Update on R_b and R_{bs}

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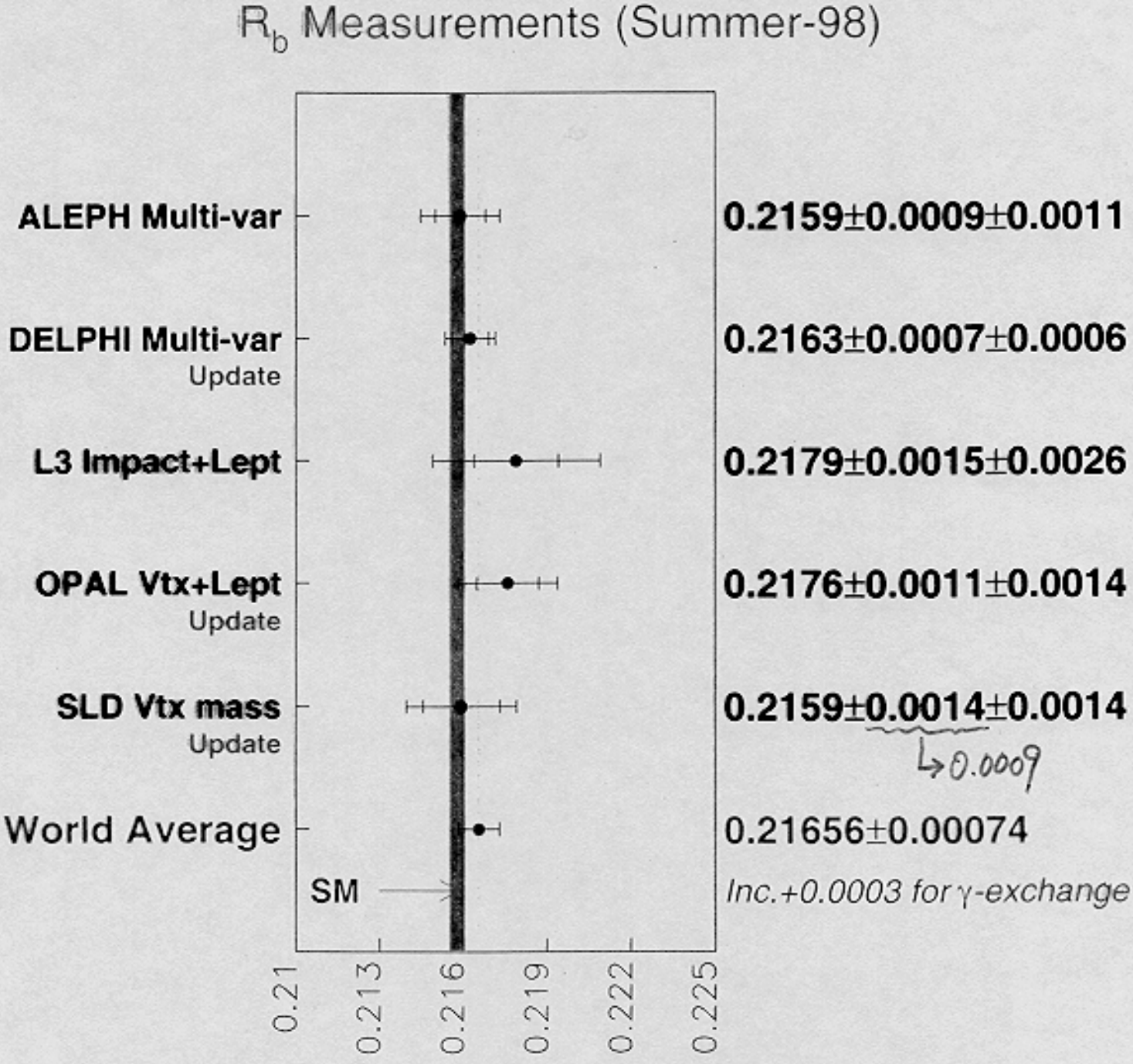
Warning: May cause drowsiness.
Do not operate heavy machinery
while attending this lecture.

official R_b : R15 only used data up to Winter 98
(~~took~~ took Z^0 in Spring, Summer 98 to add)

b tag efficiency : R15 : ~ 51% $\Pi_b \sim 97.8\%$

R17 Tom's B3MASS ~ 61% $\Pi_b \sim 98.2\%$



R17 test with full 97-98 data with B3MASS :

MC : $\epsilon_b = 61.6\%$ $\Pi_b = 98.2\%$

Data Meas. $\epsilon_b = 60.2\%$ ($\Pi_b \sim 97.8$ for official R15)

$\delta R_b \sim \pm 0.0010$ Add 93-96 $\Rightarrow \pm 0.0009$

Light Quark Systematic (ϵ_{uds})	δR_b
$g \to b\bar{b}$ 0.31±0.11%	-0.00033
$g \to c\bar{c}$ 2.38±0.48%	-0.00004
K^0 production ±10%	-0.00003
Λ production ±10%	-0.00002
Total *uds* physics systematic	**0.00034**
Charm Systematic (ϵ_c)	δR_b
D^+ production 0.259 ± 0.028	-0.00011
D_s production 0.115 ± 0.037	-0.00005
c-baryon production 0.074 ± 0.029	0.00011
c-frag. $\langle x_E \rangle_D = 0.482 \pm 0.008$	-0.00006
c-frag. function shape	-0.00001
D^0 lifetime 0.415 ± 0.004 ps	-0.00003
D^+ lifetime 1.057 ± 0.015 ps	-0.00001
D_s lifetime 0.467 ± 0.017 ps .	-0.00002
Λ_c lifetime 0.200 ± 0.011 ps	-0.00001
D^0 decay $\langle N_{ch} \rangle = 2.54 \pm 0.05$	-0.00006
D^+ decay $\langle N_{ch} \rangle = 2.50 \pm 0.06$	-0.00006
D_s decay $\langle N_{ch} \rangle = 2.65 \pm 0.33$	-0.00009
$D^0 \to K^0$ production 0.401 ± 0.059	+0.00015
$D^+ \to K^0$ production 0.646 ± 0.078	+0.00020
$D_s \to K^0$ production 0.380 ± 0.06	+0.00002
D^0 decay no-π^0 frac. 0.370 ± 0.037	+0.00005
D^+ decay no-π^0 frac. 0.499 ± 0.050	-0.00008
D_s decay no-π^0 frac. 0.352 ± 0.035	<0.00001
Total Charm Physics systematic	**0.00033**
B decay modeling (λ_b)	δR_b
B lifetime ±0.05 ps	0.00004
B decay $\langle N_{ch} \rangle = 5.73 \pm 0.35$	0.00003
b fragmentation	0.00019
Λ_b production fraciton 0.074 ± 0.03	0.00008
Hard gluon radiation	0.00008
B momentum correlation	0.00029
b-tag $\cos\theta$ dependency	0.00001
Total $b\bar{b}$ Physics systematic	**0.00038**
Detector Systematic	δR_b
Tracking resolution	0.00096
Tracking efficiency	0.00040
$\langle IP \rangle_{xy}$ tail	0.00010
MC statistics	0.00091
Event selection bias	0.00028
Total detector and MC	**0.00141**
$R_c = 0.171 \pm 0.006$	**0.00021**
Total (excl. R_c)	**0.00154**

Table 1: Summary of systematic uncertainties for the $\mathcal{M} > 2.0$ GeV/c^2 cut.

R_b Measurement

Observed Parameters

Parameters taken from Monte Carlo

Measured Parameters

$$F_s = \epsilon_b R_b + \epsilon_c R_c + \epsilon_{uds}(1 - R_b - R_c)$$

$$F_d = (\epsilon_b^2 + \lambda_b(\epsilon_b - \epsilon_b^2))R_b + \epsilon_c^2 R_c + \epsilon_{uds}(1 - R_c - R_b)$$

The aim is to decompose λ_b.

To this end, we wish to identify the major contributors to λ_b.

The current suspects are:

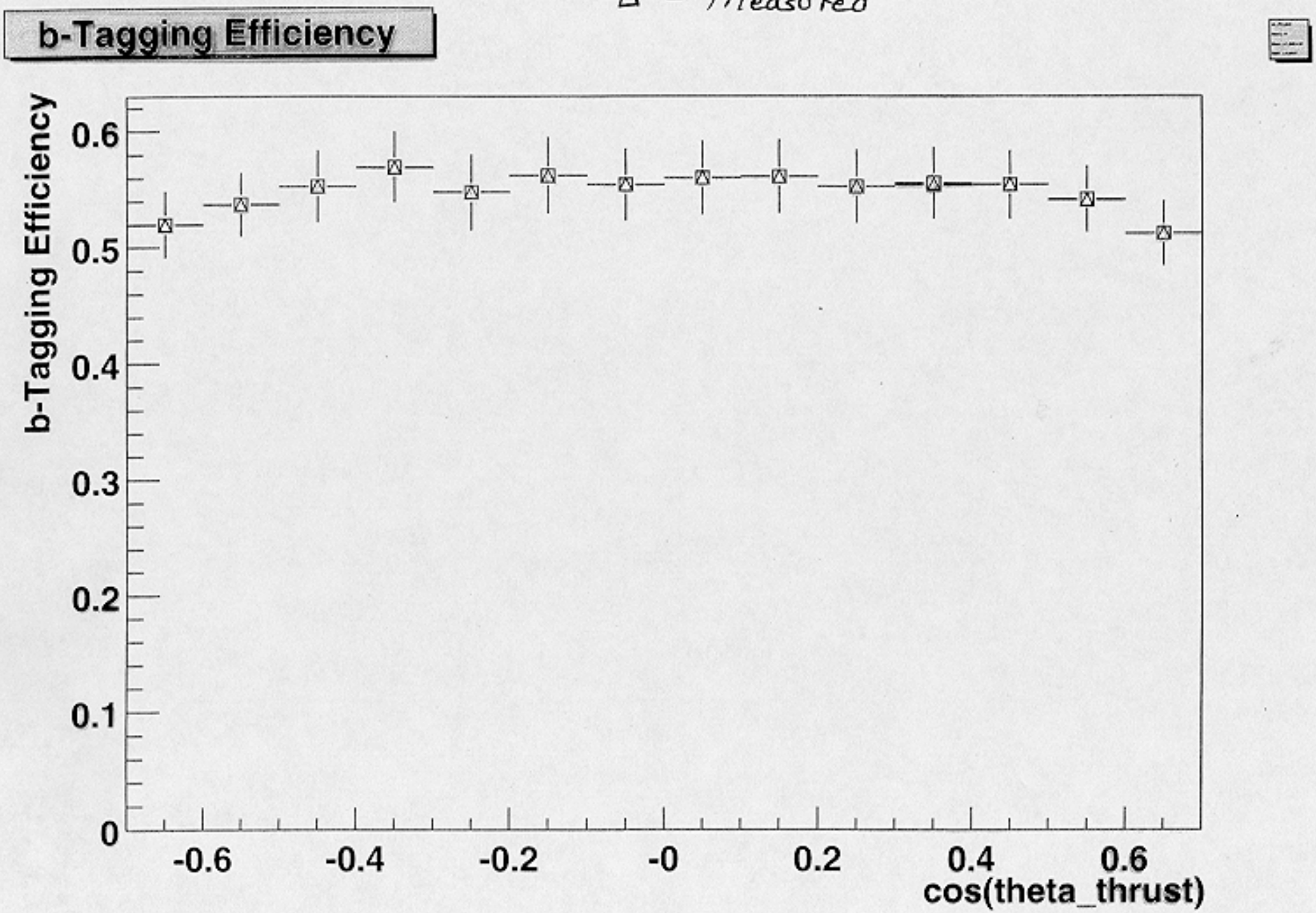
- Thrust Axis
- Gluon Emission, i.e. number of jets
- IP(z) reconstruction

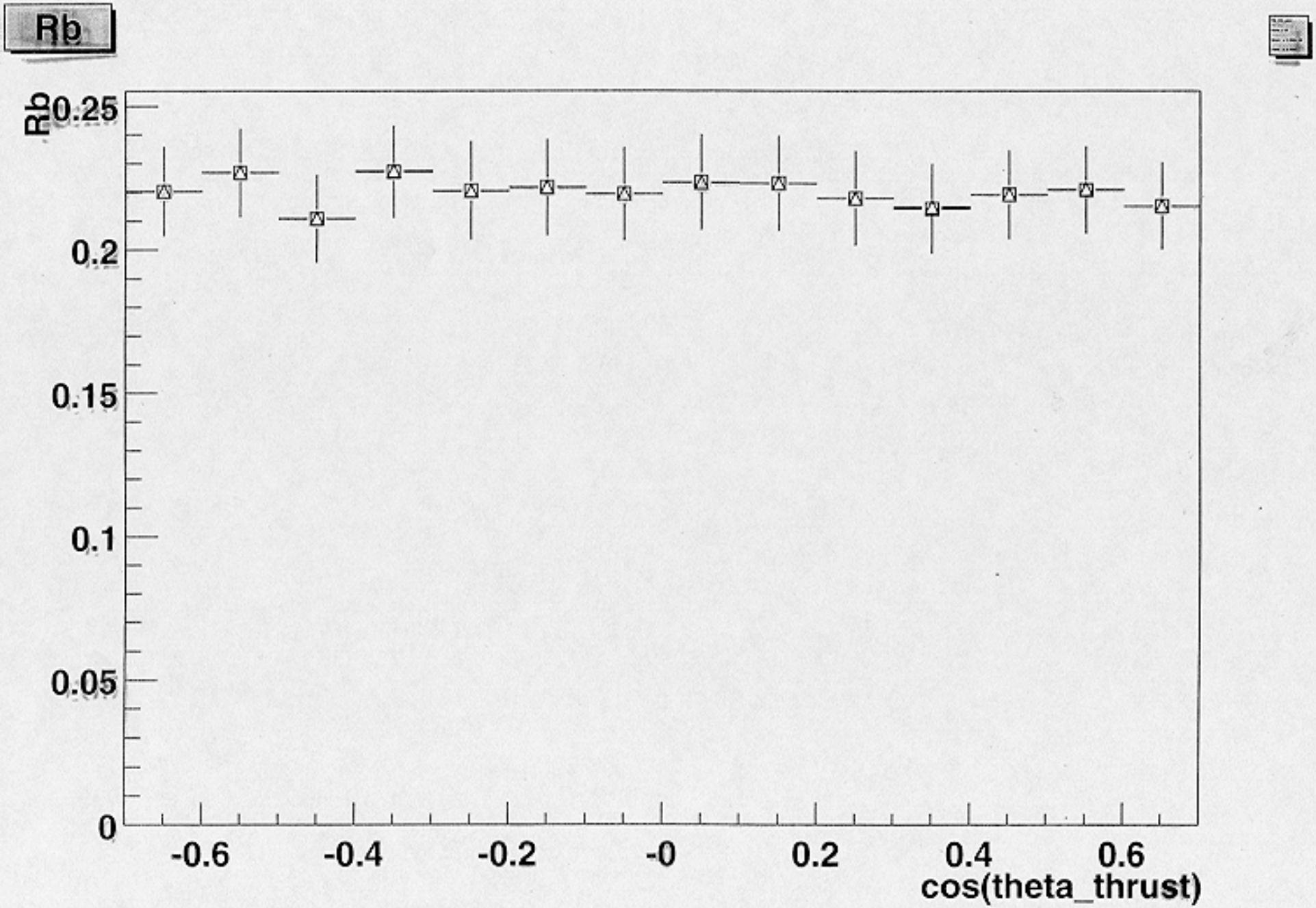
New Systematics

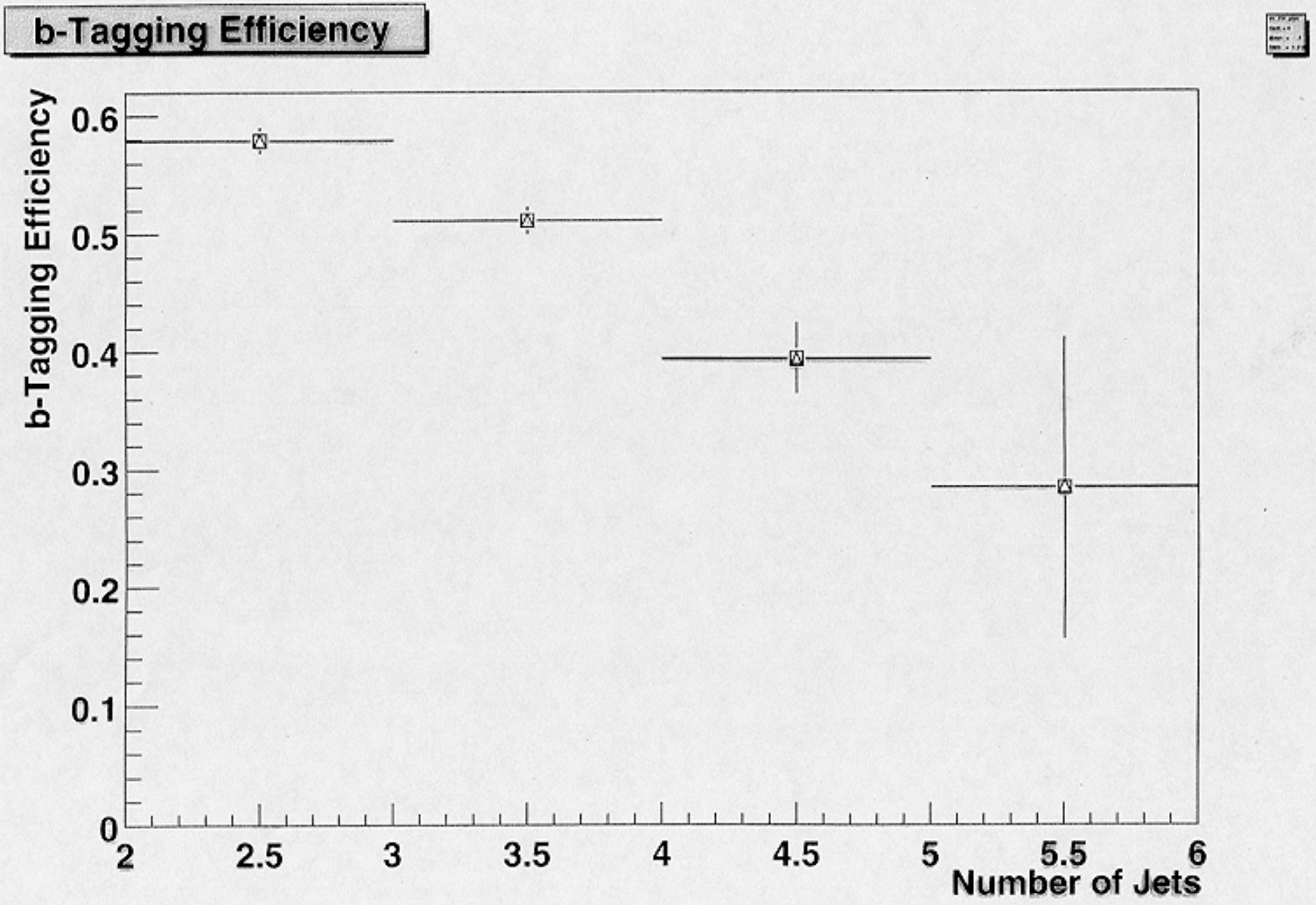
- **Thrust Axis:**
  - This affects the amount of detector parts the particles must pass through and thus the tagging efficiency.
- **Number of Jets:**
  - Because of gluon radiation, the standard 3–jet cut may affect flavour content.
- **Reconstructed IP(z):**
  - If the IP is reconstructed closer to one b–vertex, it reduces the efficiency for b–tagging that hemisphere while increasing the efficiency for b–tagging the other.

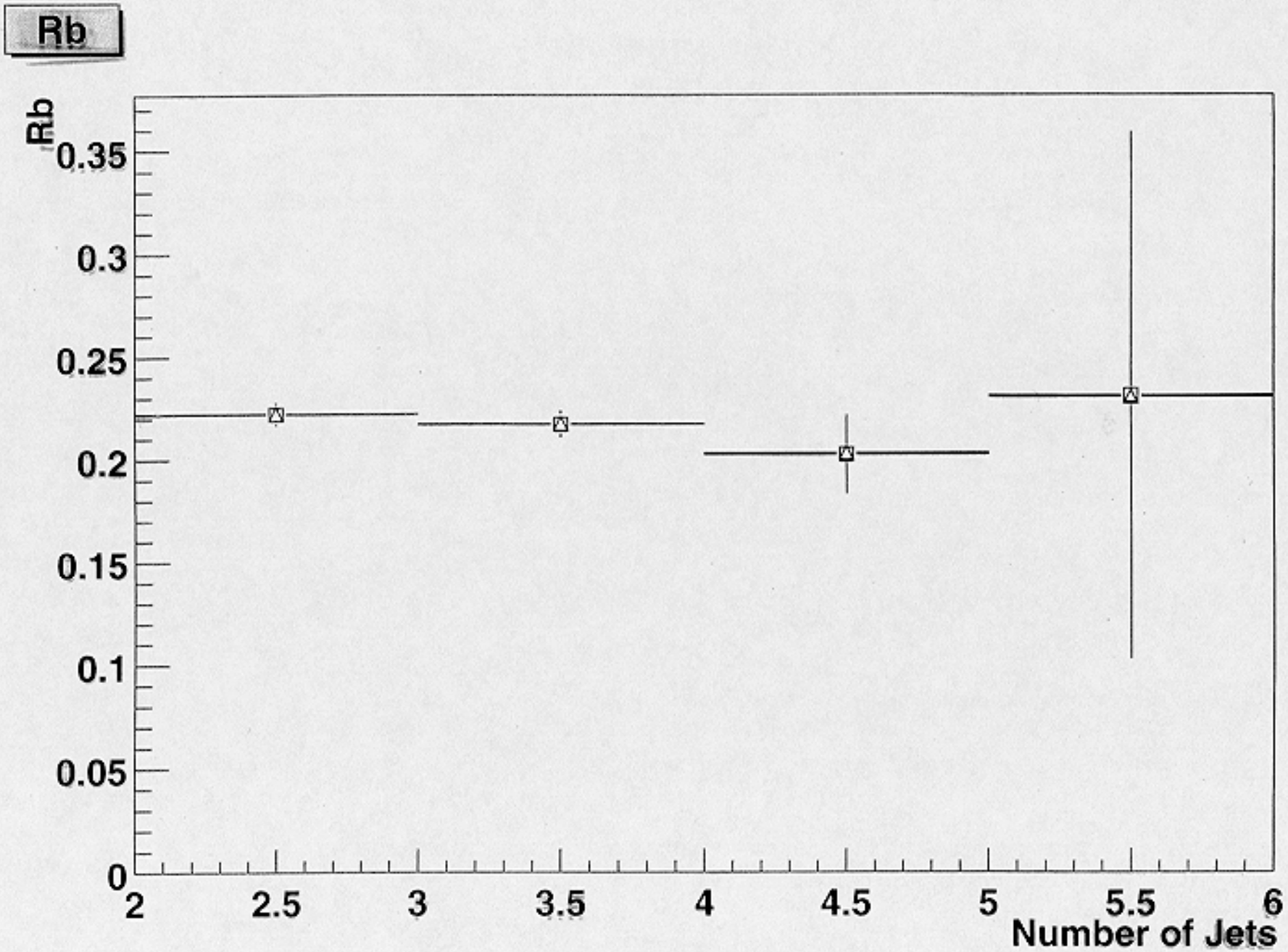
△ = Monte Carlo Truth

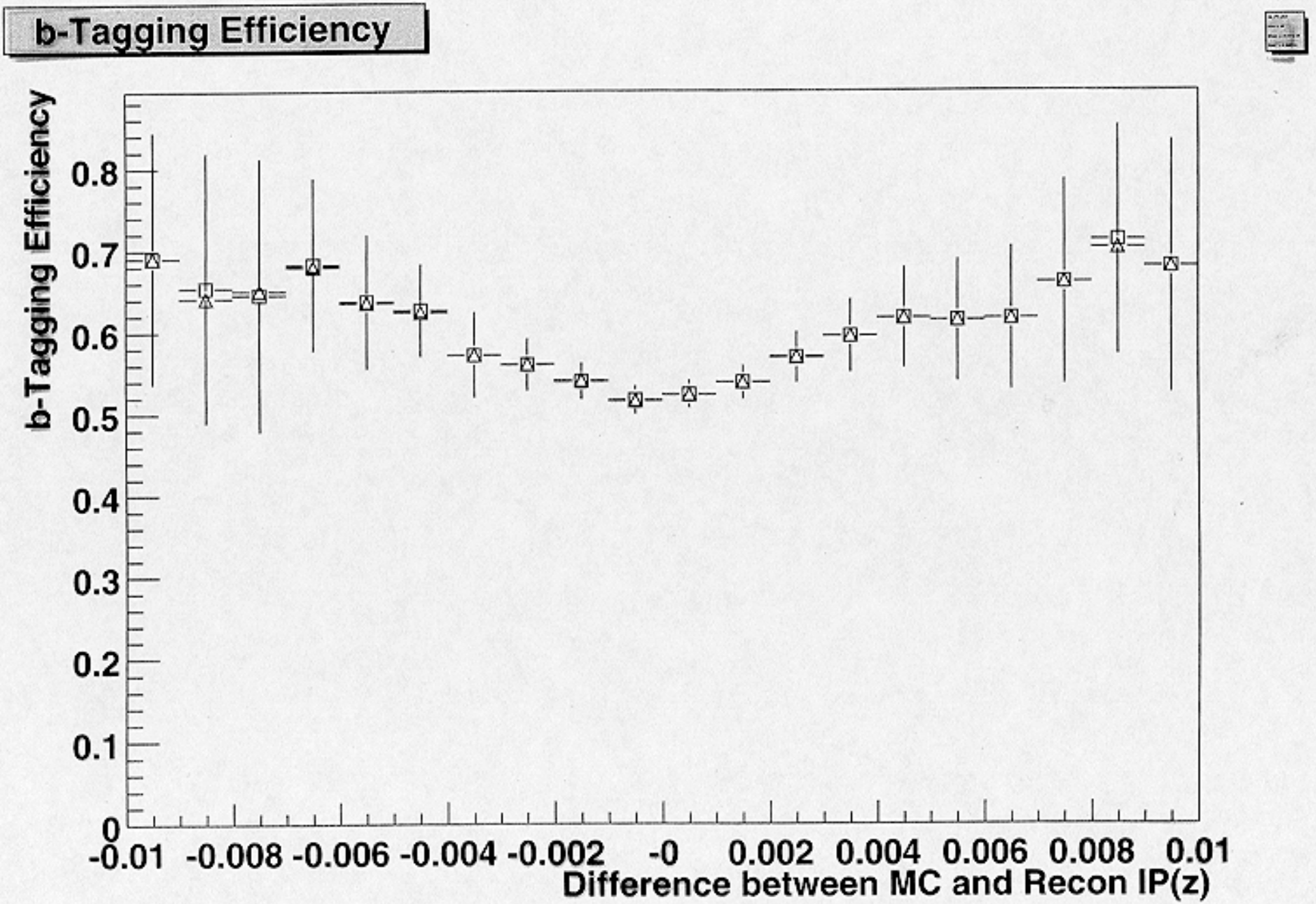
□ = Measured

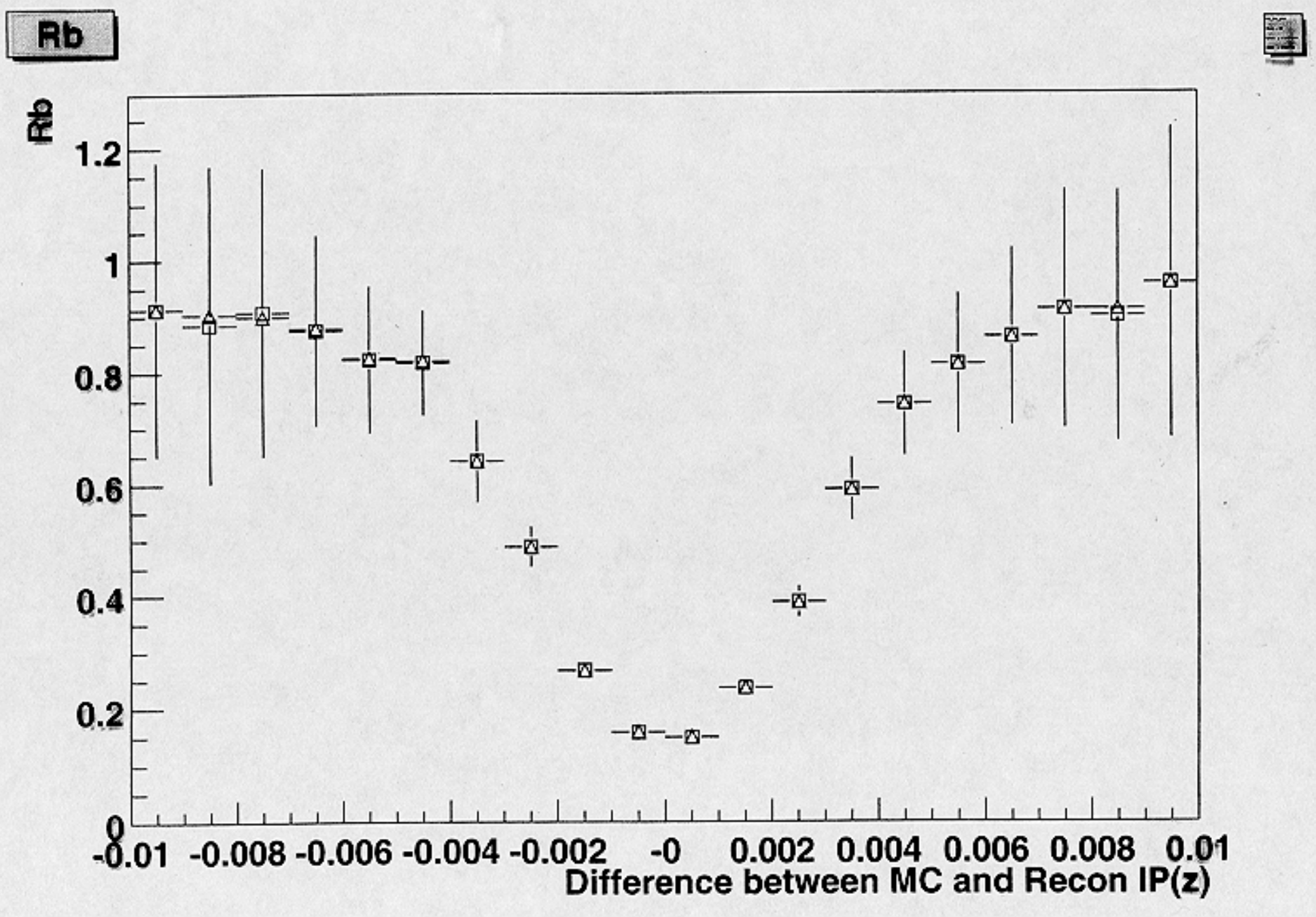



Rb
Rb
0.25
0.2
0.15
0.1
0.05
0
-0.6
-0.4
-0.2
-0
0.2
0.4
0.6
cos(theta_thrust)


b-Tagging Efficiency
b-Tagging Efficiency
0.6
0.5
0.4
0.3
0.2
0.1
0
2
2.5
3
3.5
4
4.5
5
5.5
6
Number of Jets


Rb
Rb
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2
2.5
3
3.5
4
4.5
5
5.5
6
Number of Jets


b-Tagging Efficiency
b-Tagging Efficiency
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.01
-0.008
-0.006
-0.004
-0.002
-0
0.002
0.004
0.006
0.008
0.01
Difference between MC and Recon IP(z)


Rb
Rb
1.2
1
0.8
0.6
0.4
0.2
0
-0.01
-0.008
-0.006
-0.004
-0.002
-0
0.002
0.004
0.006
0.008
0.01
Difference between MC and Recon IP(z)

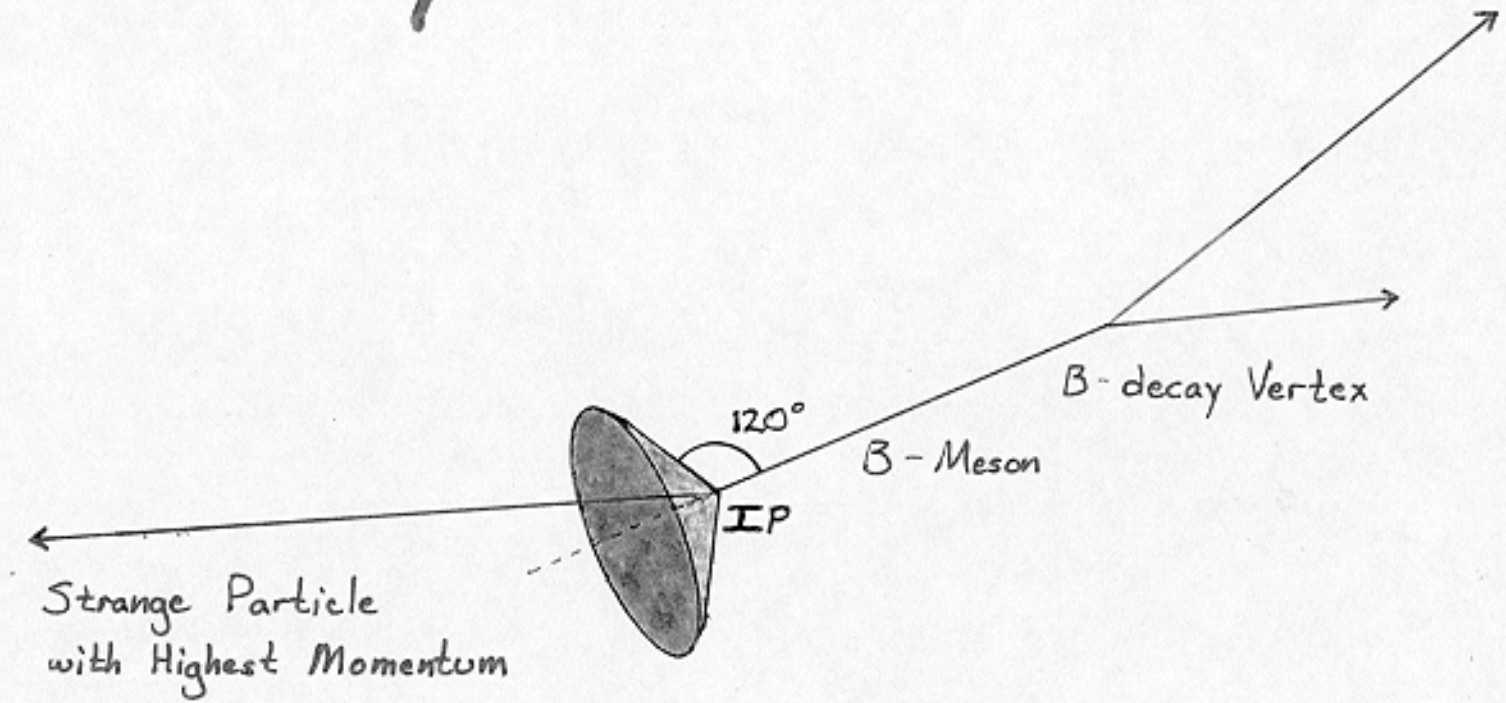
This says we need a Hemisphere Correlation for Charm, λ_c, and Maybe even a Hemisphere Correlation for light quarks, λ_{uds}

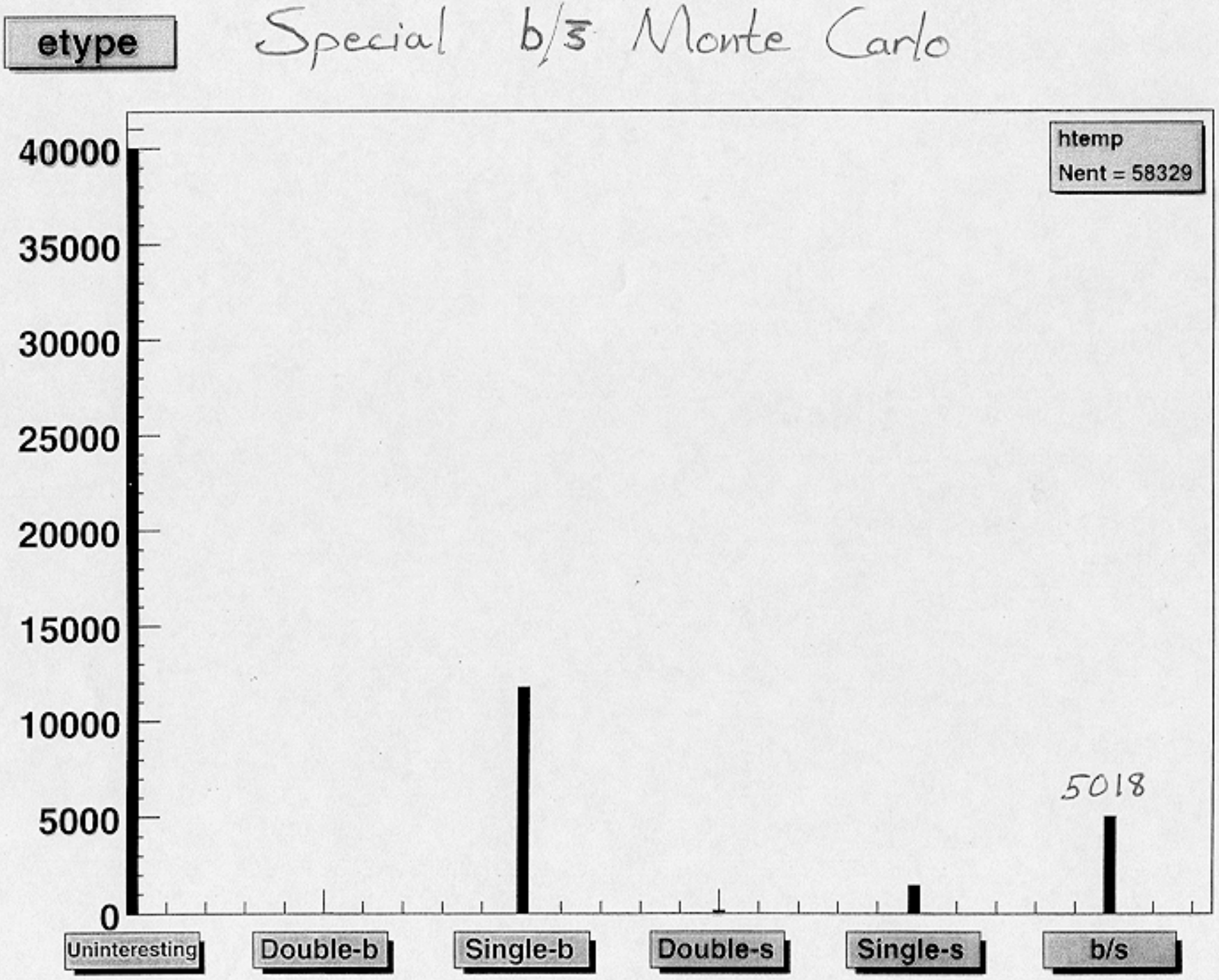
(λ_c was actually in official measurement from summer '98)

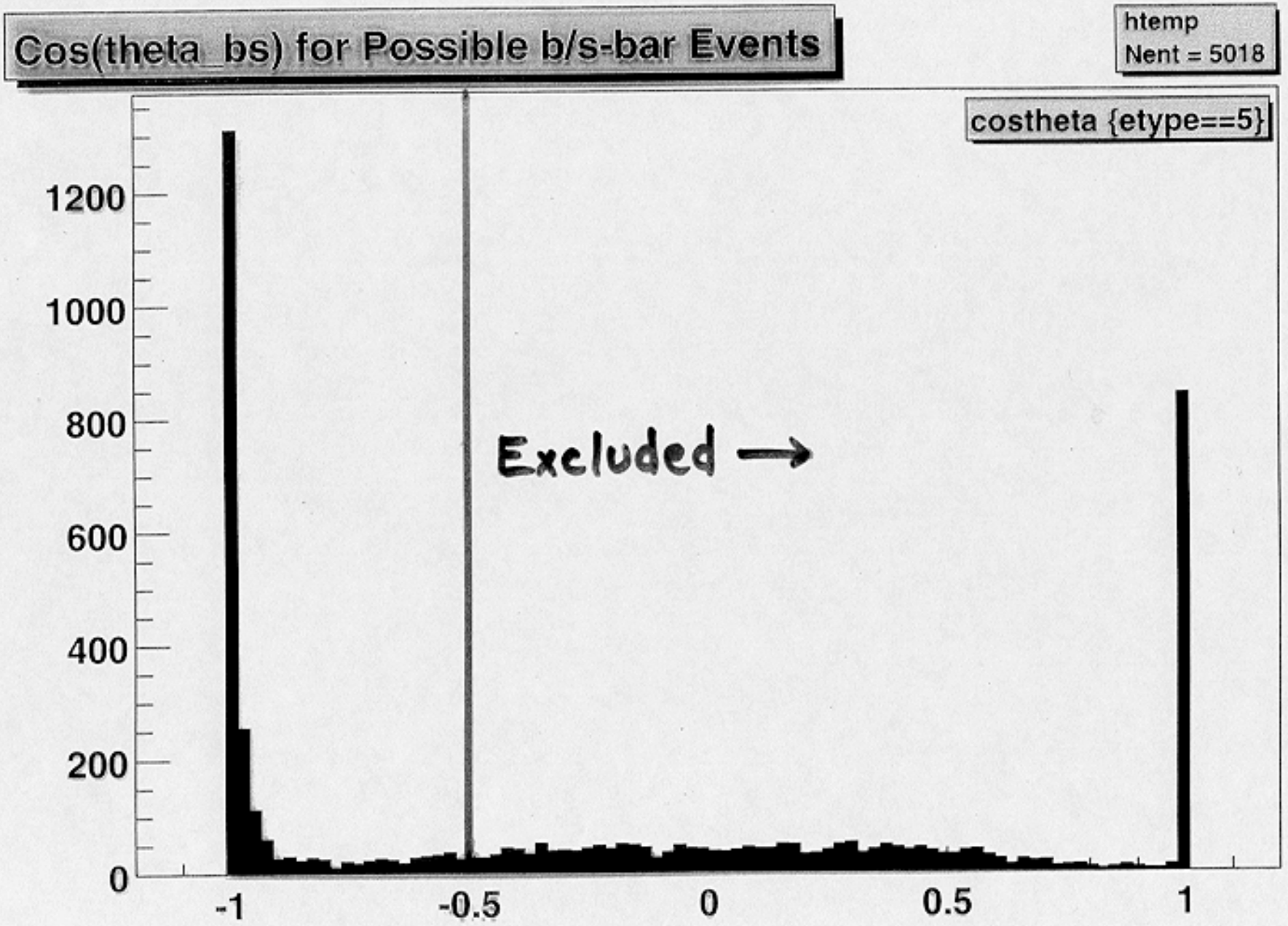
The R_{bs} Tag

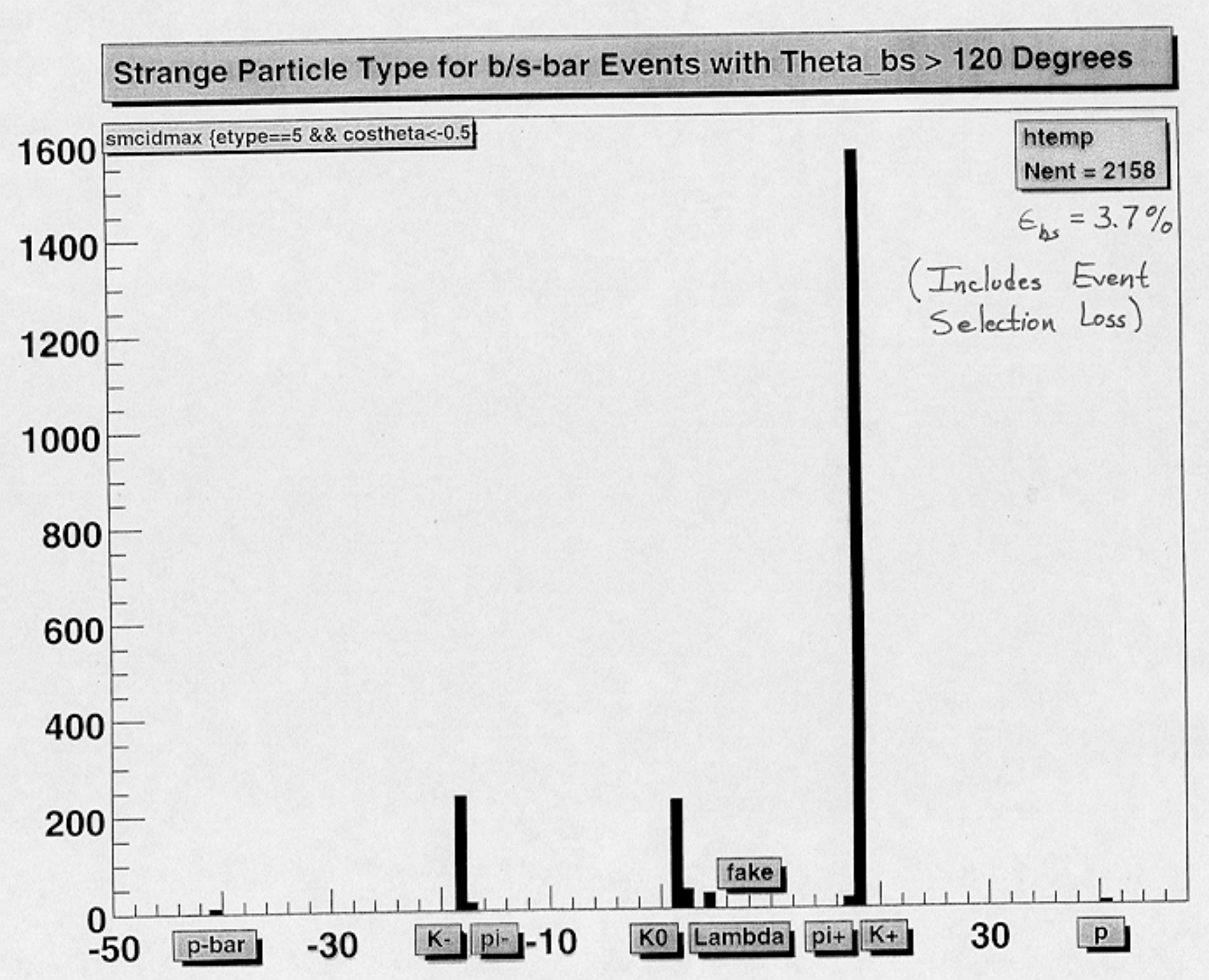
- Only Hadronic Events Considered
- p_T Corrected Vertex Mass > 2 GeV in one Hemisphere
- p_T Corrected Vertex Mass = 0 in the other Hemisphere
- At Least One Strange Particle ID'd
  - $K^{+/-}$ $p > 9.0$ GeV
  - K^0 $p > 5.0$ GeV
  - Λ^0 $p > 5.0$ GeV
- Highest Momentum Strange Particle Track >120° from b–Vertex Momentum

Anatomy of a BS Event




etype
Special b/s Monte Carlo
htemp
Nent = 58329
40000
35000
30000
25000
20000
15000
10000
5000
0
5018
Uninteresting
Double-b
Single-b
Double-s
Single-s
b/s


Cos(theta_bs) for Possible b/s-bar Events
htemp
Nent = 5018
costheta {etype==5}
Excluded →
1200
1000
800
600
400
200
0
-1
-0.5
0
0.5
1


Strange Particle Type for b/s-bar Events with Theta_bs > 120 Degrees
smcidmax {etype==5 && costheta<-0.5}
htemp
Nent = 2158
ϵ_{bs} = 3.7%
(Includes Event Selection Loss)
1600
1400
1200
1000
800
600
400
200
0
-50
p-bar
-30
K-
pi-
-10
fake
K0
Lambda
pi+
K+
30
p