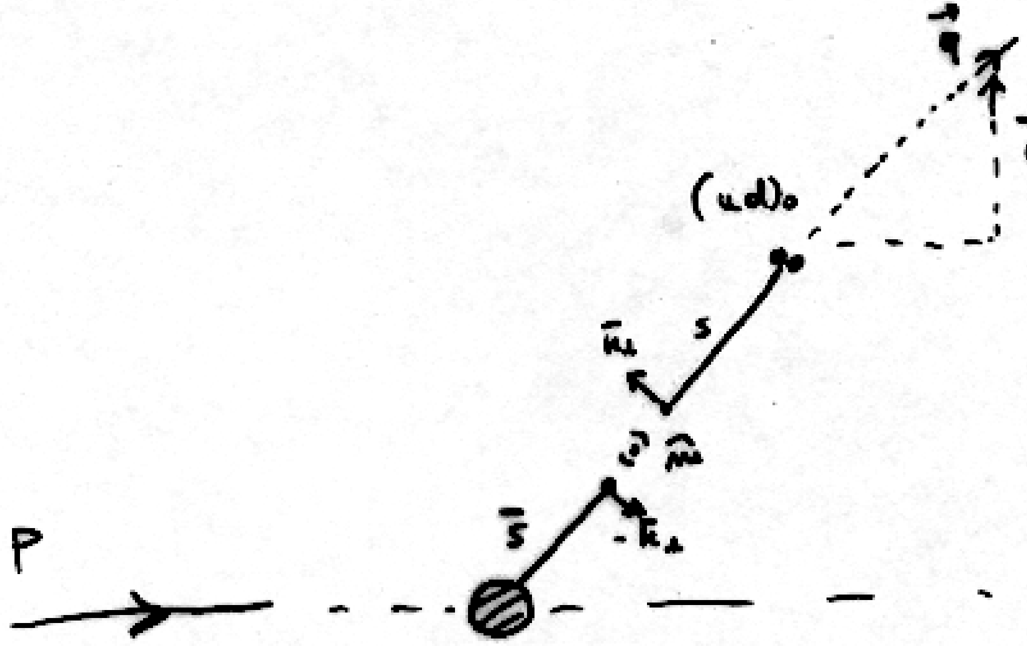
→ The context of a fixed target experiment







AGI (1979)



$$\hat{n} = \frac{\vec{q} \times \vec{k}_\perp}{|\vec{q} \times \vec{k}_\perp|}$$

* $s\bar{s}$ created at a distance to preserve energy-mom. conservation $\Rightarrow$ $s\bar{s}$ develops angular momentum
$\Rightarrow$ $s\bar{s}$ needs spin to compensate that.

* $(ud)_0$ picks up s and therefore Λ inherits its spin. $\Rightarrow$ Λ is polarized along $\hat{n}$.

* Polarization correlated with $\vec{k}_\perp$

In the context of e^+e^- collisions one can ask:

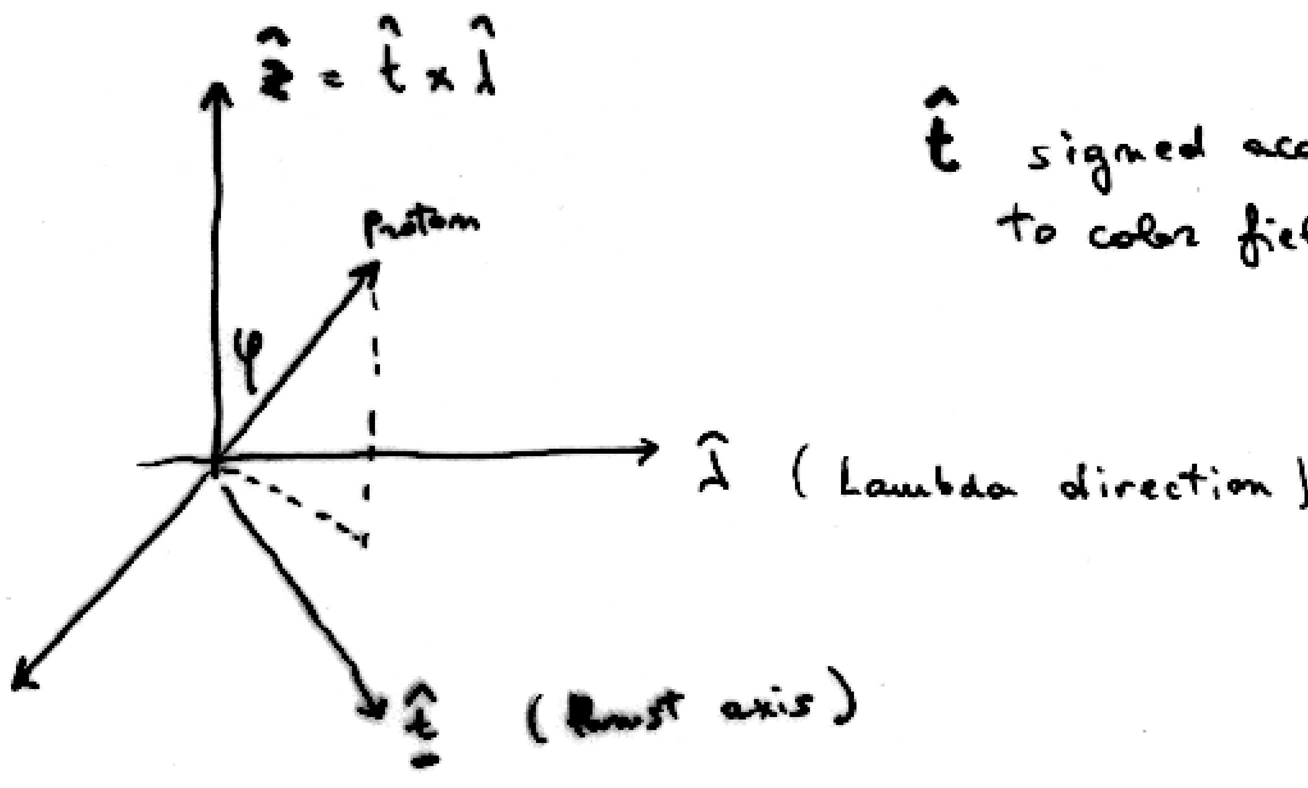
Q(1) Is Λ produced "transversely" polarized?

Q(2) What is the "transverse" direction?

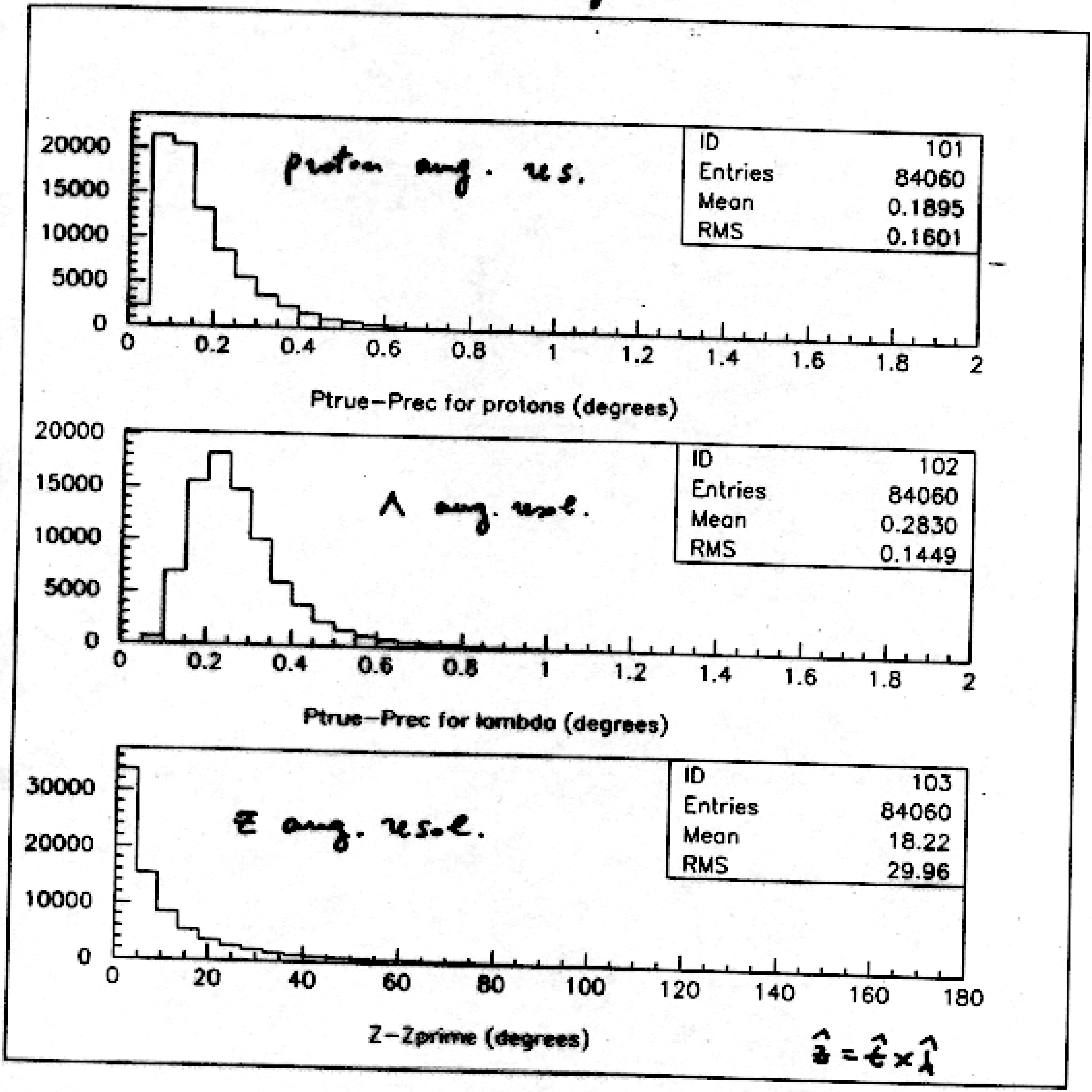
Q(3) Does "Lund" model work? (i.e. AGI, 1979)

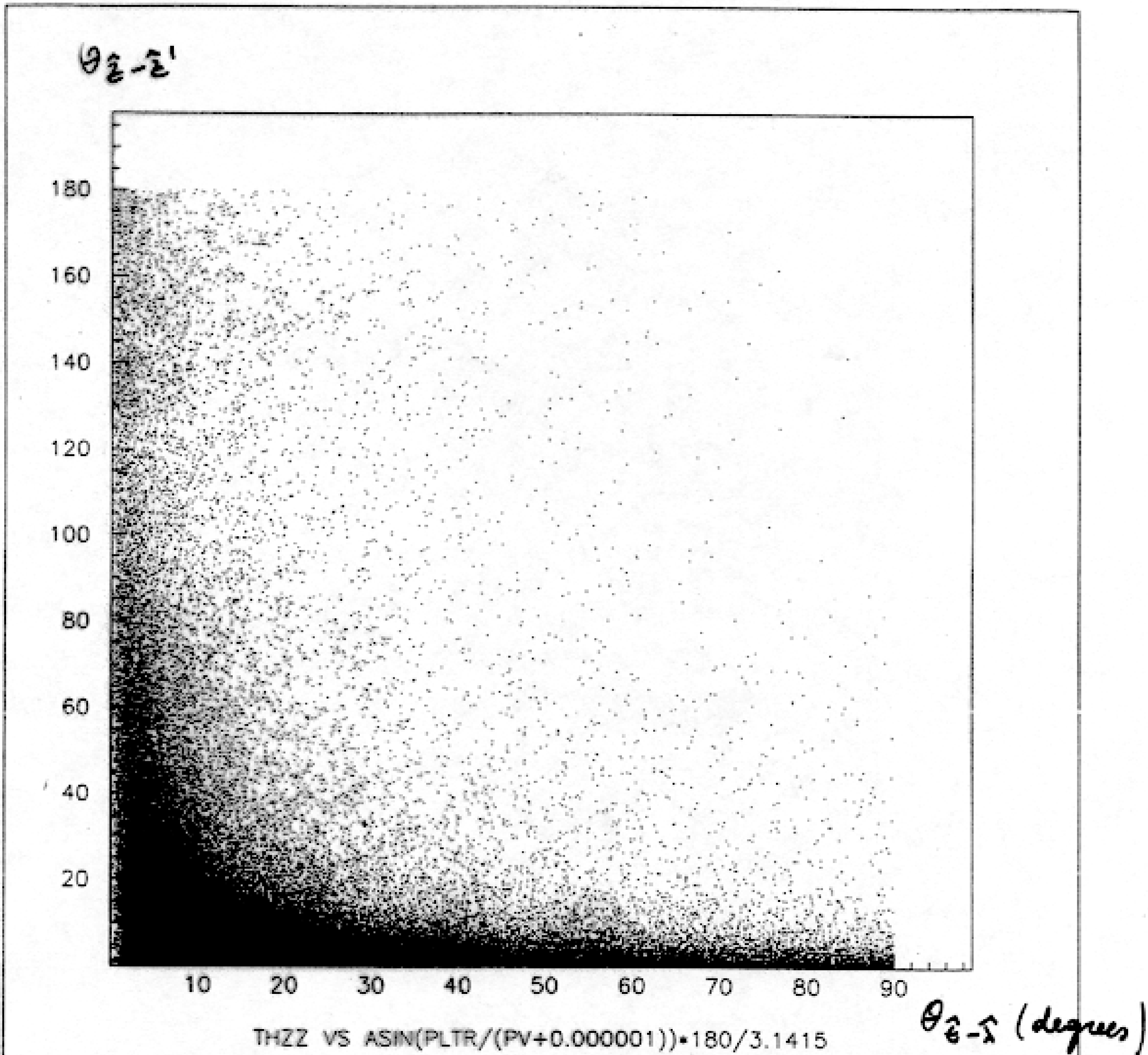
The natural choice for "transverse" direction is $\hat{z}$:

$\hat{t}$ signed according to color field



Some angular resolutions





$$\hat{z} = \hat{e} \times \hat{\lambda}$$

$$\theta = \angle(\hat{e}, \hat{\lambda})$$

Sensitivity issues

1. Due to thrust axis resolution a dilution factor of $\approx 82\%$ is expected

2. For AGI model expect $\simeq 40\%$ dilution factor due to $q(\bar{q})$ direction misassignement, given $\simeq 70\%$ polarization

Analysis

* Like for any other direction, can explore polarization along $\hat{z}$ by using

$$\frac{dN}{d(\cos\varphi^*)} \propto 1 + \alpha P_z \cos\varphi^* \qquad (\Lambda \to p\pi)$$

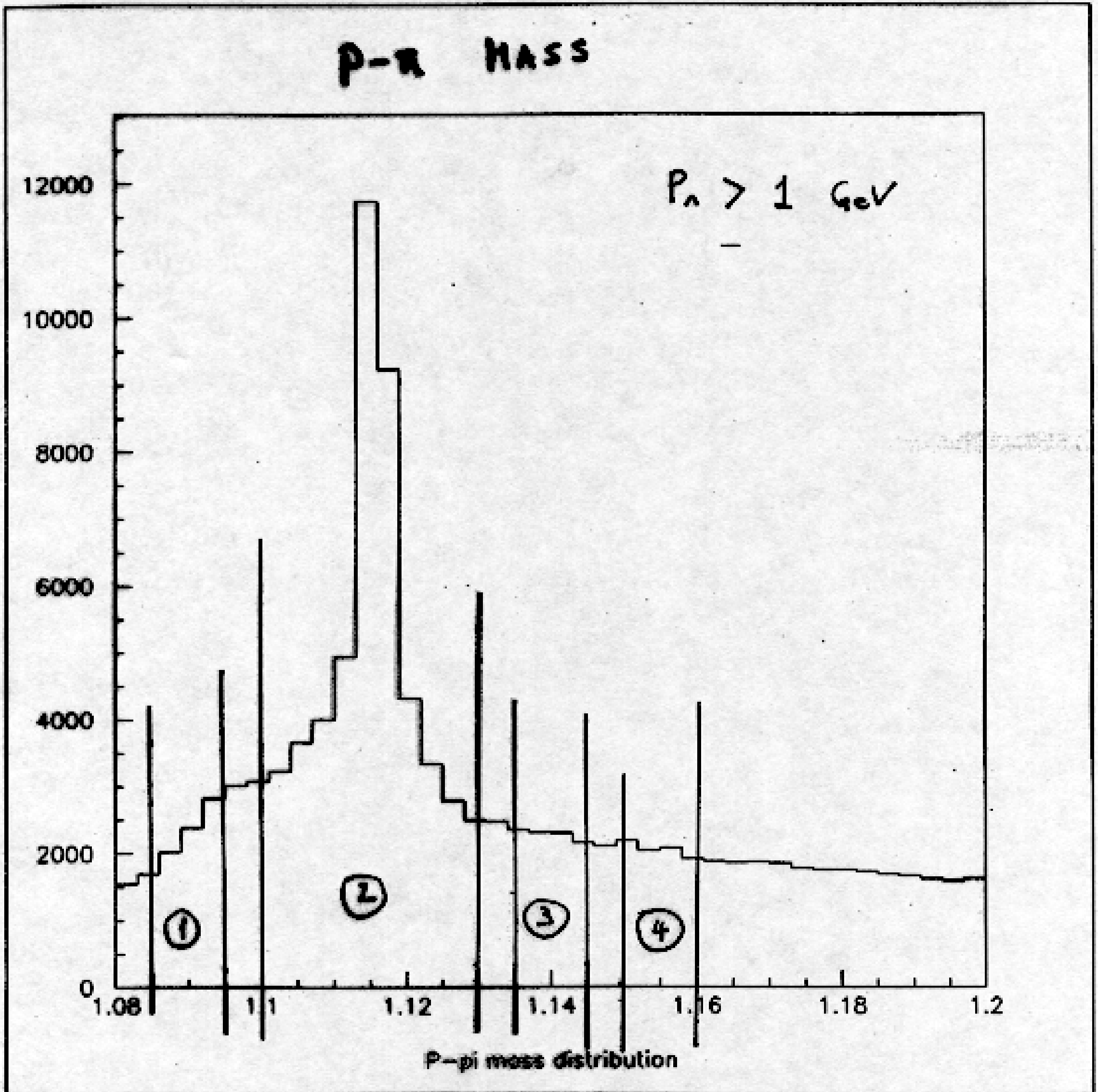
with φ^* computed in Λ rest frame.

* Select Λ candidates by using Ken's cuts.

* Take background shape from MC

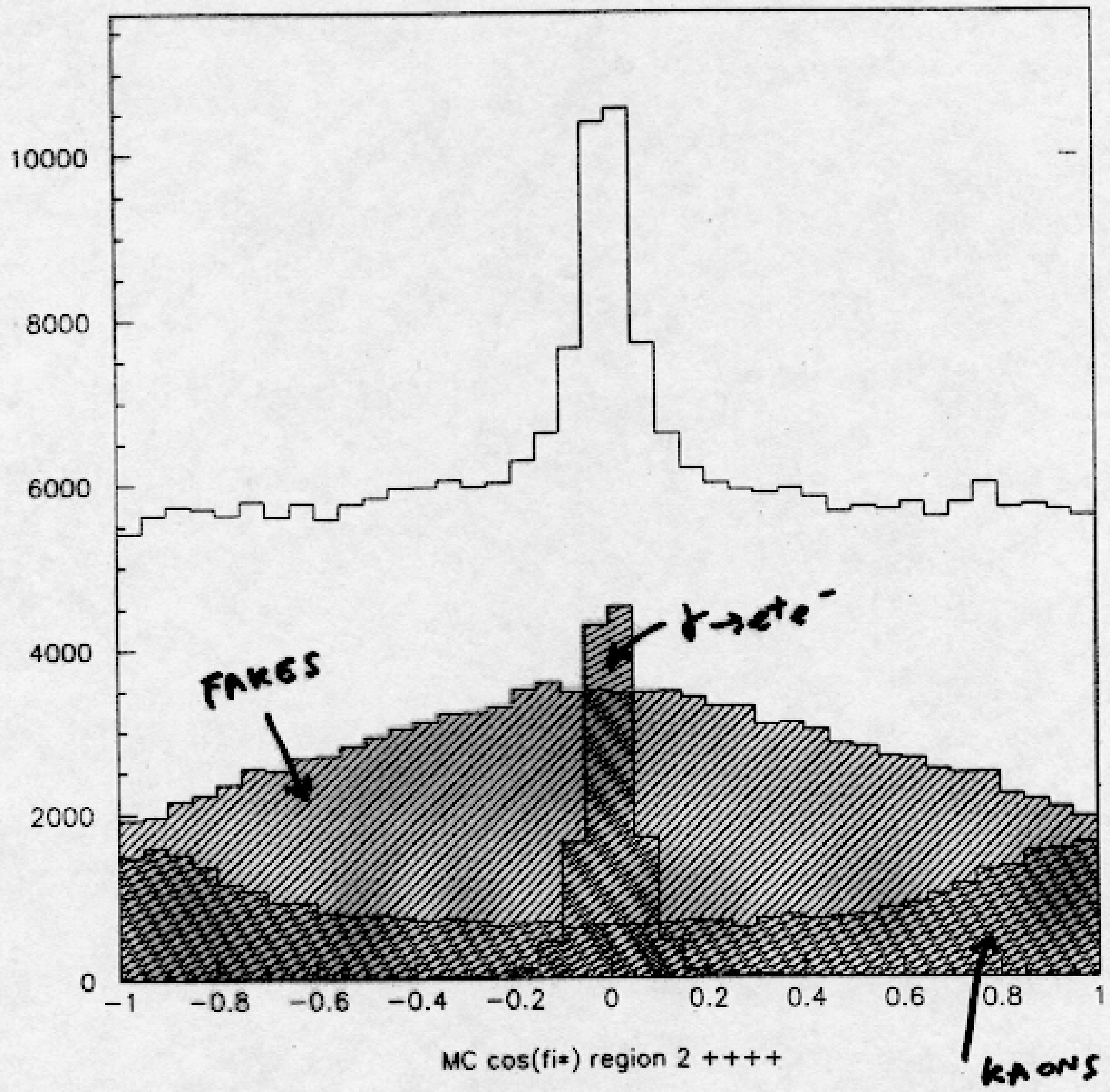
* Check MC/data agreement for background from sidebands around Λ peak. Eventually re-weight MC.

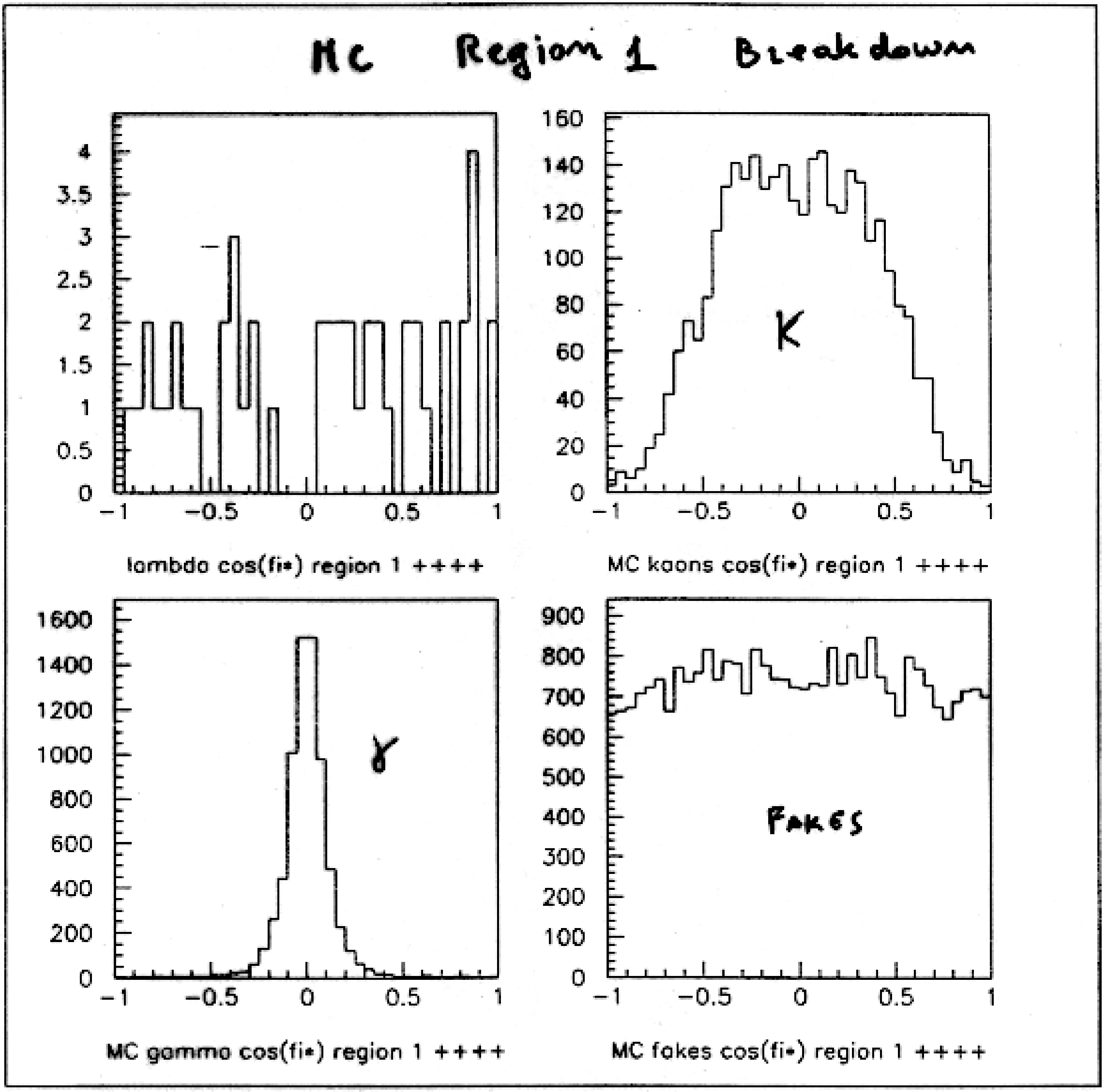
* Make a likelihood fit of $dN/d(\cos\varphi^*)$ to extract polarization.



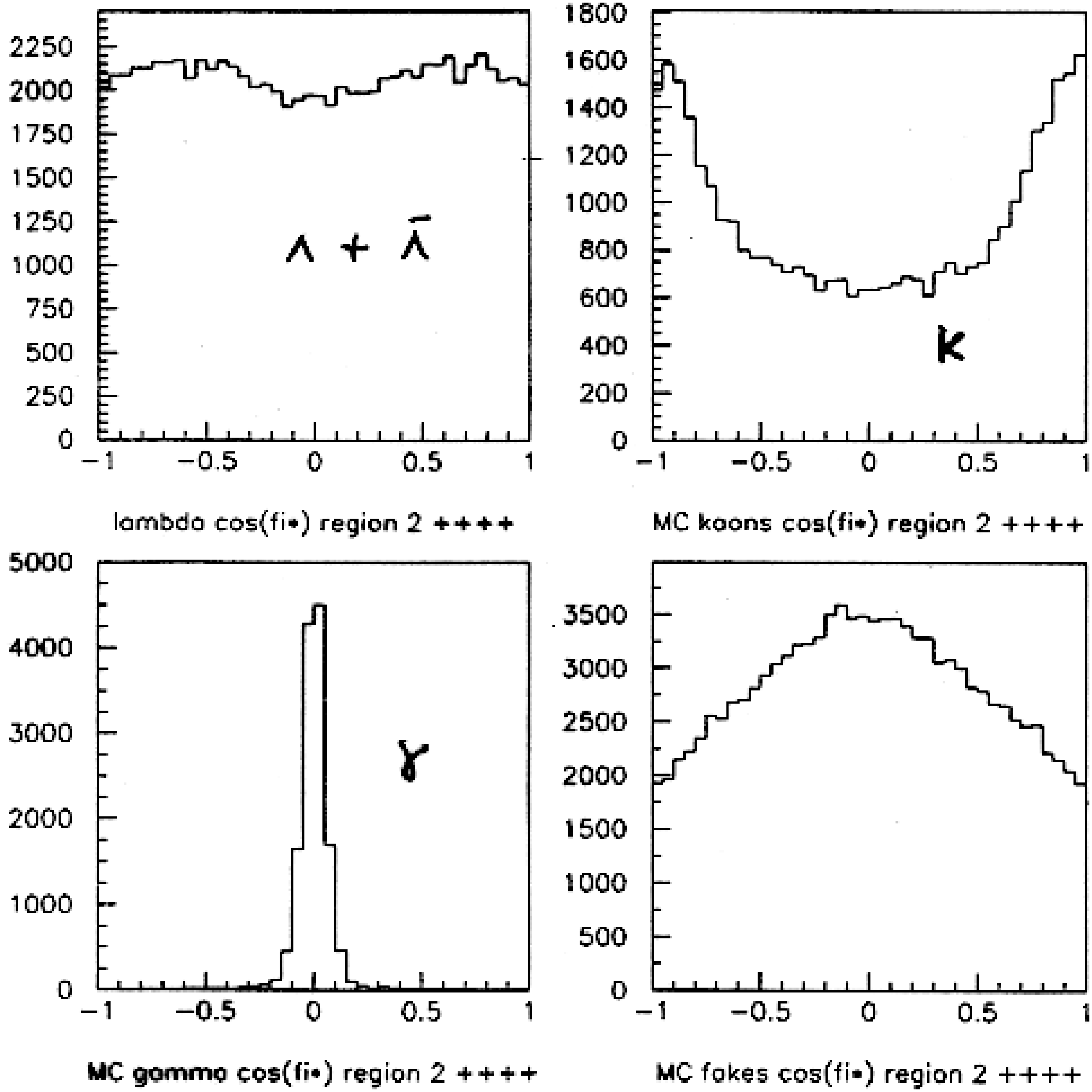
P-π MASS
$P_\Lambda > 1$ GeV
12000
10000
8000
6000
4000
2000
0
1.08
1.1
1.12
1.14
1.16
1.18
1.2
1
2
3
4
P-pi mass distribution

MC cosφ*

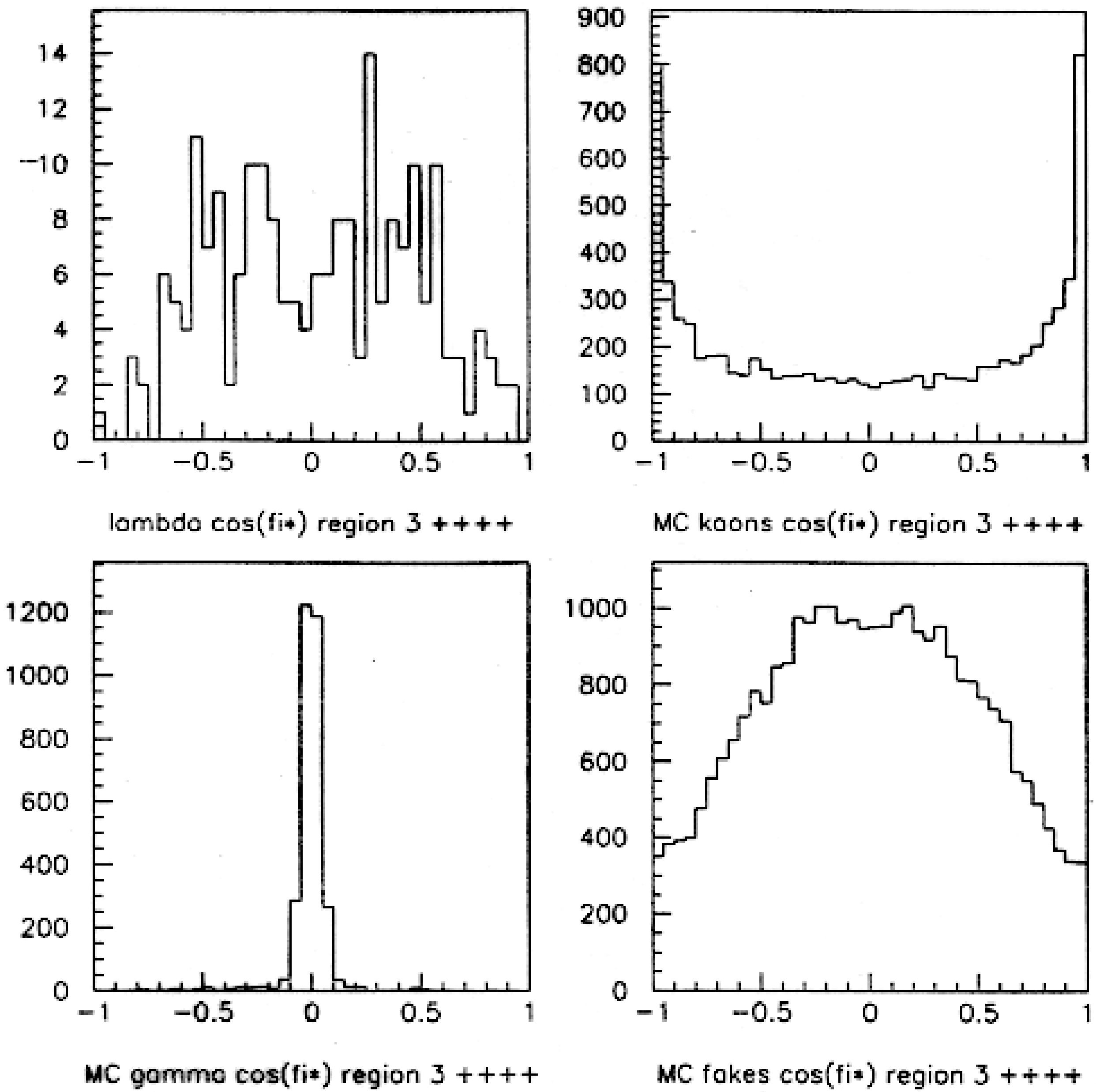

10000
8000
6000
4000
2000
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
MC cos(fi*) region 2 ++++
FAKES
KAONS


MC Region 1 Breakdown
lambda cos(fi*) region 1 ++++
K
MC kaons cos(fi*) region 1 ++++
γ
MC gamma cos(fi*) region 1 ++++
Fakes
MC fakes cos(fi*) region 1 ++++

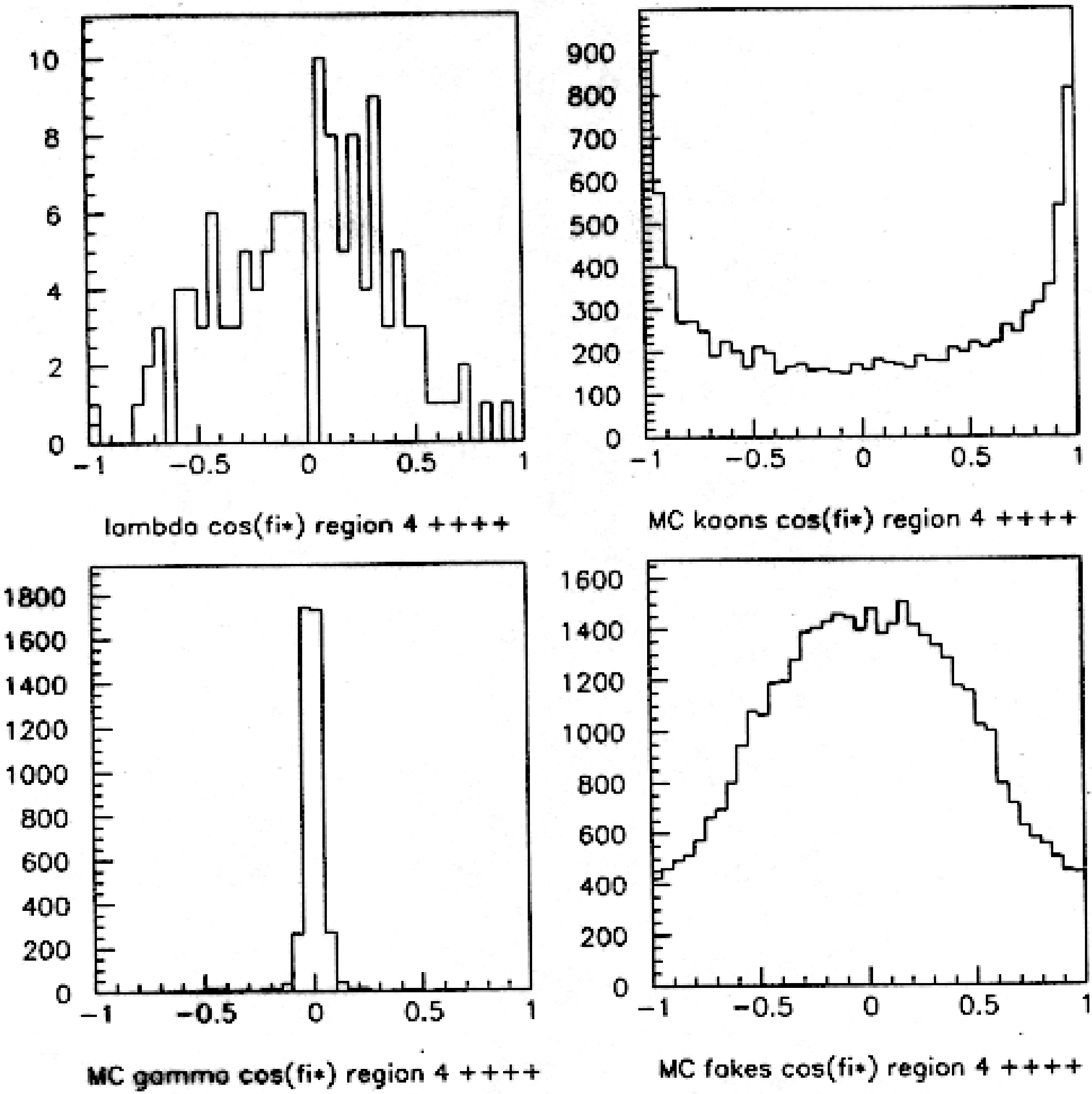
MC Region 2 Breakdown



MC Region 3 Breakdown



MC Region 4 Breakdown



Likelyhood fit of $\cos\varphi^*$ distribution

$$\mathcal{L} = \eta_K \frac{K(\cos\varphi^*)}{N_K} + \eta_G \frac{G(\cos\varphi^*)}{N_G} + \eta_F \frac{F(\cos\varphi^*)}{N_F} + (1 - \eta_K - \eta_F - \eta_G) \times$$

$$\times \frac{\varepsilon_s(\cos\varphi^*)\, S(\cos\varphi^*)}{N_{ES}}$$

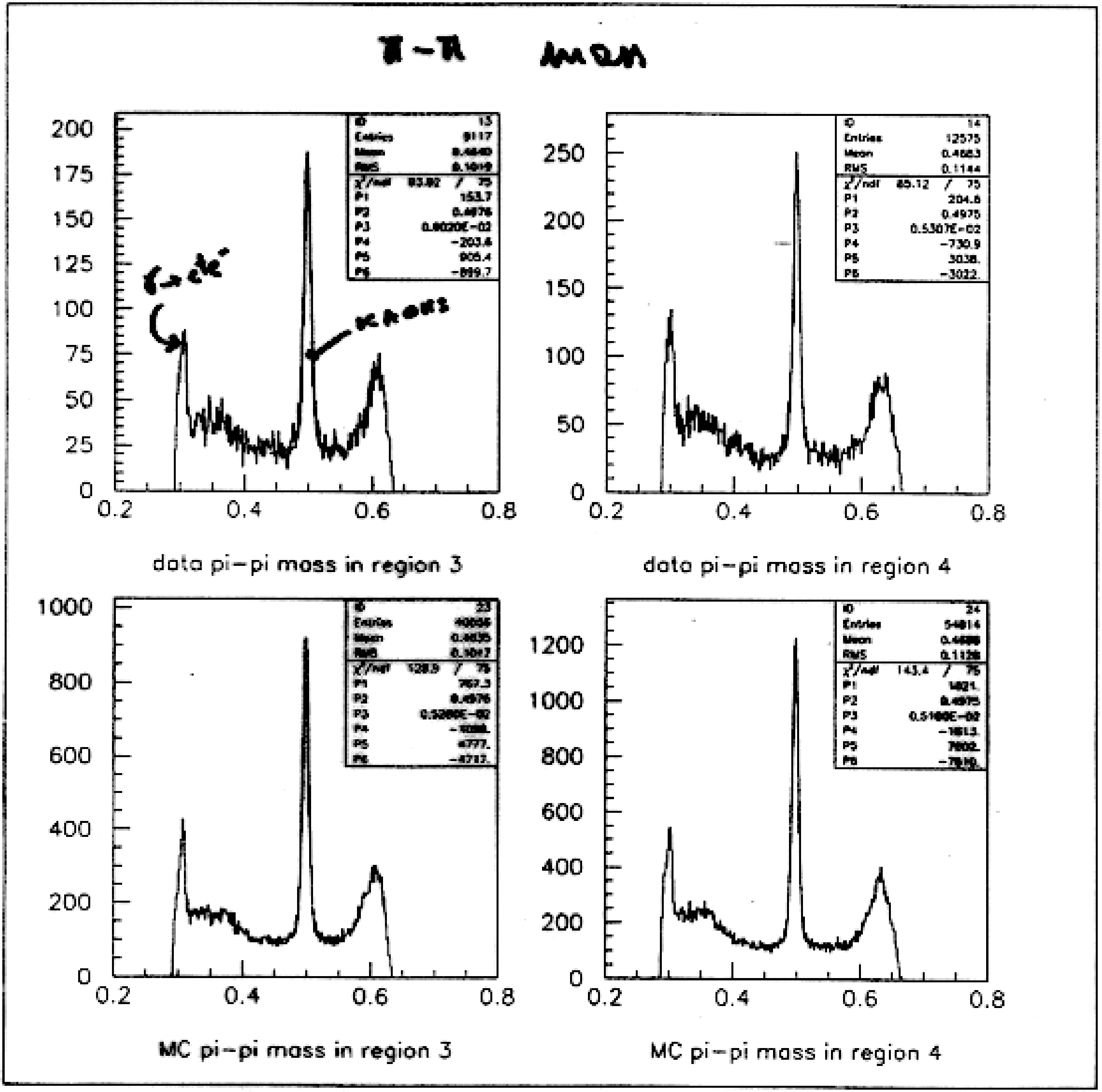
K, F, ε_s are 4^{th} order polynomials taken from MC

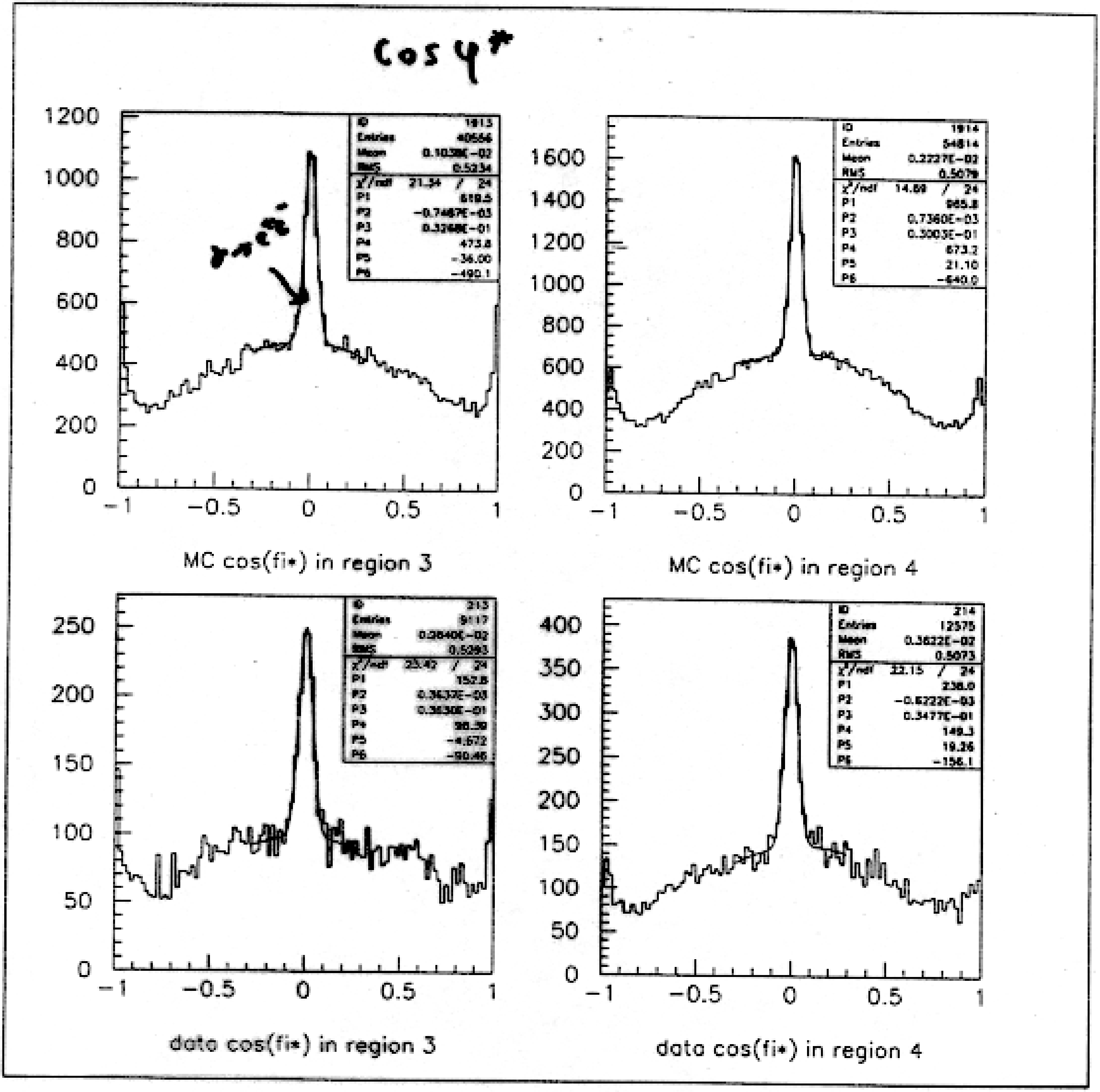
G is a Gaussian

$$S = 1 + \alpha P \cos\varphi^*$$

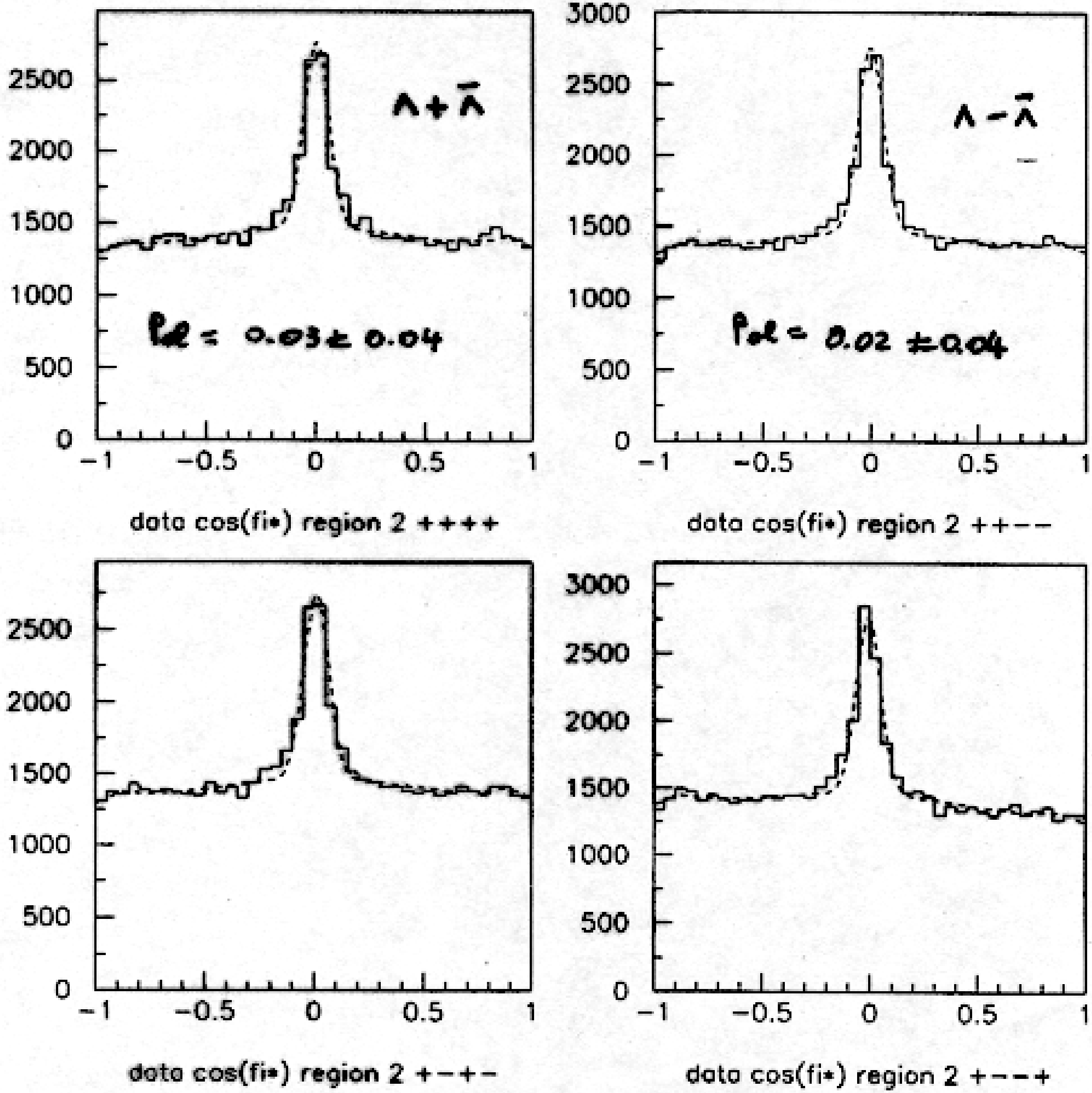
* Estimate η_K, η_F by data/MC comparison

* Fit for η_G and P


π-π mass
KAONS
data pi-pi mass in region 3
data pi-pi mass in region 4
MC pi-pi mass in region 3
MC pi-pi mass in region 4

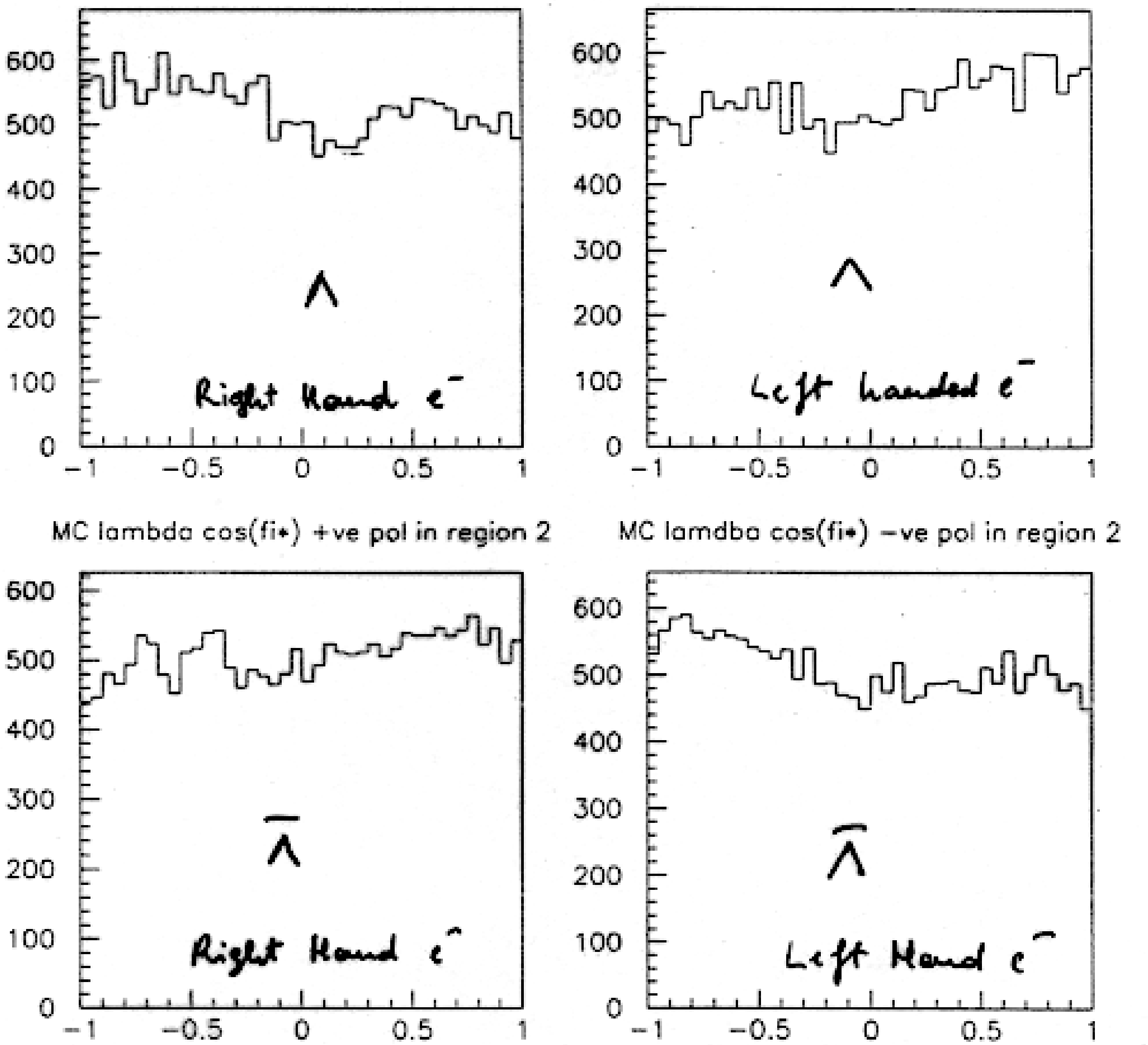

MC cos(fi*) in region 3
MC cos(fi*) in region 4
data cos(fi*) in region 3
data cos(fi*) in region 4

Fit for polarization



MC signal

(Λ cosφ^*)



MC lambda cos(fi*) +ve pol in region 2

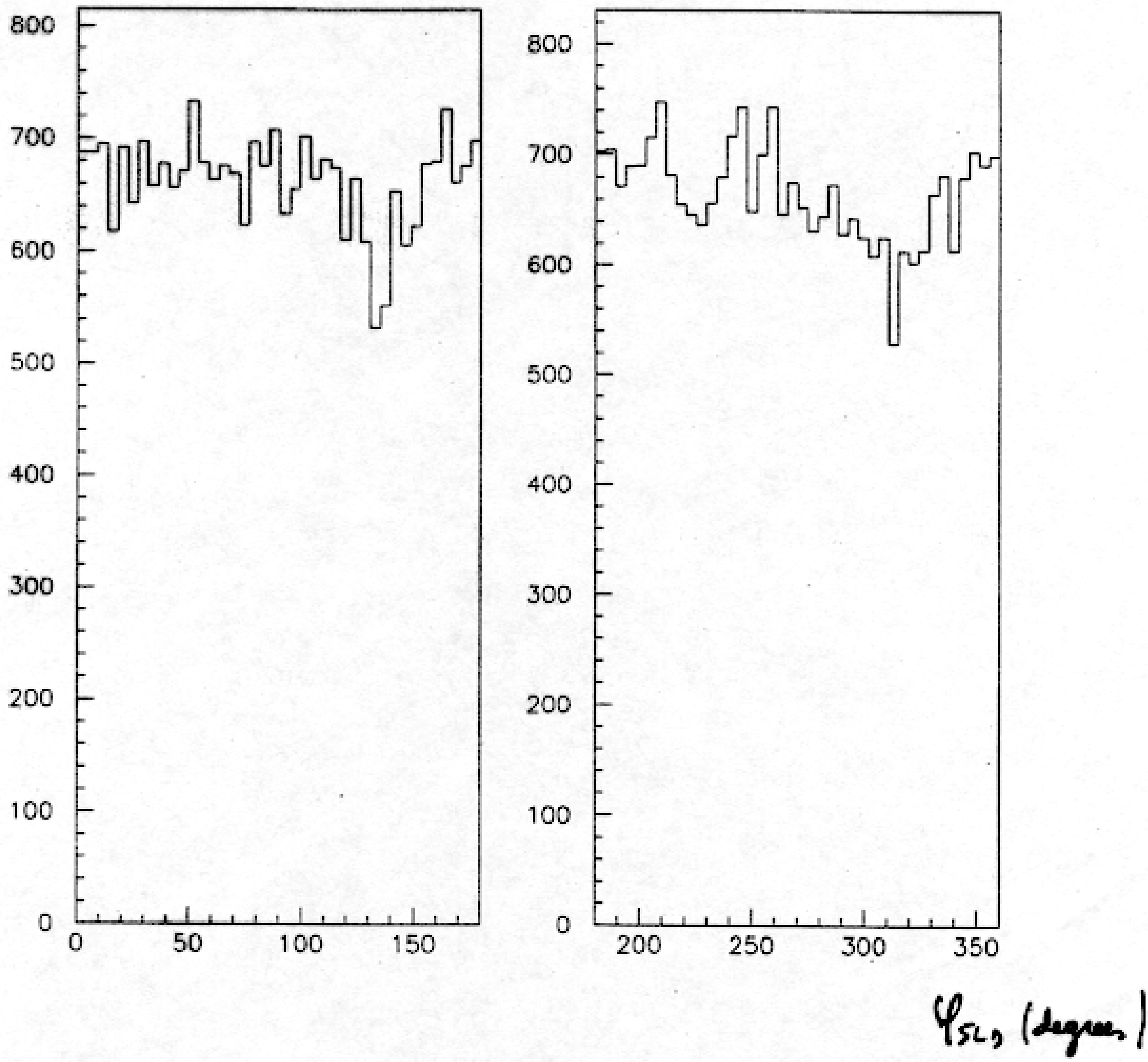
MC lamdba cos(fi*) −ve pol in region 2

MC lambdabar cos(fi*) +ve pol in region 2

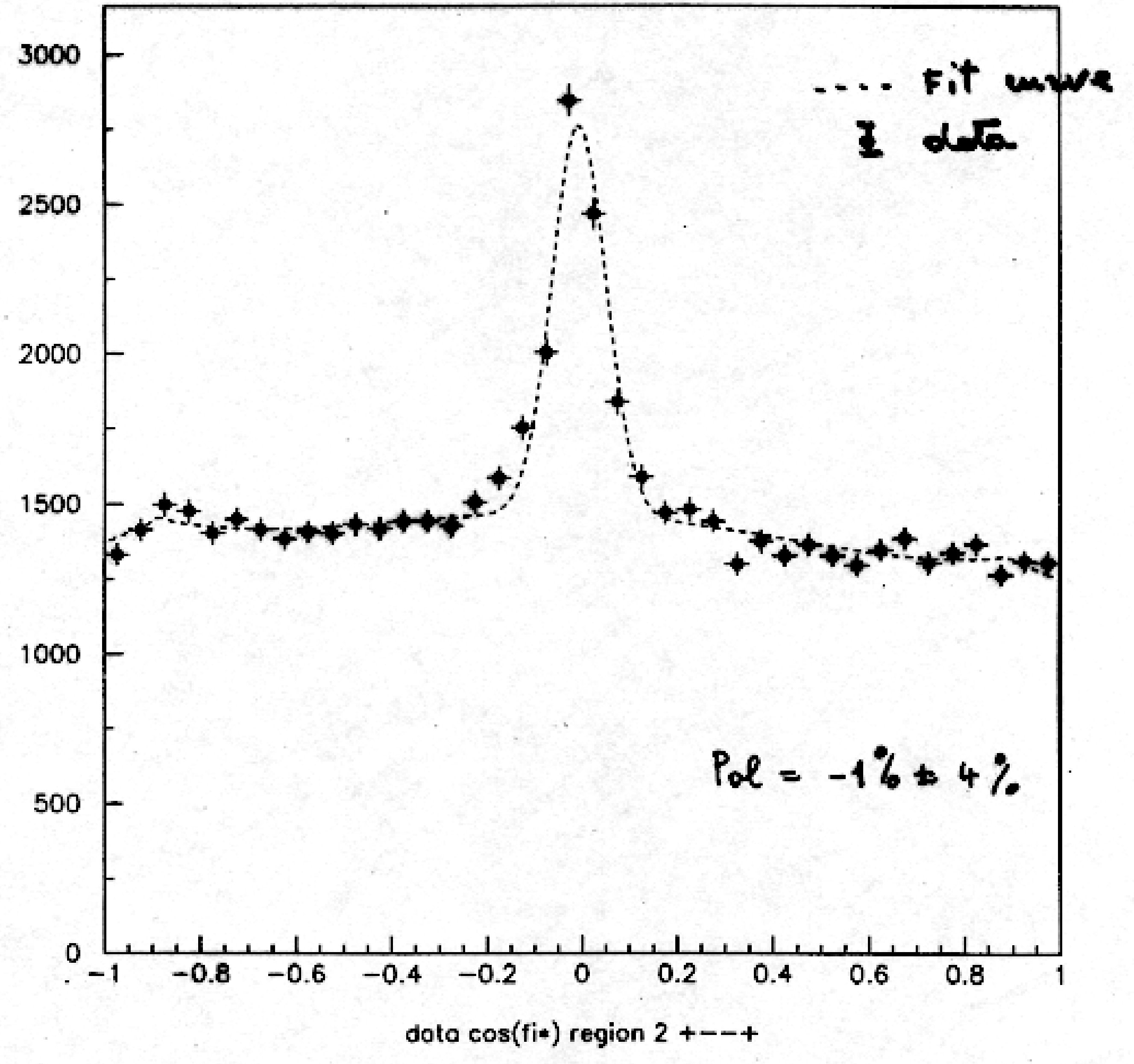
MC lambdabar cos(fi*) −ve pol in region 2

When we add Λ and $\bar{\Lambda}$ and/or +,- polarisation the effect tends to desappear

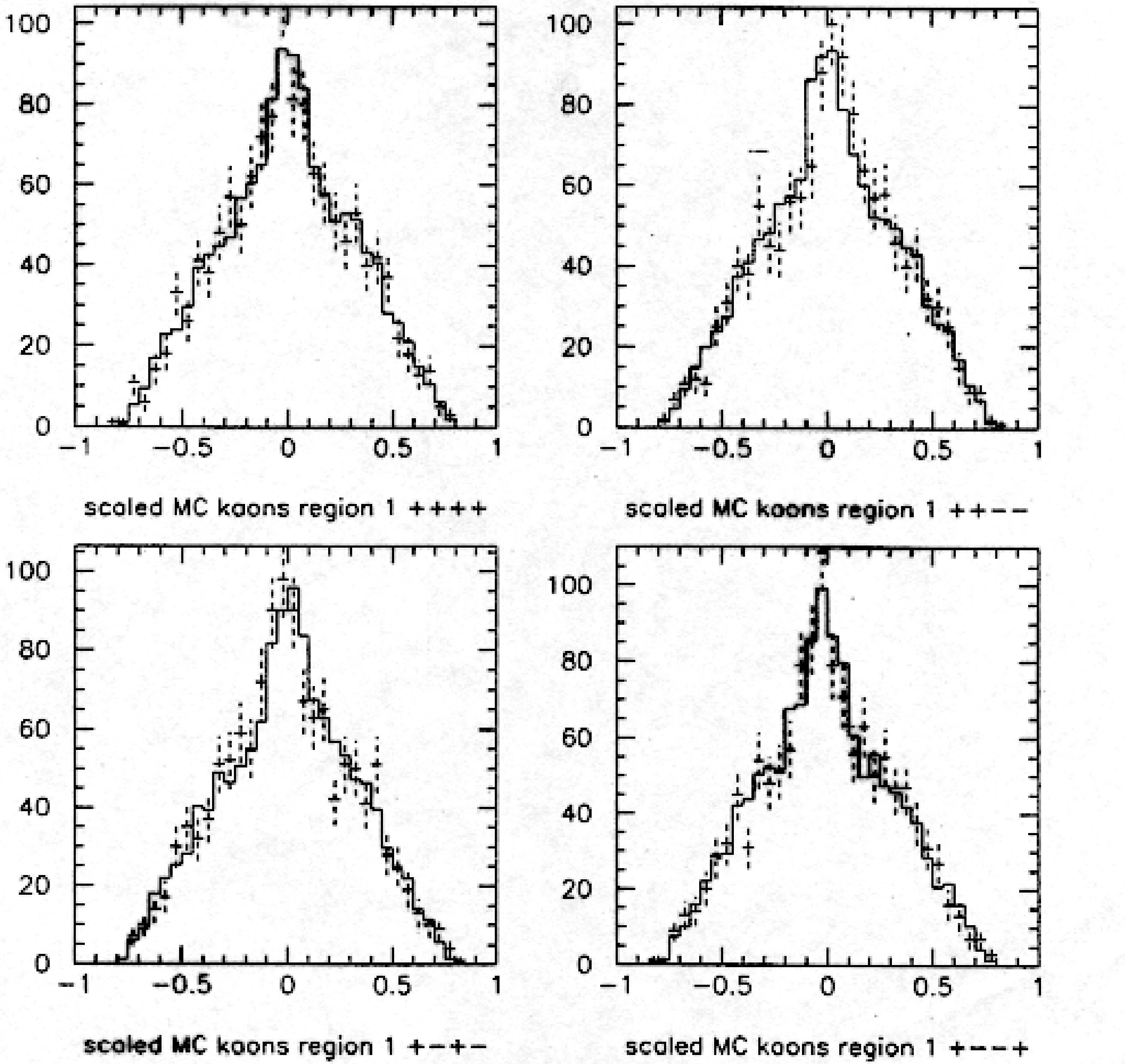
TRUE Reconstructed Λ vs φ_{SLD}



Problem seems to disappear if Λ originated < 2 cm from IP.



3000
2500
2000
1500
1000
500
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
data cos(fi*) region 2 +--+
fit curve
data
Pol = -1% ± 4%


scaled MC kaons region 1 ++++
scaled MC kaons region 1 ++−−
scaled MC kaons region 1 +−+−
scaled MC kaons region 1 +−−+
0
20
40
60
80
100
−1
−0.5
0
0.5
1

Summary

* We have $\geq 3\sigma$ sensitivity for Pol $\geq 50\%$
  No Polarization yet, but

* Need to explore p_T cuts
* 2 vs 3 jets
* Optimize Λ selection cuts

* Play with $\theta_{\lambda-\hat{t}}$ for optimal resolution in thrust axis direction.

* Systematics

* Preliminary results for Osaka.