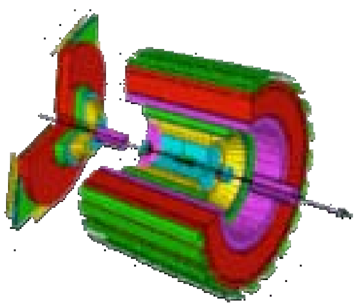
Heavy Flavour Results from LEP 1



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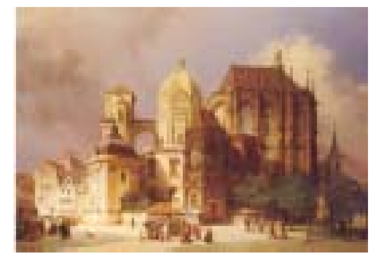
DELPHI Collaboration

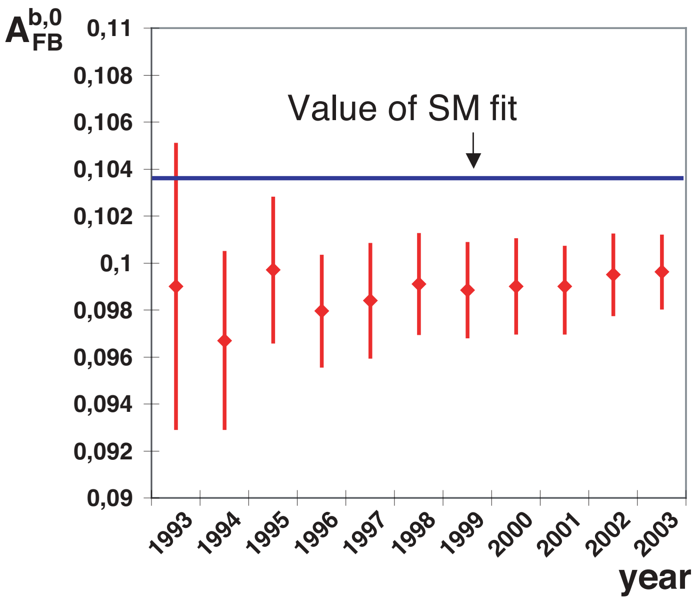
Representing the LEP Collaborations



Outline:

- Final LEP b-asymmetry results at this conference
- Summer '03 LEP+SLD average
- Consistency and checks

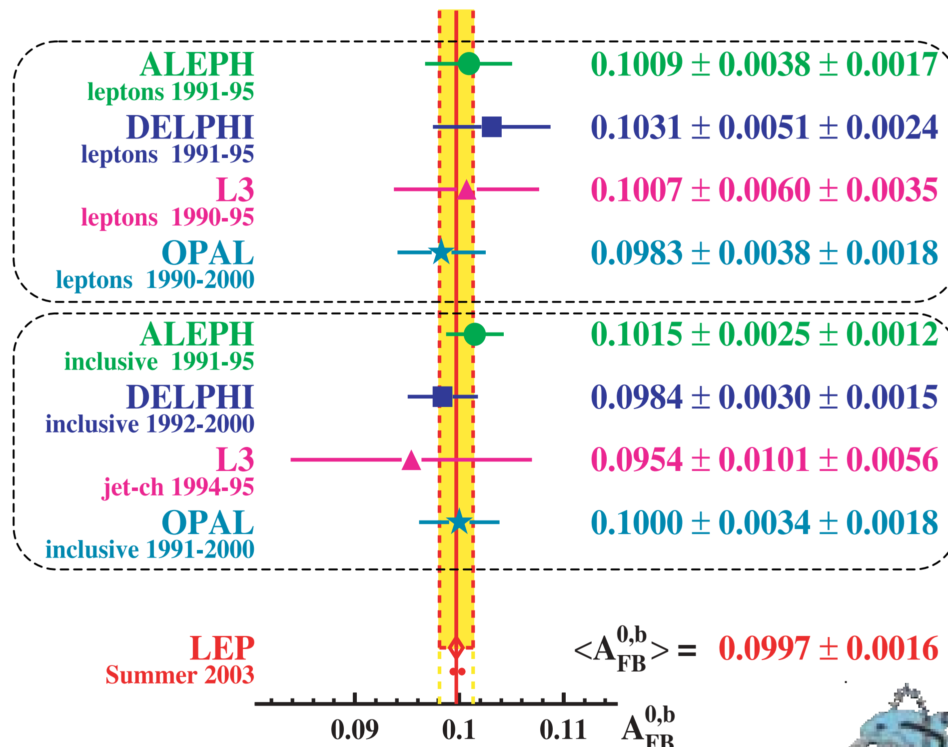
Introduction



➡ $A_{FB}^{0,b}$ average stable vs time

➡ Error significantly reduced:

- New analysis techniques
- Latest data reprocessing



➡ Mean low w.r.t. EW-fit

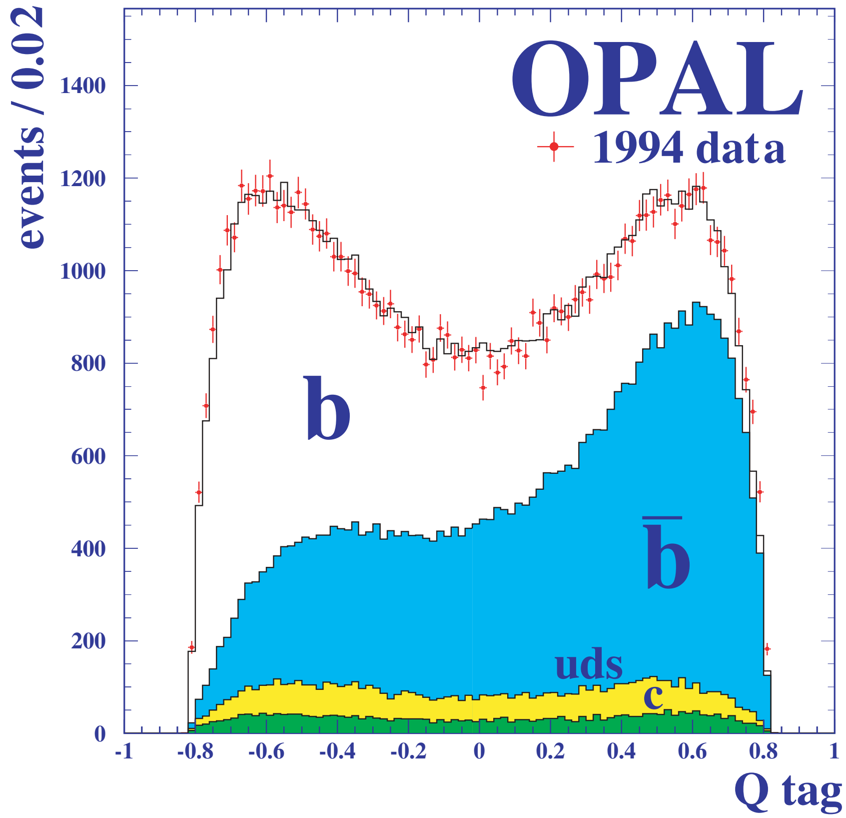
($\sin^2\theta_{eff}^{lept}$ average prob.~6.2%)

➡ Final results:

- Last talk ~ using leptons
- This talk ~ inclusive

Inclusive Measurements

- **Principle of measurements:**
  - Select pure b-sample
    - ⇒Enhanced impact parameter b-tagging
  - Improved inclusive charge tag
    - ⇒Jet-charge
    - ⇒Vertex-charge
    - ⇒Identified particles
- **Double hemisphere self calibration** (like R_b):
  - OPAL/ALEPH ~ charge flow
  - DELPHI ~ cut based analysis (require vertex in hemisphere)

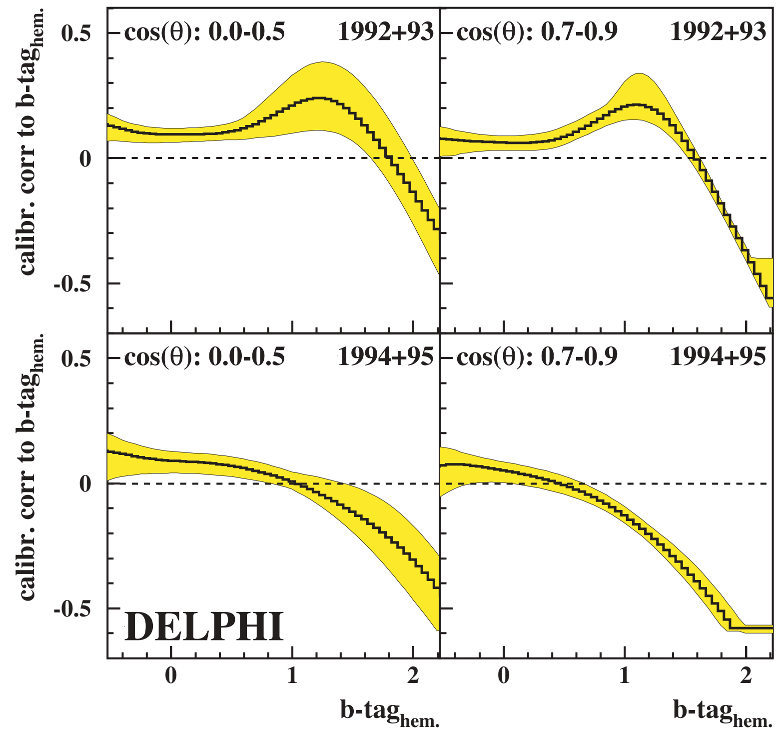


- **Critical issues:**
  - b-purity + charm background
  - Calibration of charge tag for b+c
  - Hemisphere correlations !

Updated DELPHI Result (1)

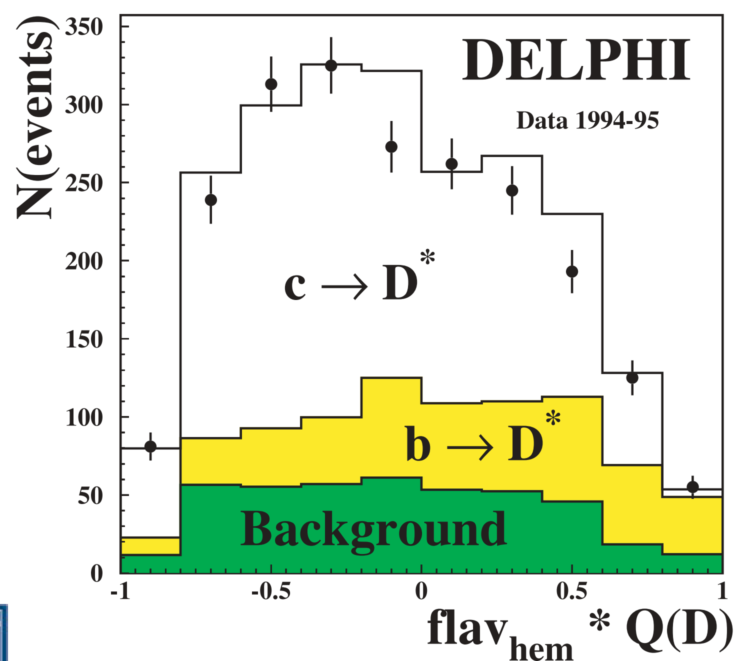
- **b-charge tagging calibration (data)**

$$\frac{N_{opp}}{N_{same}} = \frac{\omega_b^2 + (1-\omega_b)^2}{2\omega_b(1-\omega_b)}$$



- **New: measure charm charge tag**

D* hemisphere flav$_{hem}$ hemisphere



- **New: correct charm efficiency using hemisphere double tags**
- **Counteracting effects on $A_{FB}^{0,b}$**

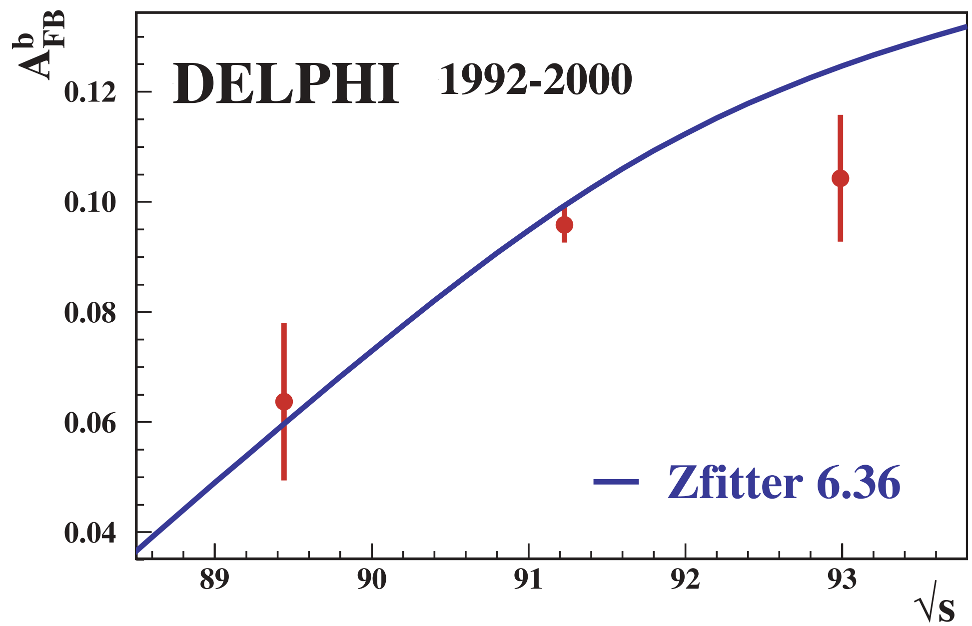
(20-30% on charm background, well covered by old systematic errors)

Updated DELPHI Result (2)

- $A_{FB}^{0,b}$ measured from differential asymmetry:

$$\frac{N^+ - N^-}{N^+ + N^-} = \sum_{f=bcuds} P_f (2\omega_f - 1) A_{FB}^f \frac{8}{3} \bullet \frac{\cos\theta}{1+\cos^2\theta}$$

- New: more data added
  - 1996-2000 Z peak data
  - Off-peak data 1993+1995



- Results:

$$A_{FB}^b(89.449GeV) = 0.0637 \pm 0.0143 \pm 0.0017$$

$$A_{FB}^b(81.231GeV) = 0.0958 \pm 0.0032 \pm 0.0014$$

$$A_{FB}^b(92.990GeV) = 0.1041 \pm 0.0115 \pm 0.0024$$

- Pole asymmetry:

$$A_{FB}^{0,b} = 0.0978 \pm 0.0030 \pm 0.0014$$

- Dominant systematic contributions:
  - Hemisphere correlations ~ ±0.0011
  - Charm+uds background ~ ±0.0006
  - QCD correction ~ ±0.0004
  - Detector resolution ~ ±0.0004

About the QCD Correction

➡ QCD correction (in $O(\alpha_s^2)$):

$$A_{FB}^{b,meas} = (1 - \{3.5 \pm 0.63\}\%) \bullet A_{FB}^{b,noQCD}$$

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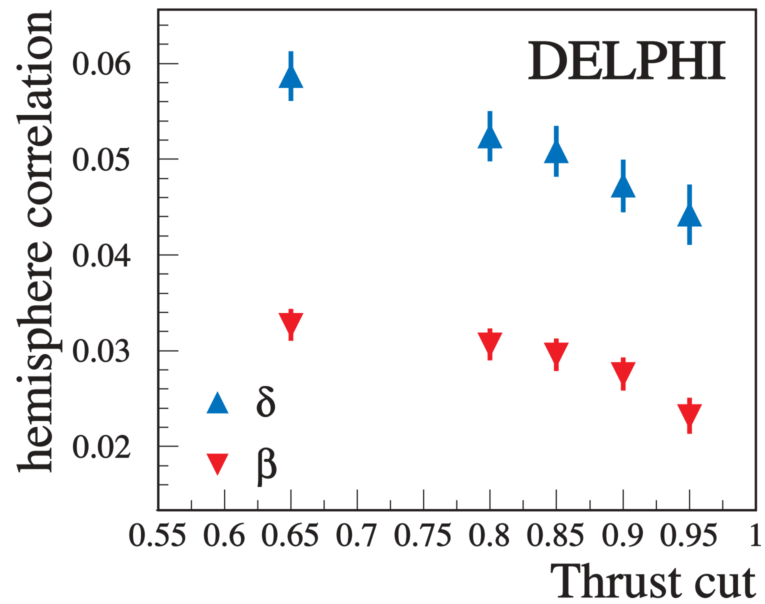
- Precision of LEP average ~1.5%

➡ Selection: bias against QCD effect

- Observe ~ 1/4 of QCD correction



➡ Jet-charge hemisphere correlations hide large part of QCD correction

- Add to error on QCD correction:

DELPHI: ±0.00009 ⇒ ±0.00040
ALEPH: ±0.00005 ⇒ ±0.00015
OPAL more conservative, take full error

➡ QCD correction largest common systematics

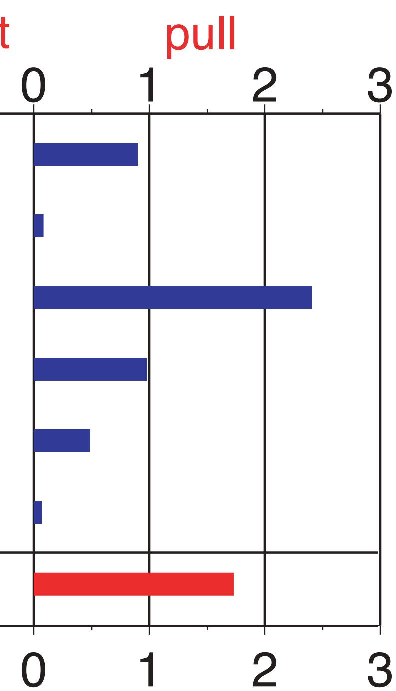
(~25% of total error)

➡ Test: use full QCD error ~average unchanged

LEP+SLD Averages

- **Different methods ~ internal $A_{FB}^{0,b}$ correlations**
- **14 parameter fit:**
  - $b \to l, b \to c \to l, c \to l, \bar{\chi}$
  - $f(D^0), f(D_S), f(\Lambda_c), P(c \to D^*)$
  - **+6 EW observables**
- $\chi^2/NDF = 53/91$
  - **Small correlations: 15%~ $A_{FB}^{0,b}$ vs $A_{FB}^{0,c}$**
  - **Statistical only:** $\delta A_{FB}^{0,b} = -0.06\sigma$

	measurement	full EW fit
R_b	0.21638 ± 0.00066	0.21579
R_c	0.1720 ± 0.0030	0.1723
$A_{FB}^{0,b}$	0.0997 ± 0.0016	0.1036
$A_{FB}^{0,c}$	0.0706 ± 0.0035	0.0740
A_b	0.925 ± 0.020	0.935
A_c	0.670 ± 0.026	0.668
A_l(SLD)	0.1513 ± 0.0021	0.1477



correlation matrix
(I was asked to put it)

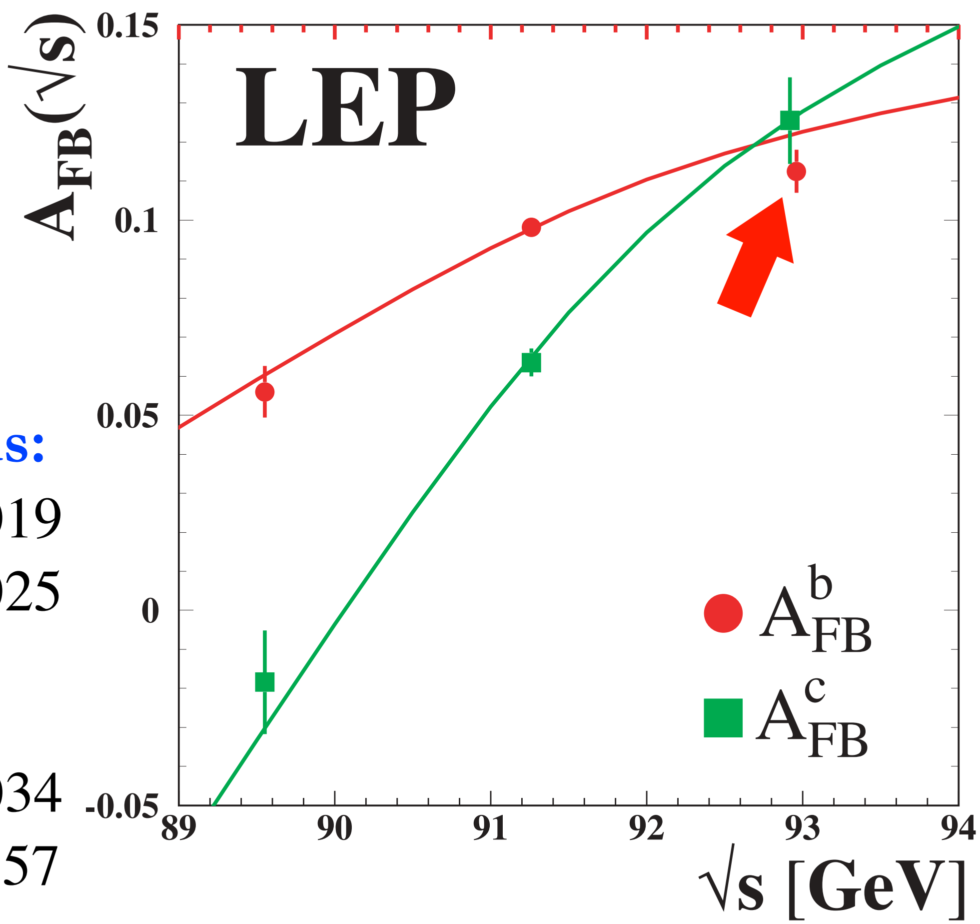
1.00	−0.14	−0.10	0.07	−0.07	0.05
	1.00	0.03	−0.06	0.03	−0.05
		1.00	0.15	0.03	−0.01
			1.00	−0.02	0.04
				1.00	0.13
					1.00

Energy Dependence + Checks

- Change in $A_{FB}^{0,b}$ since last summer ~ +0.1σ
  - DELPHI inclusive ~ -0.2σ
  - OPAL lepton ~ +0.3σ
  (also change in $\overline{\chi}$)

- Compare different methods:
  - Inclusive: $A_{FB}^{0,b} = 0.1000 \pm 0.0019$
  - Leptons: $A_{FB}^{0,b} = 0.1000 \pm 0.0025$

- Charm asymmetries:
  - Leptons: $A_{FB}^{0,c} = 0.0699 \pm 0.0034$
  - D-mesons: $A_{FB}^{0,c} = 0.0711 \pm 0.0057$
  (fixing b-asymmetry)



- Only on-peak data (+0.6σ):

$$A_{FB}^{0,b} = 0.1006 \pm 0.0017$$

Are LEP and SLD Compatible?

- Compare results in terms of A_b:
  - indirect (LEP only !):

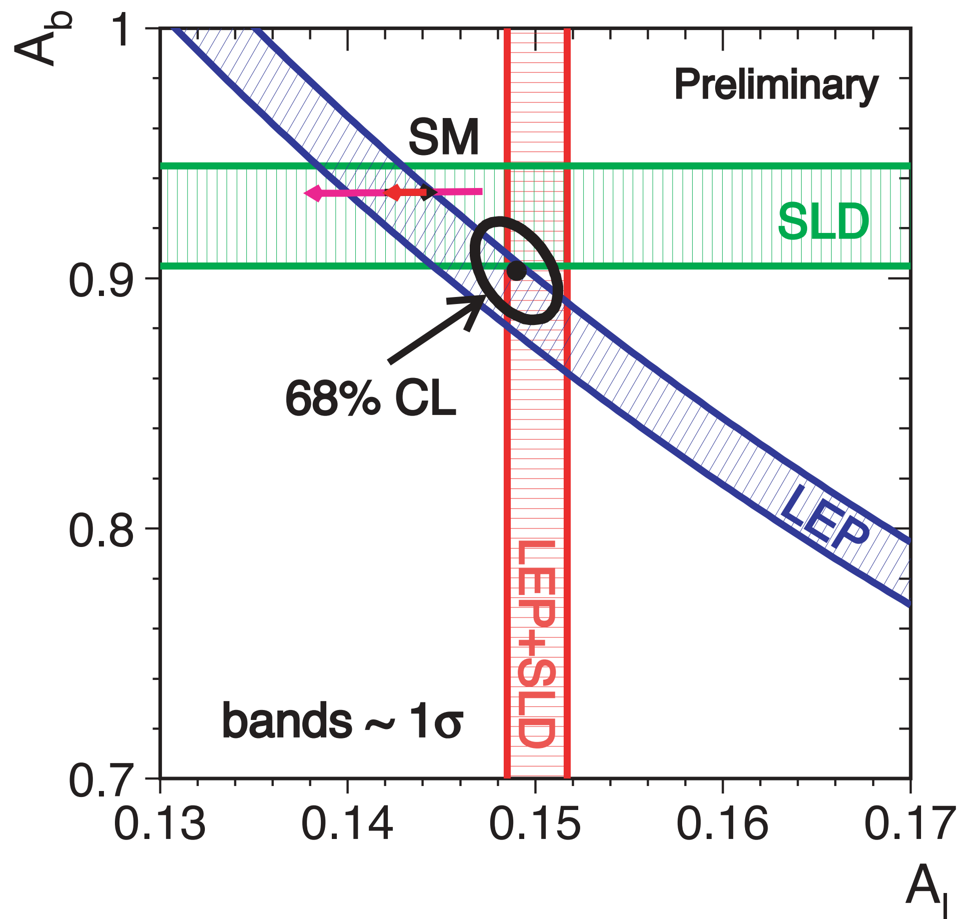
    $A_b = 0.898 \pm 0.021$
  - and SLD:

    $A_b = 0.925 \pm 0.020$
- Agree within 0.8σ !

- Combined LEP + SLD:

  $A_b = 0.903 \pm 0.013$

  (0.935 SM)



$$A_{FB}^{0,b} = \frac{3}{4} A_e A_b \qquad A_{LR,FB}^{b} = \frac{3}{4} A_b$$

$$A_l \sim \{A_{LR}, A_{FB}^{0,l}, \tau - Pol.\}$$

Does MSSM describe Data?

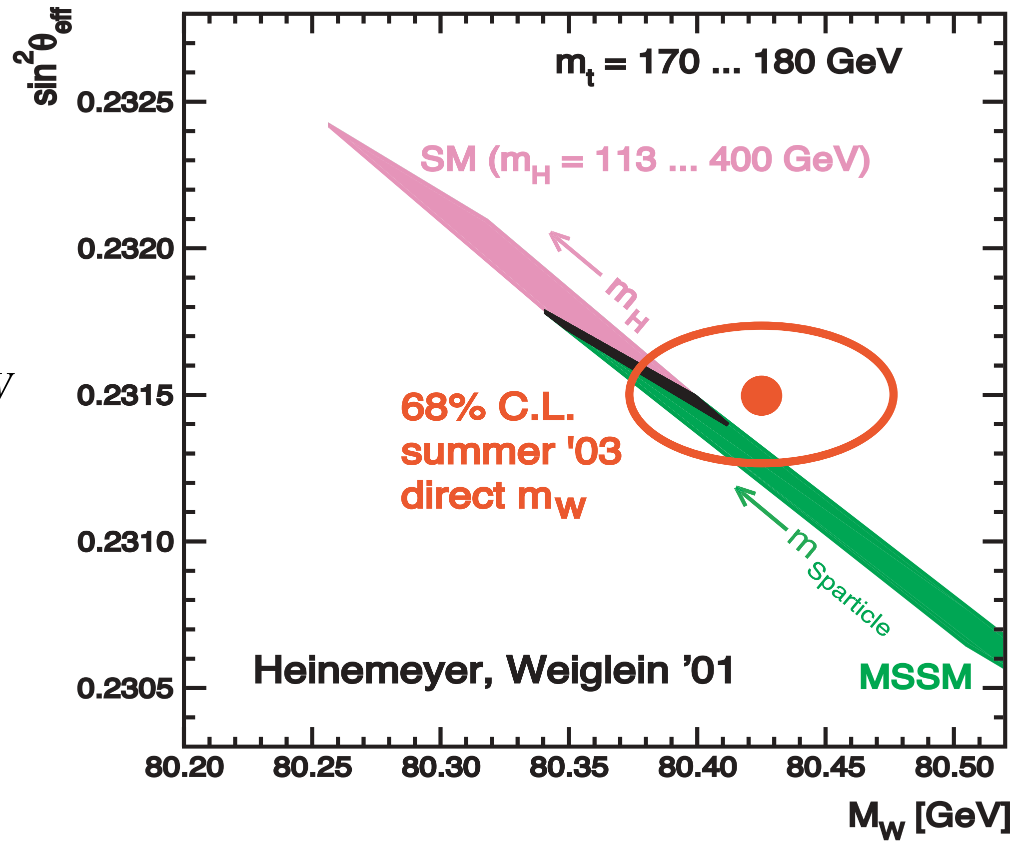
- A_{LR} and $A_{FB}^{0,b}$ measure $\sin^2\theta_{eff}^{lept}$
  - apparent 2.9σ difference

- In SM are $\sin^2\theta_{eff}^{lept}$ and m_W related:

$$m_W^2 = \frac{A^2}{\sin^2\theta_{eff}^{lept}(1-\Delta r_W)}$$

  with A known and EW correction Δr_W depending on $\log(m_H/m_W)$

- In MSSM this relation is affected from supersymmetric particles, mainly from partners of top quark



- MSSM compatible, but not preferred
- EW data ~ small m_H

Summary

- Final LEP b-asymmetry results presented at this conference
- Experiments have finished the 2nd iteration on $A_{FB}^{0,b}$ using final reprocessings and latest experimental techniques
- Significant improvements in experimental precision, control of systematic uncertainties using data itself
- LEP +SLD average internally consistent
- Apparent 3σ difference between "hadronic" and "leptonic" mixing angle confirmed
- Interpretation of electroweak data difficult