Final Lepton Asymmetries Analysis.

Toshinori Abe

6/21/2000

@ Kirkwood SLD Meeting

Measurement of A_e, A_μ, and A_τ using pol. $Z^0 \to e^+e^-$, $\mu^+\mu^-$, and $\tau^+\tau^-$

Another A_e (or lepton) measurement

→ Left - Right

& Left - Right - Forward - Backward Asym.

$$A_{LR} = \frac{\sigma_L - \sigma_R}{\sigma_L + \sigma_R} = \mathcal{P}_e \cdot A_e$$

$$\tilde{A}_{FB}(x) = \frac{\sigma_{LF}(x) - \sigma_{LB}(x) - \sigma_{RF}(x) + \sigma_{RB}(x)}{\sigma_{LF}(x) + \sigma_{LB}(x) + \sigma_{RF}(x) + \sigma_{RB}(x)} = \frac{2x}{1+x^2} \mathcal{P}_e \cdot A_f$$

Final State

e^+e^-	$A_e^{(e)}$		
$\mu^+\mu^-$	$A_e^{(\mu)}$	A_μ (← The only existing direct measurement)	
$\tau^+\tau^-$	$A_e^{(\tau)}$		A_τ
$q\bar{q}$	A_{LR} (talk by Dima).		

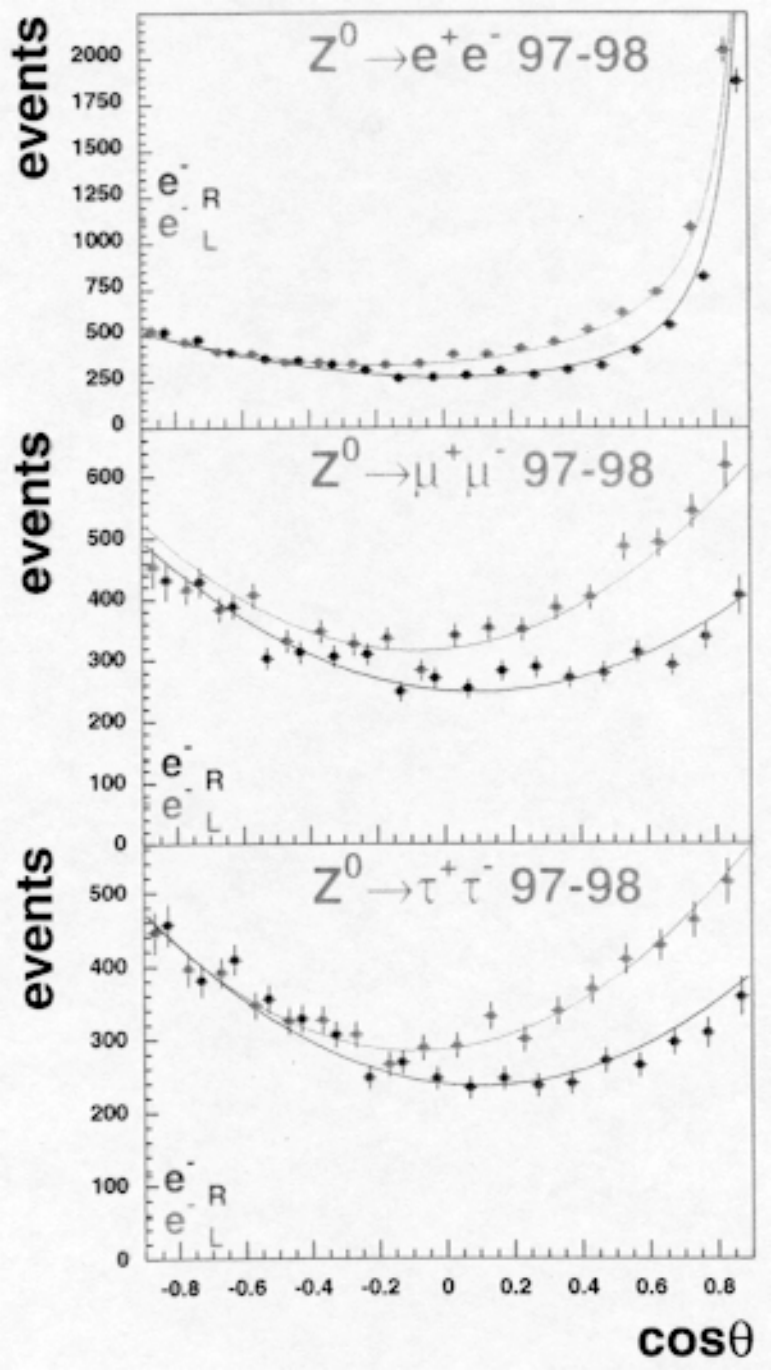
Combine A_e → A_e A_μ A_τ → Lepton Universality

Combine A_e A_μ A_τ → A_{lepton} → determine $\sin^2\theta_W^{eff}$

Event Selection.

- Low track multiplicity ($1 < N < 9$)
- $|\cos\theta_{thrust}| < 0.9$ for 97-98 (0.8 for 96).
- + etc ....

1997-1998	e^+e^-	$\mu^+\mu^-$	$\tau^+\tau^-$
Events	15675 (2052 '96)	11431 (1625 '96)	10841 (1494 '96)
Efficiency	75% (87% '96)	77% (83% '96)	70% (77% '96)
Purity	99.3% (99.2%)	99.8% (99.8%)	94.7% (95.9%)


events
$Z^0 \to e^+e^-$ 97-98
e^-_R
e^-_L
2000
1750
1500
1250
1000
750
500
250
0
events
$Z^0 \to \mu^+\mu^-$ 97-98
e^-_R
e^-_L
600
500
400
300
200
100
0
events
$Z^0 \to \tau^+\tau^-$ 97-98
e^-_R
e^-_L
500
400
300
200
100
0
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
cosθ

Extract A_e, A_μ and A_τ

→ unbinned maximum likelihood method.

$$\mathcal{L} = \sum f_z (1 - P_e A_e) x^2 + (A_e - P_e) A_\ell \cdot 2x + f_{\gamma z} \cdots + f_\gamma (1 + x^2).$$

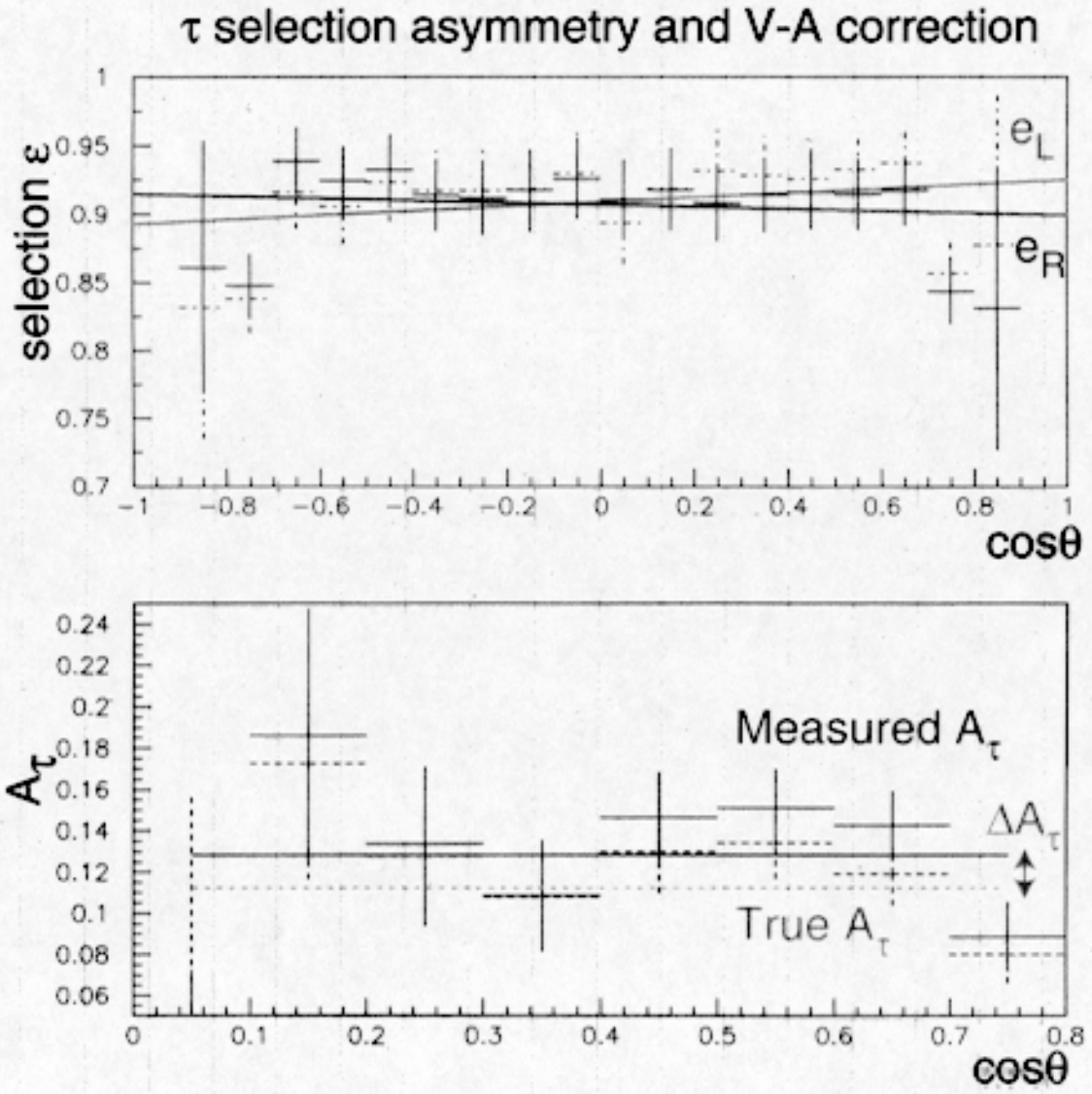
A_e, A_ℓ : free parameter

$x = \cos\theta_{thrust}$

f_z, $f_{\gamma z}$, f_γ ← determined concerning initial state radiation + etc ....

→ 10 terms with t-channel effect.

V-A correction for A_τ.



$\Delta A_\tau = 0.0182 \pm 0.0018$

Bug was found since Moriond and fixed....

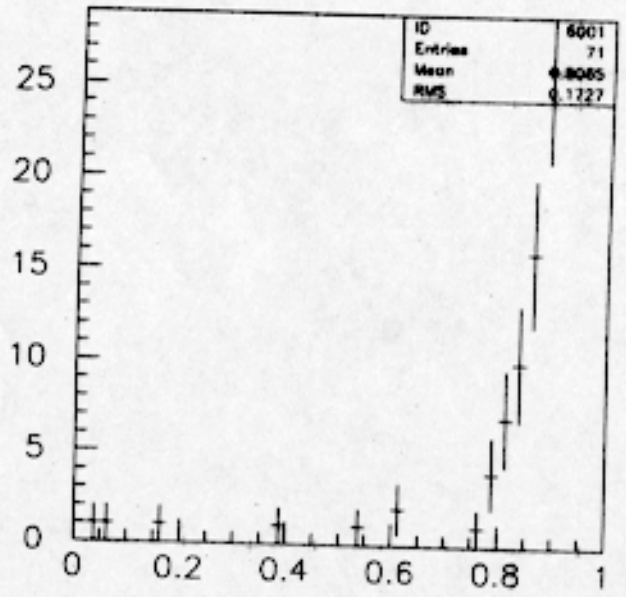
Systematic Error.

TABLE II. Summary of systematic uncertainties in units of 10^{-4} for the 1997-98 data. Results for 1996 data are given in parentheses.

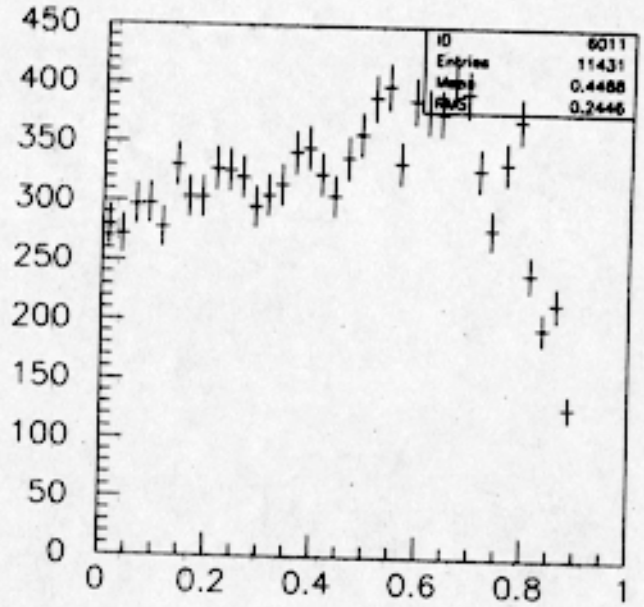
Source	A_e^e	A_e^μ	A_e^τ	A_μ^μ	A_τ^τ
Polarization	8 (8)	8 (8)	8 (8)	8 (8)	8 (8)
Backgrounds	5 (3)	–	13 (14)	–	14 (13)
Radiative Correction	23 (17)	2 (2)	2 (2)	3 (1)	2 (2)
V-A	–	–	–	–	18 (17)
Charge Confusion	–	–	–	7 (–)	11 (1)
Detector asymmetry	–	–	–	–	4 (4)
Ununiform efficiency	2 (–)	–	–	–	–

μ Charge Confusion (Data)"

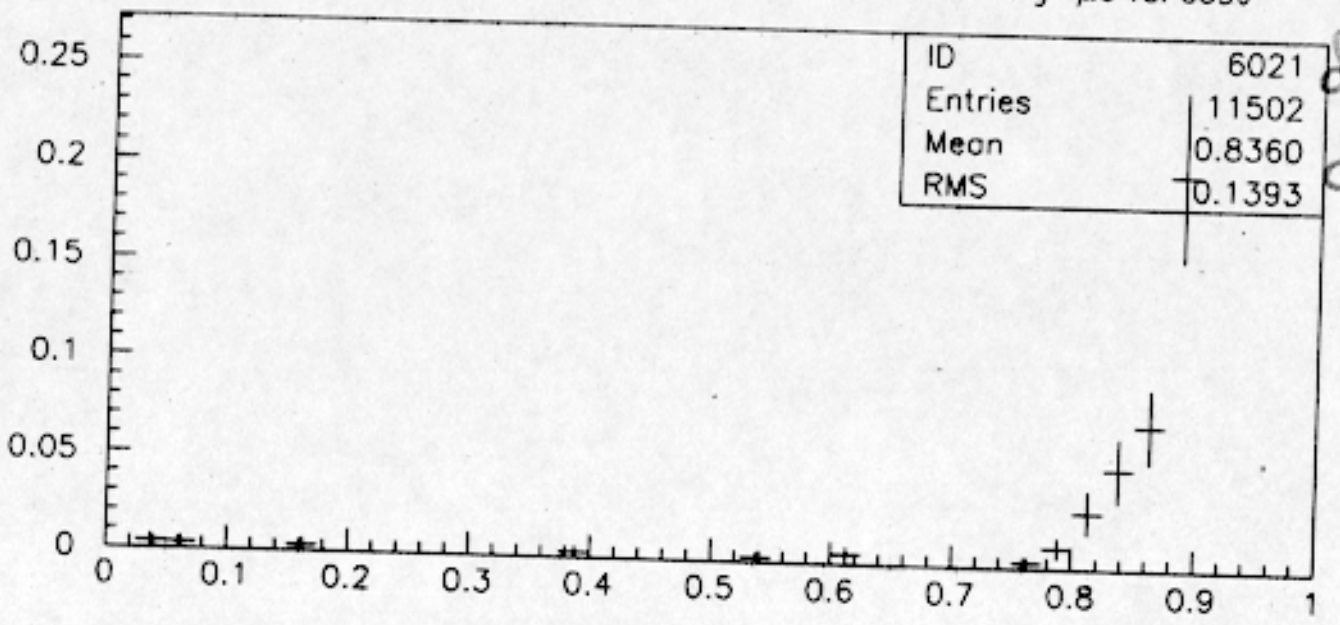
Prob. (Charge Conf.) = $\left(\frac{n_{like}}{n_{unlike}}\right)$



Like-sign μs vs. cosϑ



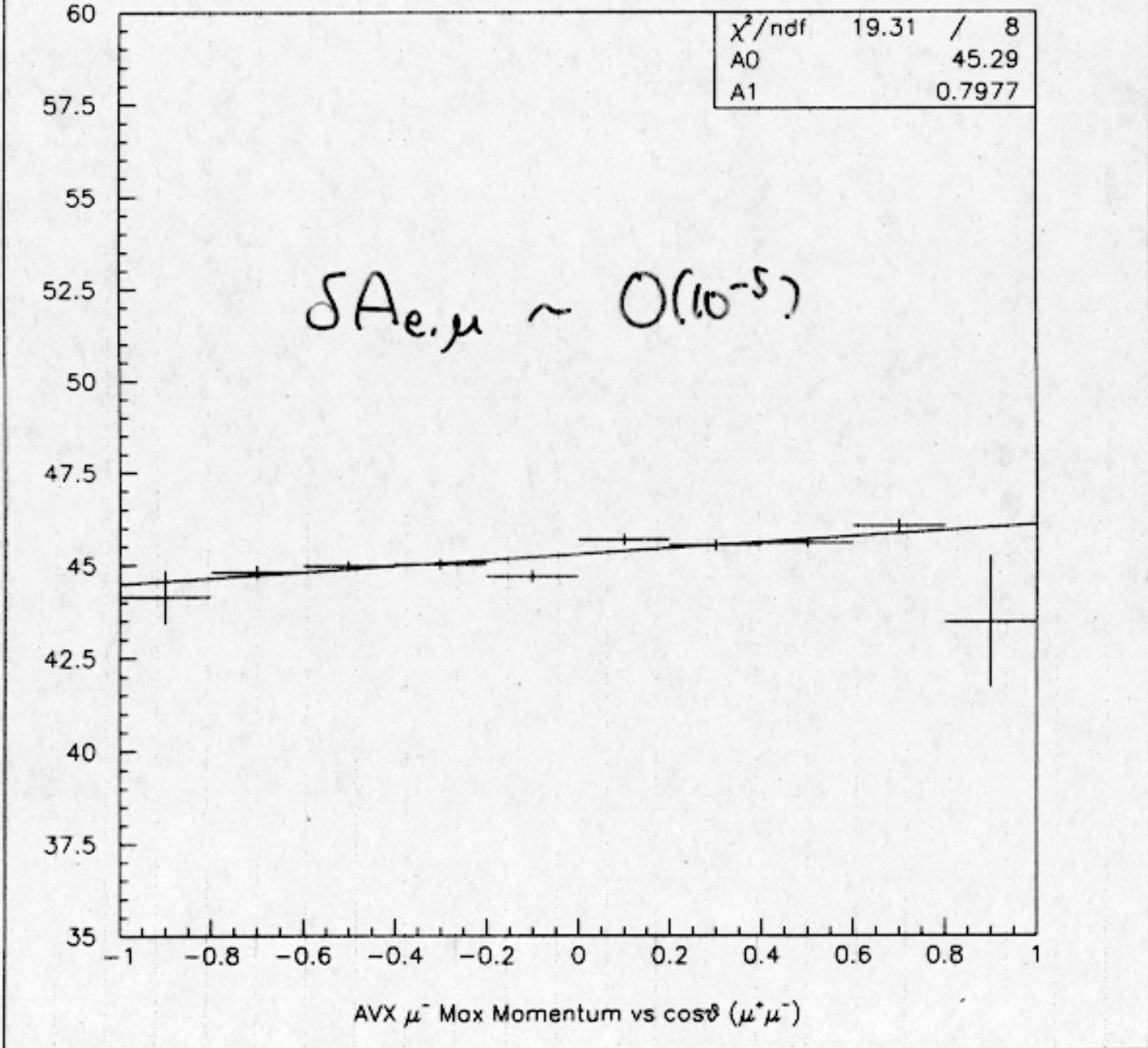
UnLike-sign μs vs. cosϑ

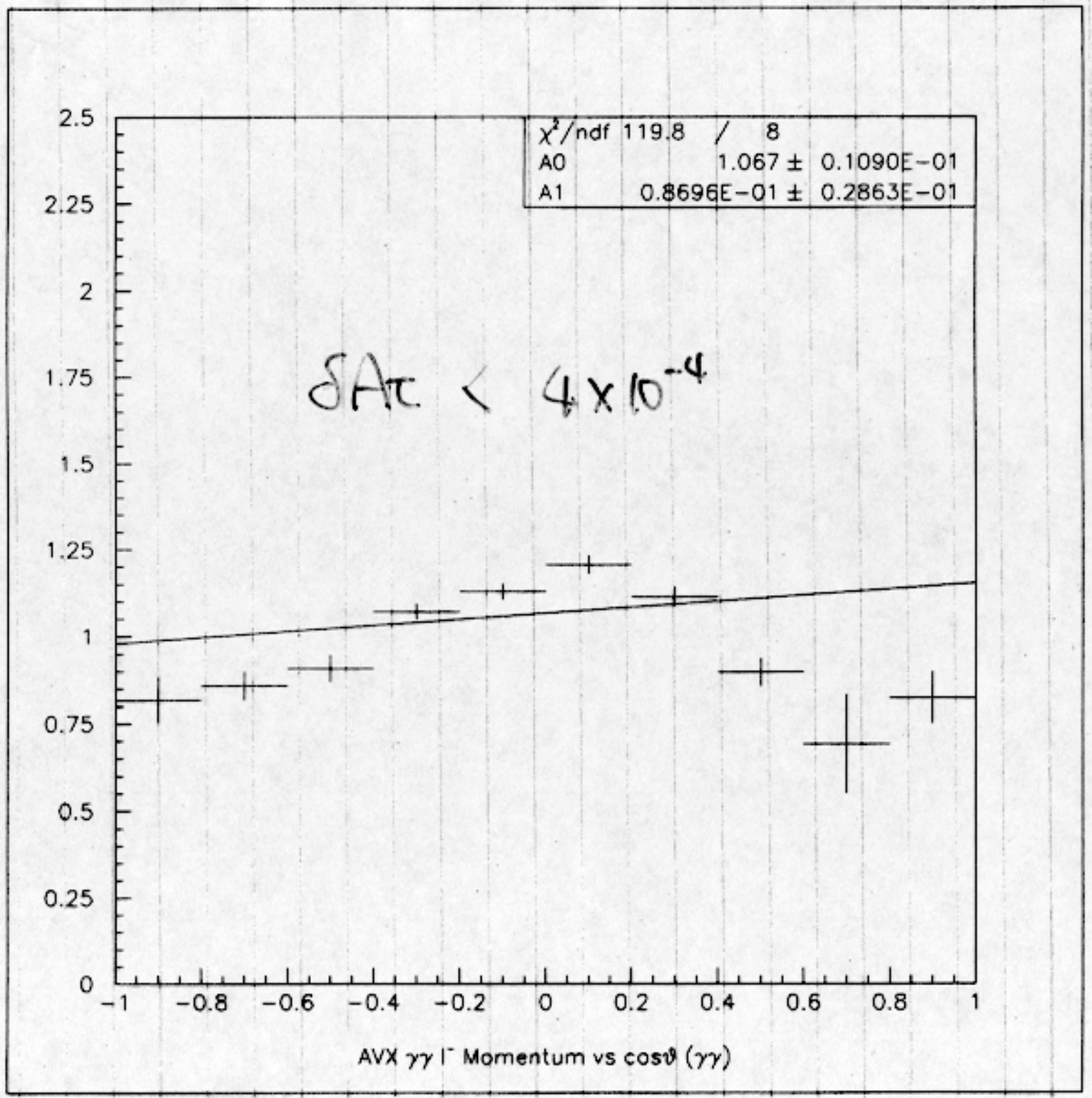


Like-sign/UnLike-sign μs vs. cosϑ

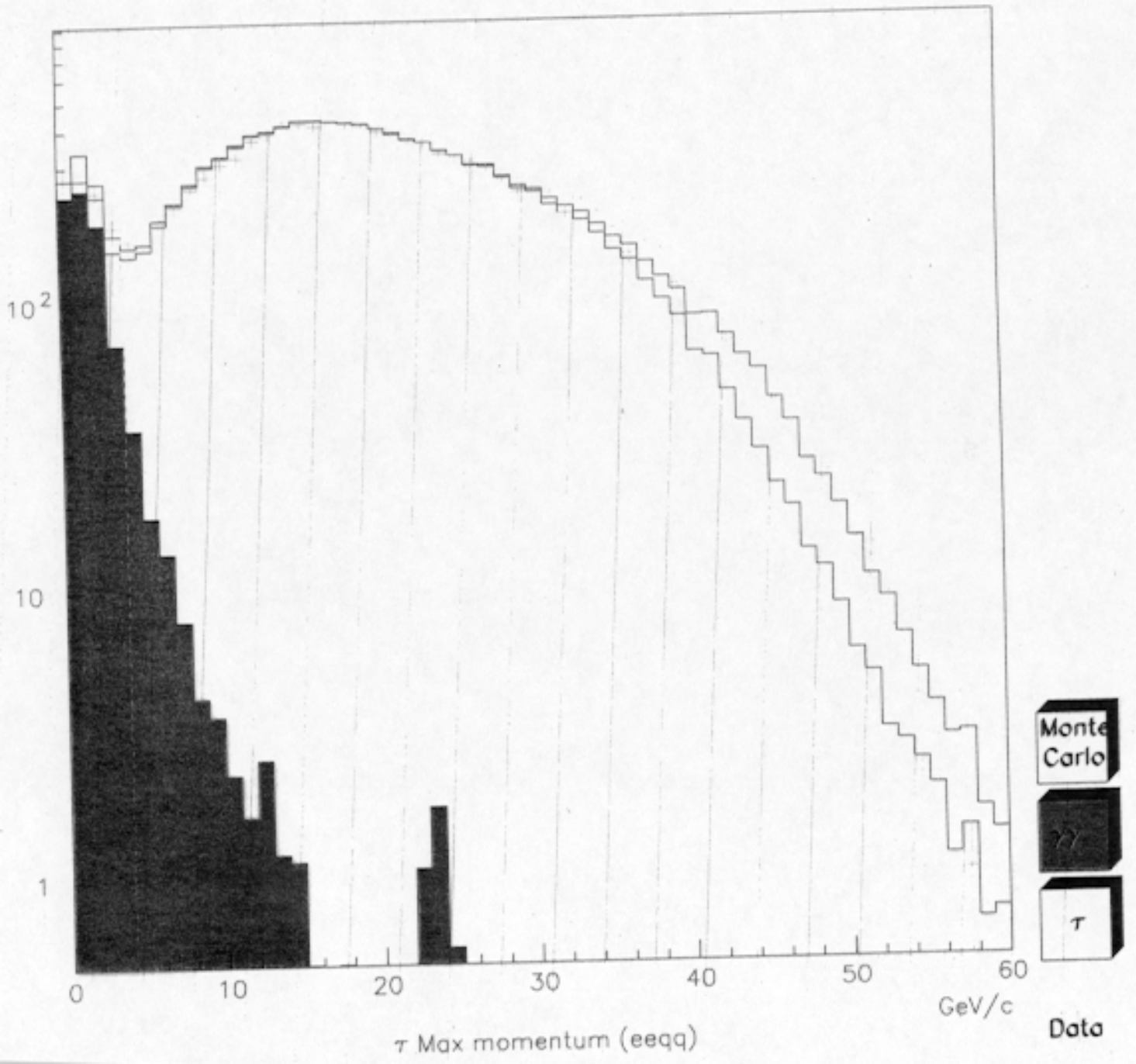
$\delta A_\mu = \pm 7 \times 10^{-4}$

$\delta A_c = \pm 11 \times 10^{-4}$


χ^2/ndf 19.31 / 8
A0 45.29
A1 0.7977
$\delta A_{e,\mu} \sim O(10^{-5})$
60
57.5
55
52.5
50
47.5
45
42.5
40
37.5
35
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
AVX μ^- Mox Momentum vs cosϑ ($\mu^+\mu^-$)


χ^2/ndf 119.8 / 8
A0 1.067 ± 0.1090E-01
A1 0.8696E-01 ± 0.2863E-01
$\delta A_T < 4 \times 10^{-4}$
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
AVX γγ l⁻ Momentum vs cosϑ (γγ)

τ cut: Max momentum ($\gamma\gamma$)



A_e, A_μ and A_τ

$$A_e = 0.1549 \pm 0.0066 \pm 0.0013$$
$$A_\mu = 0.152 \pm 0.016 \pm 0.001$$
$$A_\tau = 0.121 \pm 0.017 \pm 0.003$$

} 96-98.

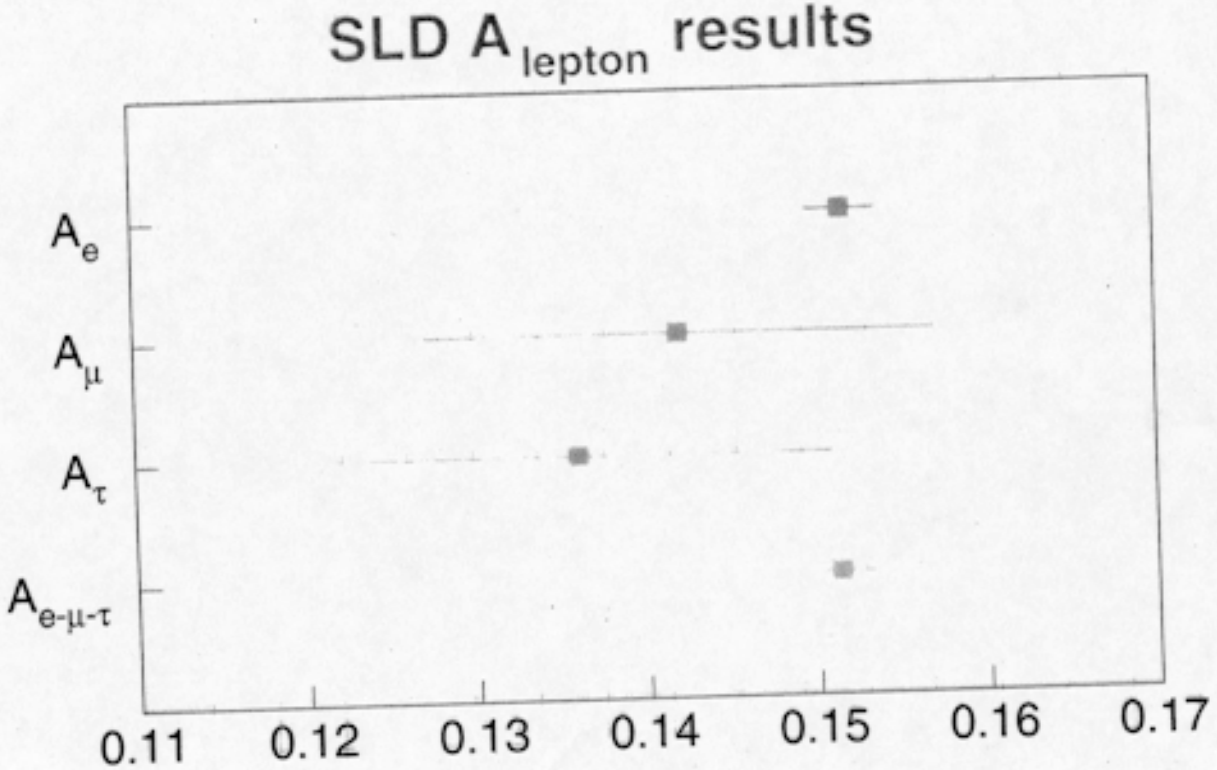
A_e (with A_{LR}) $= 0.1516 \pm 0.0021$

$A_\mu = 0.142 \pm 0.015$

$A_\tau = 0.136 \pm 0.015$

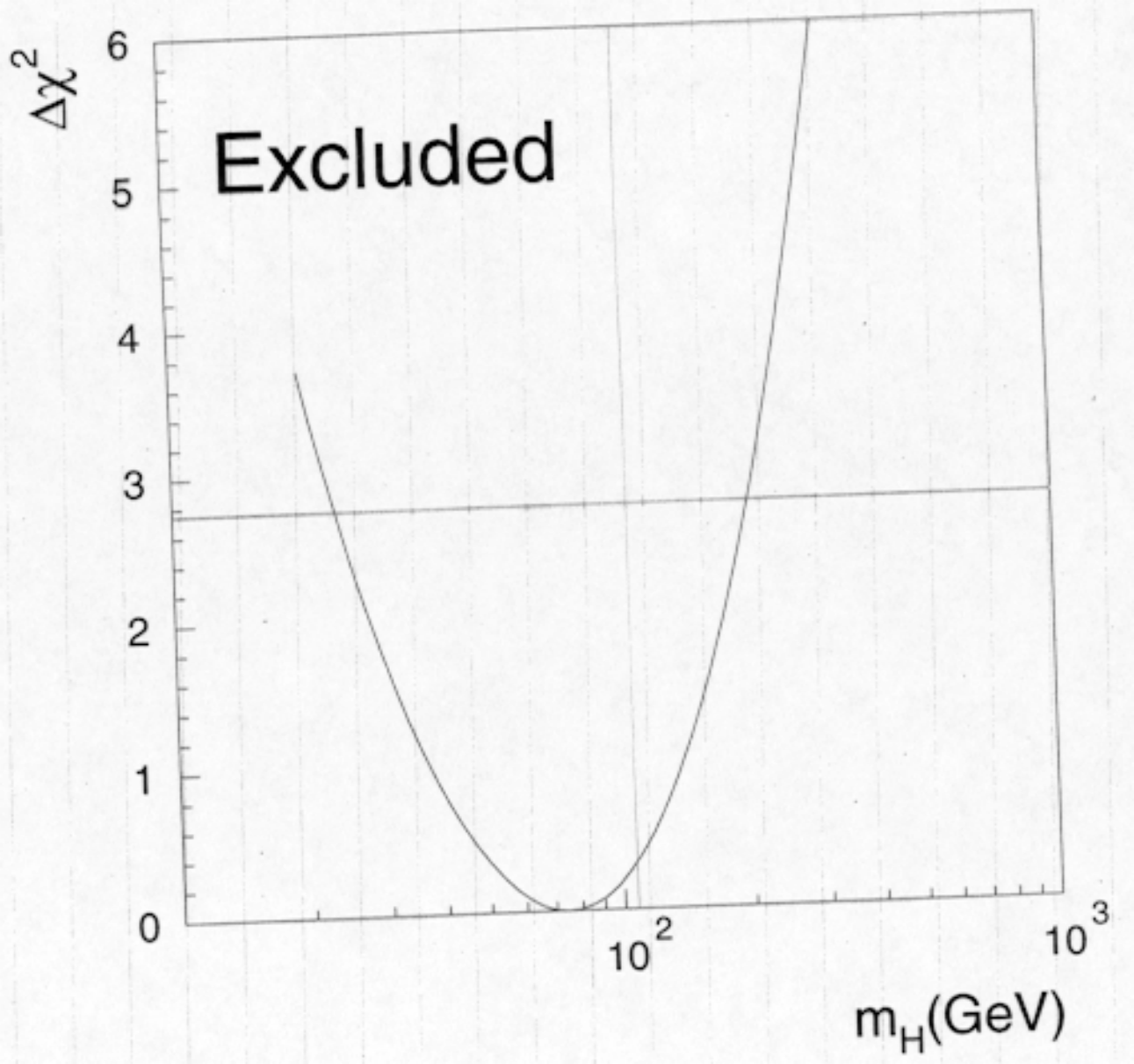
} 93-98

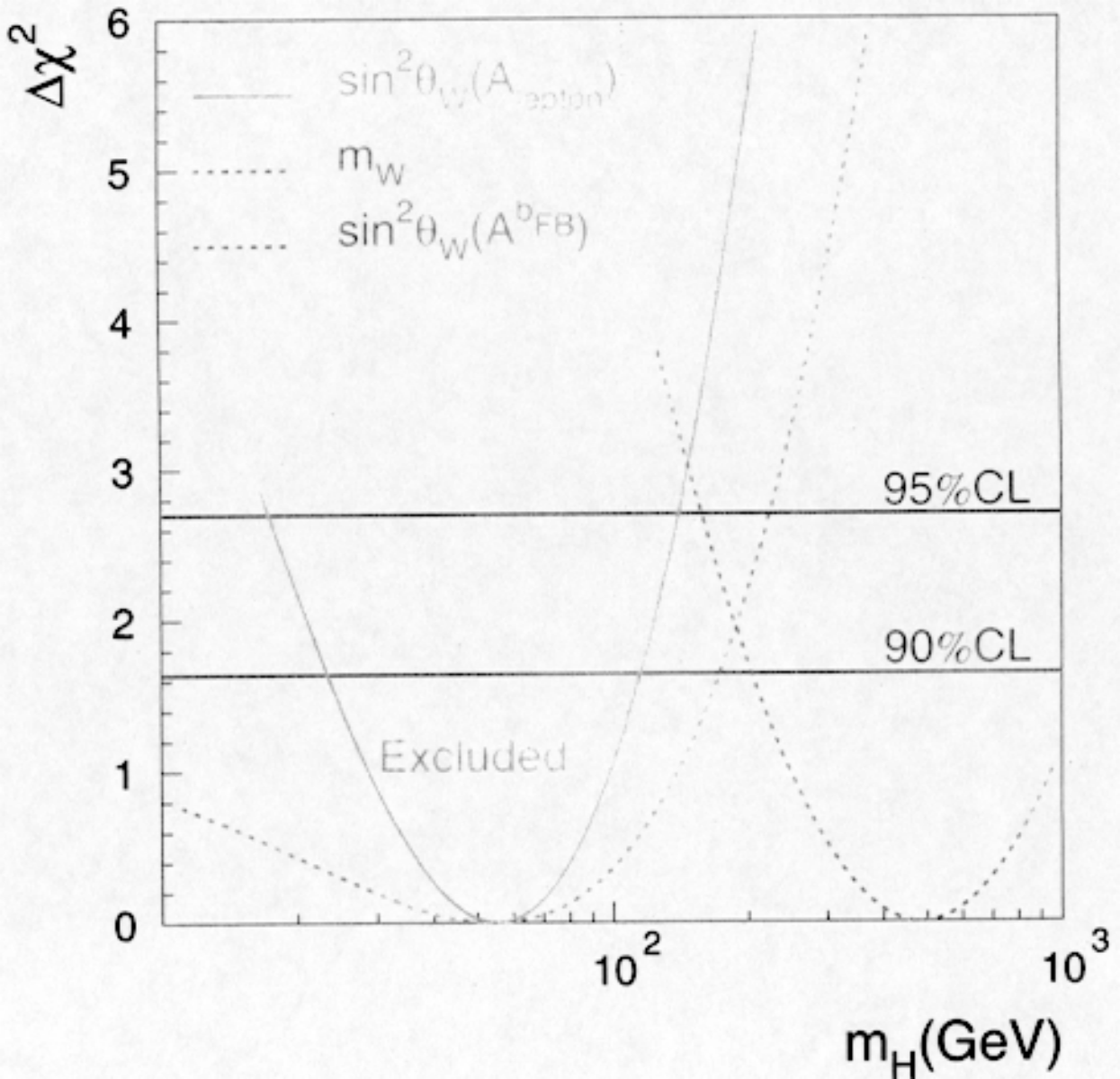
Final A_{lepton} $\sin^2\theta_W^{eff}$ result

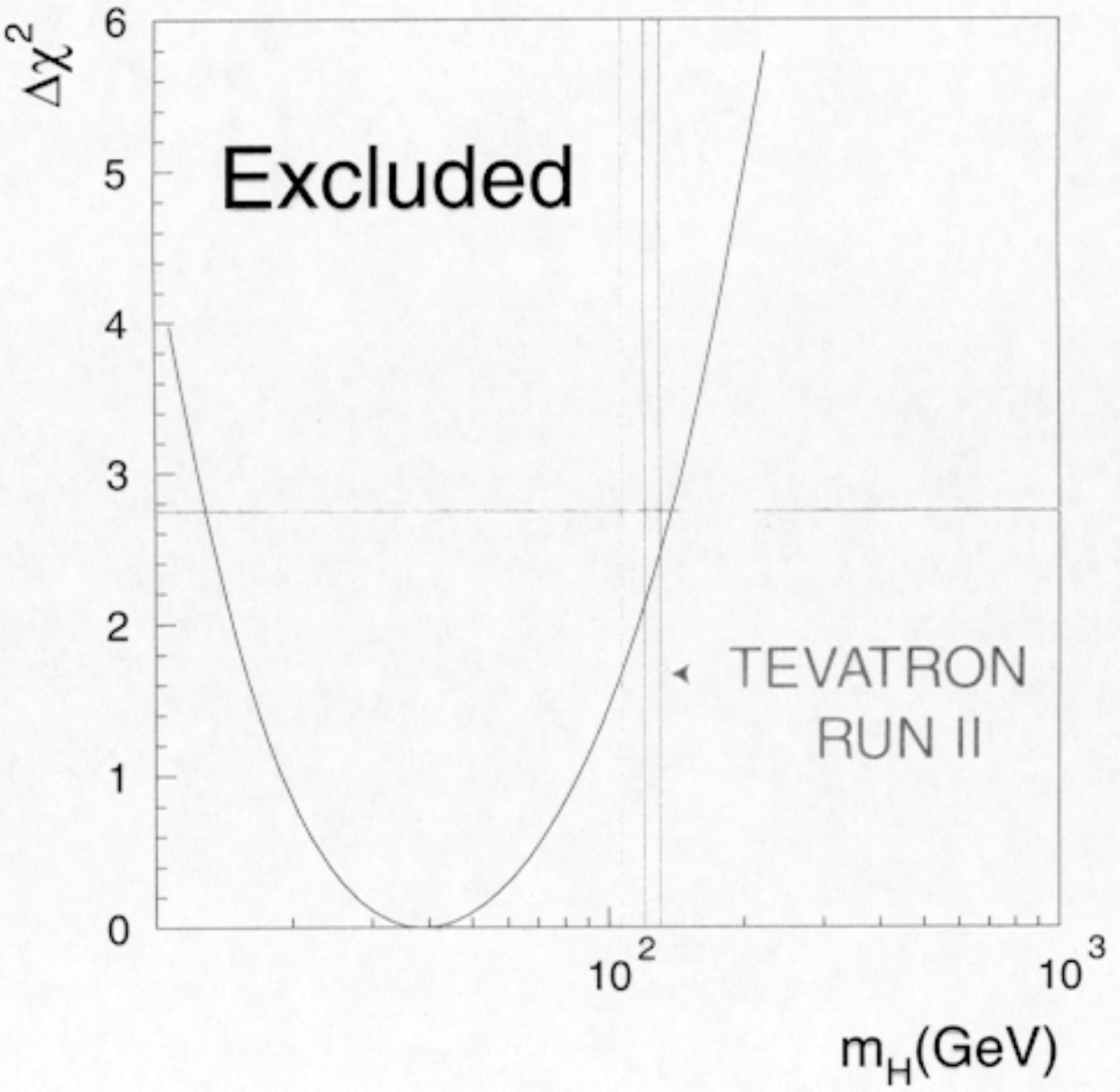


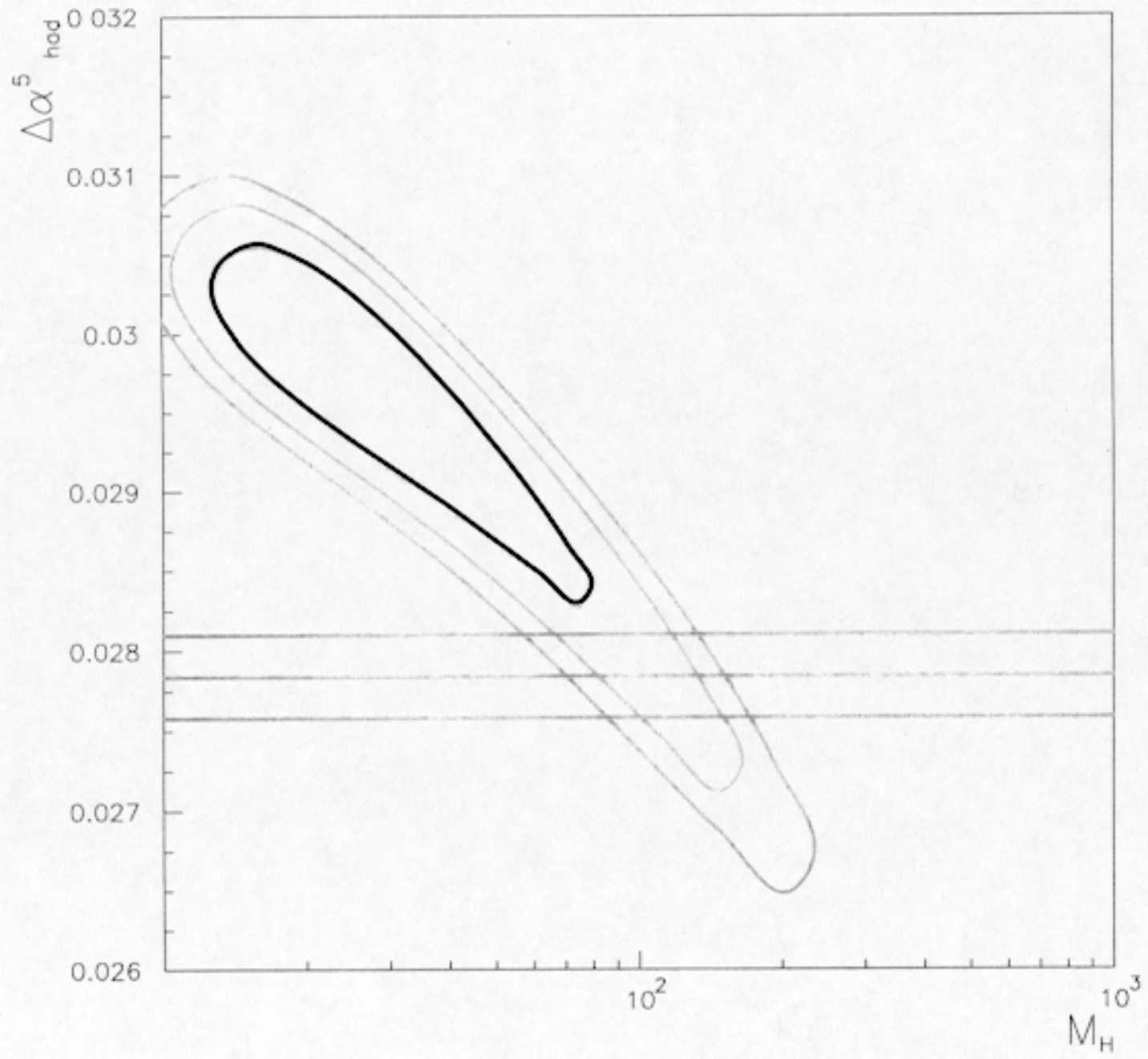
$A_{lepton} = 0.15130 \pm 0.00207$

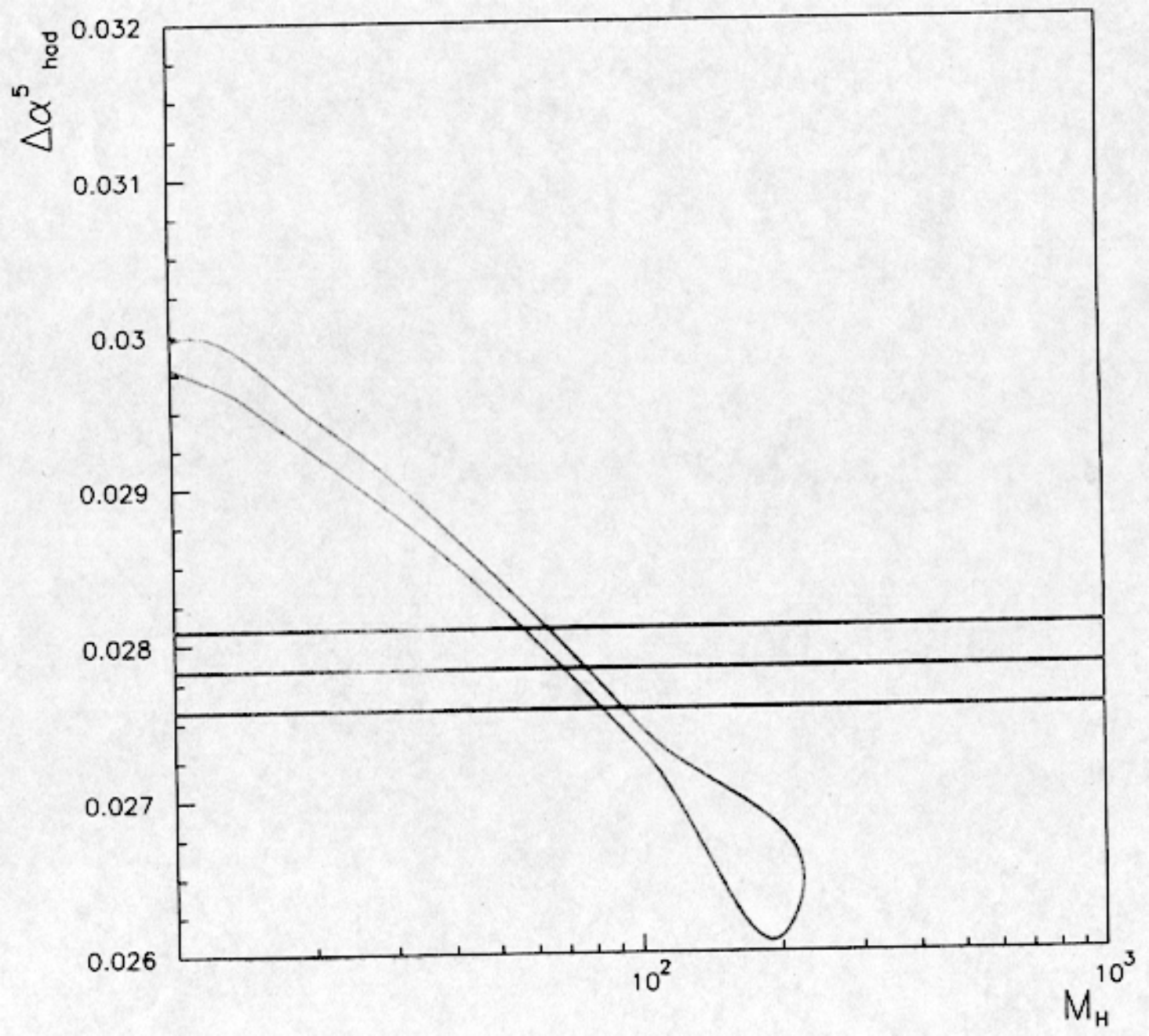
$\sin^2\theta_W^{eff} = 0.23098 \pm 0.00026$


$\Delta\chi^2$
6
5
4
3
2
1
0
Excluded
10^2
10^3
m_H(GeV)


$\Delta\chi^2$
6
5
4
3
2
1
0
$\sin^2\theta_W(A_{leptons})$
m_W
$\sin^2\theta_W(A^bFB)$
95%CL
90%CL
Excluded
10^2
10^3
m_H(GeV)


$\Delta\chi^2$
6
5
4
3
2
1
0
Excluded
TEVATRON
RUN II
10^2
10^3
m_H(GeV)


$\Delta\alpha^5_{had}$
0 032
0.031
0.03
0.029
0.028
0.027
0.026
10^2
10^3
M_H


$\Delta\alpha^5_{had}$
0.032
0.031
0.03
0.029
0.028
0.027
0.026
10^2
10^3
M_H

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An Improved Direct Measurement of Leptonic Coupling Asymmetries with Polarized Z Bosons[†]

The SLD Collaboration*

Stanford Linear Accelerator Center

Stanford University, Stanford, California, 94309

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Abstract

We present new direct measurements of the Z boson/lepton coupling asymmetry parameters A_e, A_μ, and A_τ, with the complete sample of polarized Z bosons collected by the SLD detector at the SLAC Linear Collider. The parameters are extracted from the measurement of the left-right and left-right forward-backward asymmetries using leptonic Z decays and combined with left-right asymmetry using Z decays to hadrons. The results are $A_e = 0.1516 \pm 0.0021$, $A_\mu = 0.142 \pm 0.015$, and $A_\tau = 0.136 \pm 0.015$. If lepton universality is assumed, a combined effective weak mixing angle of $\sin^2\theta_W^{eff} = 0.23098 \pm 0.00026$ results.

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