A^b_{FB} status of results

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Introduction

- NEW at this conference:

  Final ALEPH measurement using leptons

  (CERN-EP/2001-097)

- This is the only new result with respect to summer 2001
- Most of this presentation will be dedicated to this measurement and its impact on the LEP combination
- The method is similar to the other measurements using leptons performed by DELPHI, L3 and OPAL
  - Most important differences will be mentioned
- See next talk for a more general review

Outline of the method

- Leptons are used both to tag the quark flavour and the quark charge
  - Leptons from direct $b \to \ell^-$ decays have high p and pt
- Thrust axis measures the quark direction
- The asymmetry is extracted from a fit to the angular distribution:

$$\frac{1}{N}\frac{dN}{dx} = \frac{3}{8}\left(1 + x^2 + \frac{8}{3}A_{FB}x\right)$$

where $x \equiv -Q_{lep} \cdot \cos J_{thrust}$

Asymmetry extraction

- Because of $b \to c \to \ell^+$ and $c \to \ell^+$ decays and of B^0 mixing probability $\overline{\chi}$

$$A_{FB}^{obs} = P_b (f_{b\to\ell} - f_{b\to c\to\ell})(1-2\overline{c})A_{FB}^{b} + (1-P_b)A_{FB}^{c}$$

$$A_{FB}^{b} = \frac{A_{FB}^{obs} + (1-P_b)A_{FB}^{c}}{P_b (f_{b\to\ell} - f_{b\to c\to\ell})(1-2\overline{c})}$$

non-prompt and fake leptons to be added

$\Rightarrow A_{FB}(b)$ depends explicitly on $\overline{\chi}$ and $A_{FB}(c)$

$$dA_{FB}^{b} / d\overline{c} \approx 0.3, \quad dA_{FB}^{b} / dA_{FB}^{c} \approx 1 - P_b$$

$\Rightarrow P_b$, $f_{b\to l}$ and $f_{b\to c\to l}$ are taken from the simulation

$\Rightarrow$ good separation b /c and $b \to \ell^-$ / $b \to c \to \ell^+$ improves sensitivity...

$\Rightarrow$... and allows to measure $A_{FB}(c)$ too!

Flavour separation

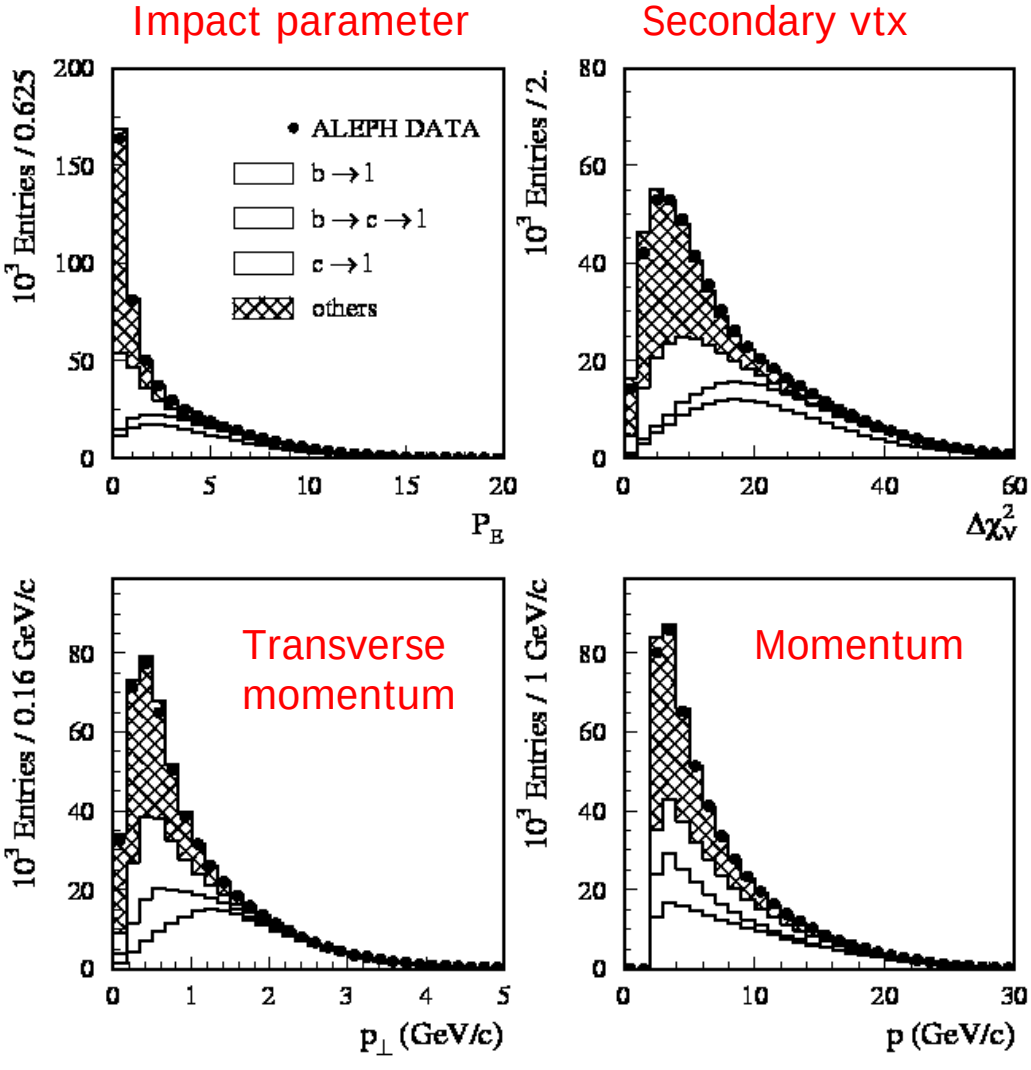
In addition to lepton p and pt, ALEPH uses:

- Lifetime tags
- The missing energy
- Mass tags
- A soft pion D* tag

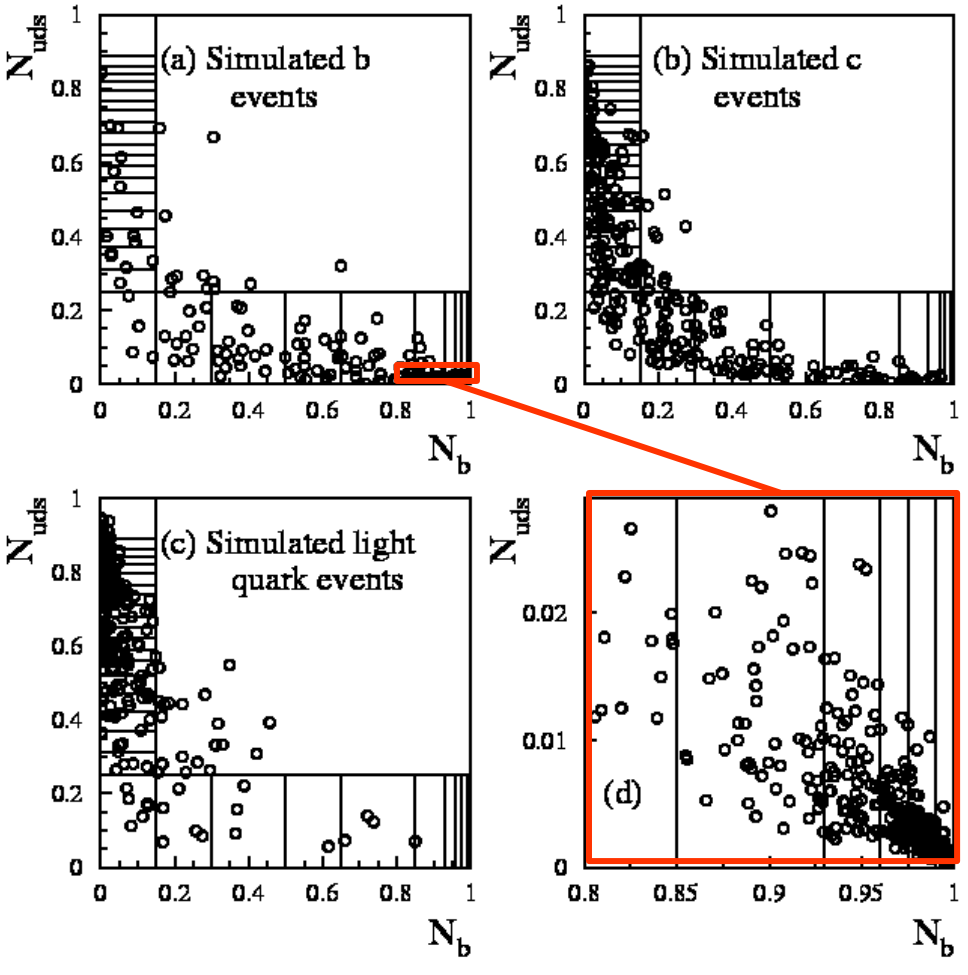
+

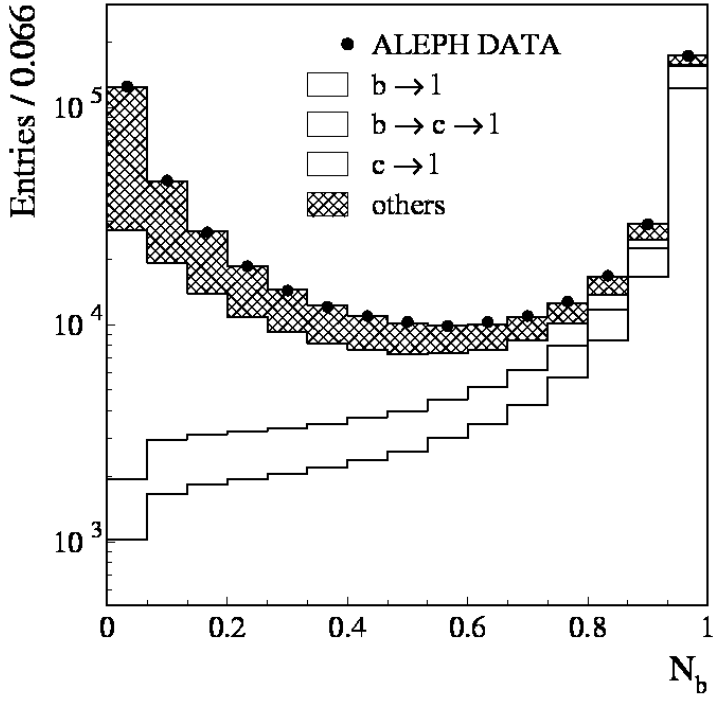
$|\cos\theta|$ as a control variable

All these variables are combined in a single NN with two outputs



Flavour Neural Network





Binning is chosen as to have equal occupancy in each bin

Similar methods for flavour discrimination are used by DELPHI and OPAL too

b→l / b→c→l discrimination

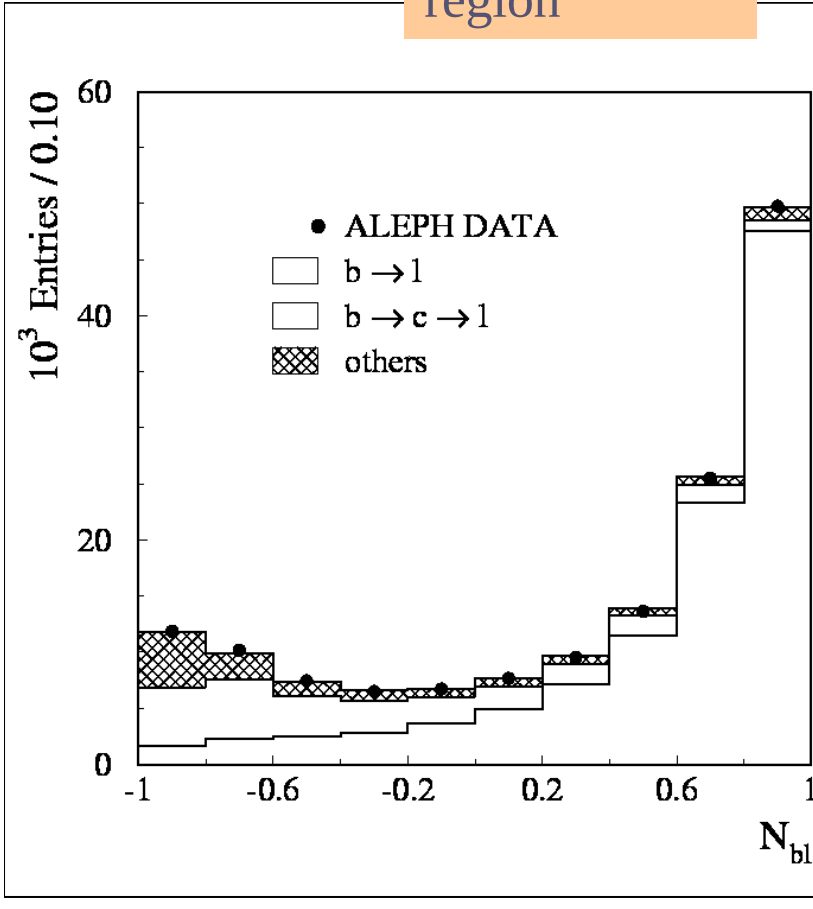
ALEPH uses another NN based on:

- lepton kinematical properties
- lepton jet properties
  - in b→l decay the jet is made of D decay products
  - in b→c→l decay both the W and D decay products are present

Decreases error on A^b_{FB} by ~10% with respect to using p and pt only

Use of the lepton jet properties was pioneered by OPAL, combining them with flavour discriminating variables

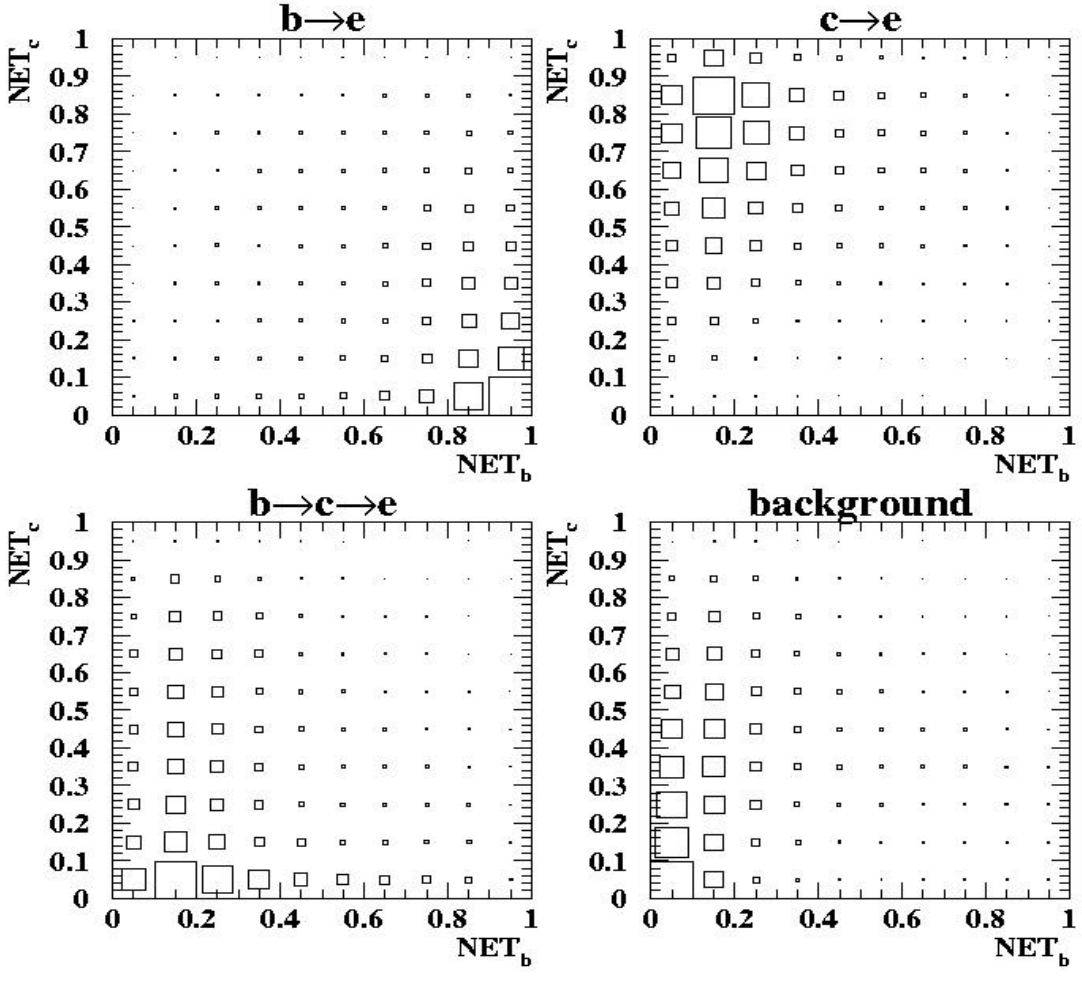
High b-purity region



OPAL preliminary (Warsaw 1996)

Uses lepton-jet properties to separate direct from cascade decays

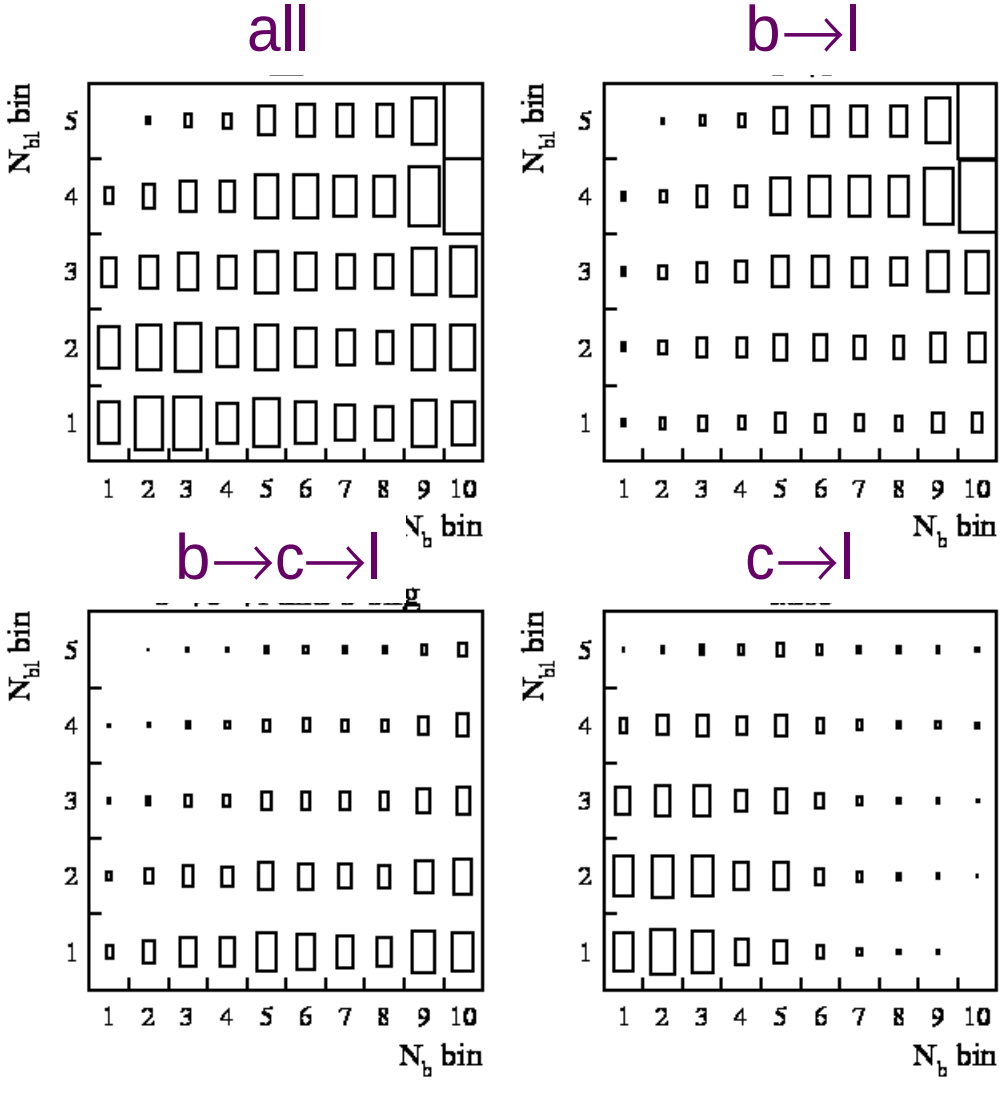
Lifetime-tag used to anti-tag b's and select c→l



ALEPH combination of the two NN's

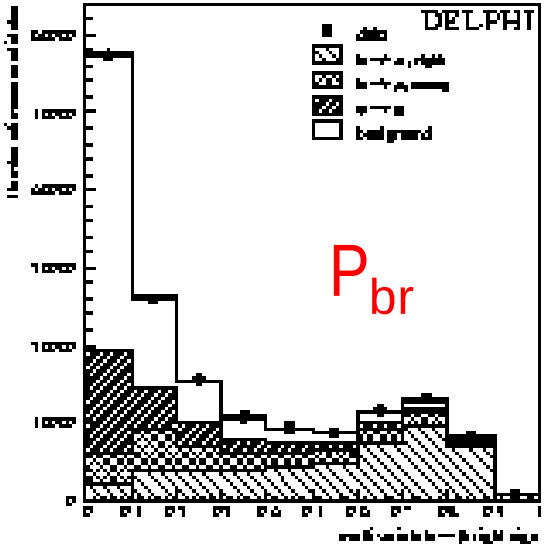
In the region populated mostly by heavy quarks the two NN are combined

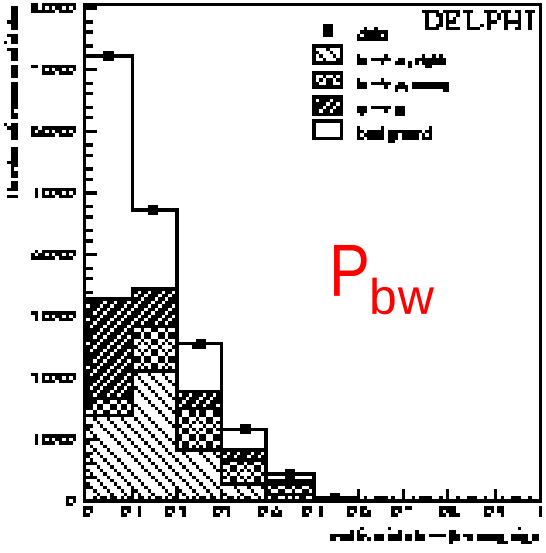
DELPHI does something similar but using the correlation between the lepton charge and the jet-charge in the opposite hemisphere instead of the lepton jet properties

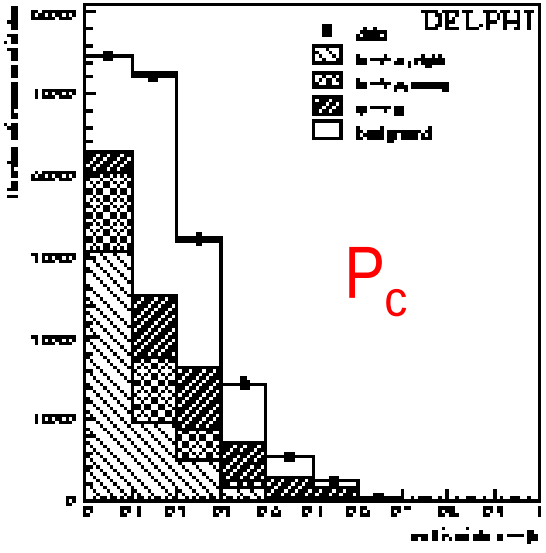


DELPHI preliminary (Osaka 2000)

- Multivariate analysis
  - Uses (p,pt), jet-charge, b-tag







- Fit is performed in bins of ($\cos\theta$,P_{br}- P_{bw}, P_c)

Mixing measurement

Measured in a dilepton sample enriched in b→l

- $N_{bl} > 0.5$ for both leptons

Fraction of (b→l, b→l) ≈ 84%

Rate of like-sign dileptons ∝ $2\chi(1-\chi)$

Final ALEPH result

$$\chi = (11.96 \pm 0.49^{+0.43}_{-0.50})\%$$

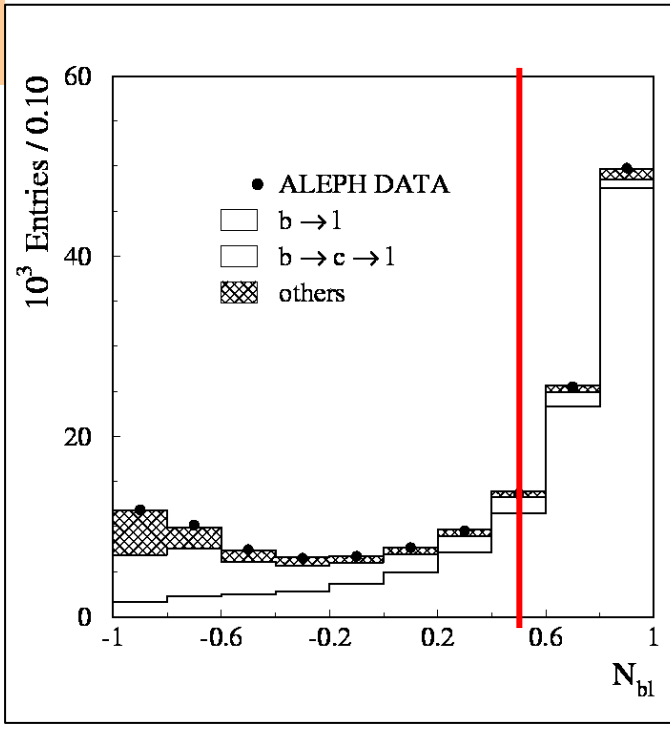
Previous result

$$\chi = (12.46 \pm 0.51 \pm 0.52)\%$$

Phys. Lett. B384 (1996) 414

but using the same semileptonic BR's:

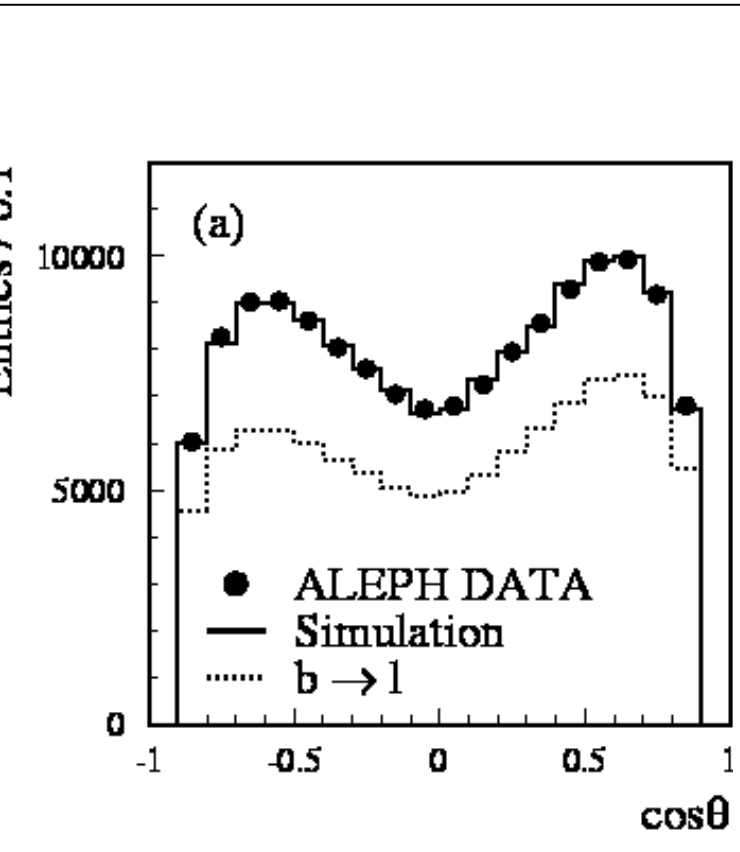
$$\chi = 11.93\%$$

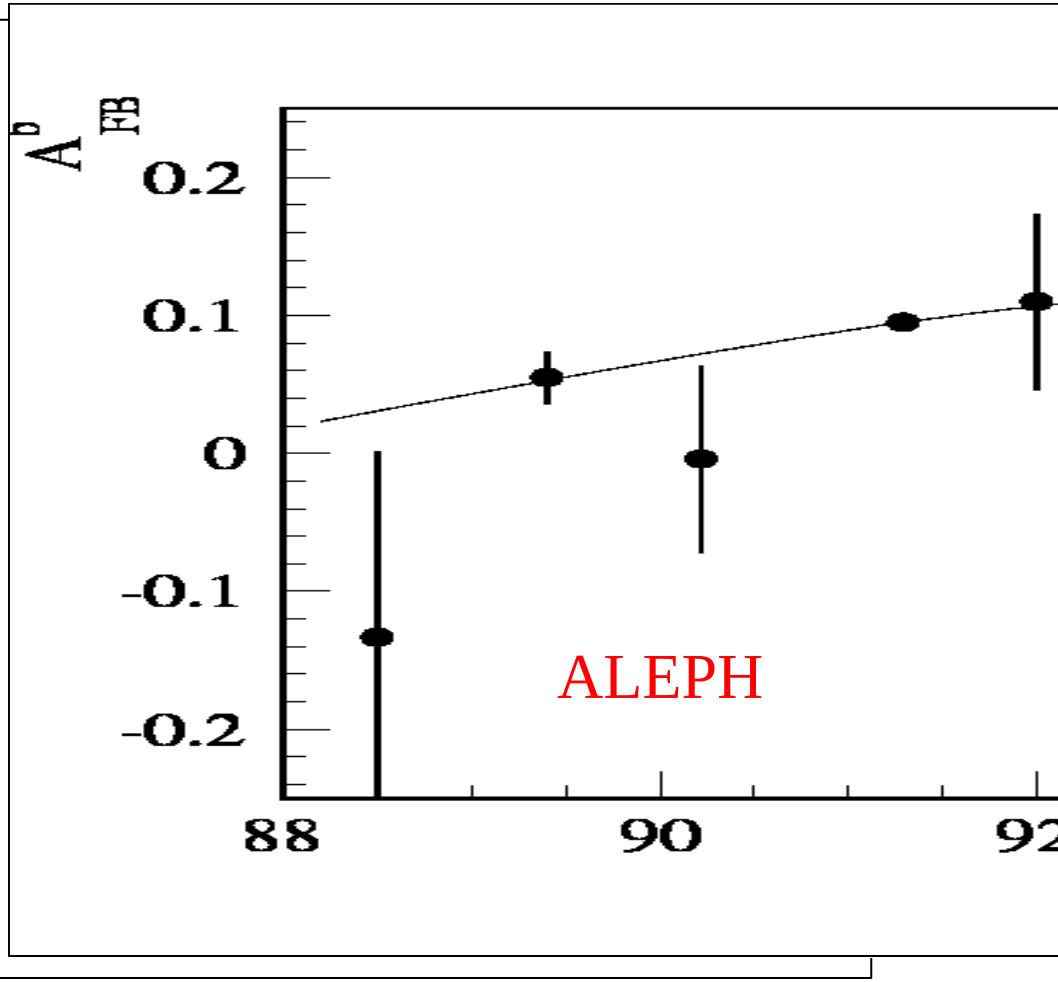


The final b asymmetry…

Final value at peak, before QED and QCD corrections

$$A_{FB}(b) = 0.0952 \pm 0.0041 \pm 0.0017$$





...compared to previous ALEPH results

Final value

$$A_{FB}(b) = 0.0952 \pm 0.0041 \pm 0.0017$$

Previous results

$$A_{FB}(b) = 0.0965 \pm 0.0044 \pm 0.0026$$ (Phys. Lett. B384 (1996) 414)

$$A_{FB}(b) = 0.0949 \pm 0.0040 \pm 0.0023$$ (Tampere 1999)

...but for Tampere result χ=12.46% was used

Using the same χ as for the final measurement the change from preliminary to final is indeed:

$$dA_{FB}(b) = +0.0014$$

The final c asymmetry

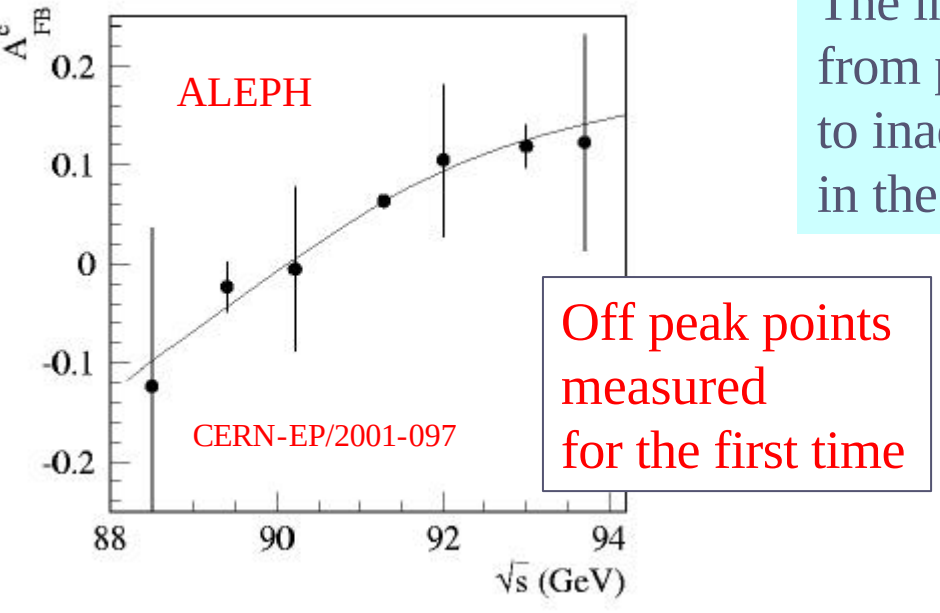
Final value at peak, before QED and QCD corrections

$$A_{FB}(c) = 0.0645 \pm 0.0057 \pm 0.0037$$

Previous results

$$A_{FB}(c) = 0.091 \pm 0.020 \pm 0.021$$ (Z. Phys. C 62 (1994) 179)

$$A_{FB}(c) = 0.0562 \pm 0.0053 \pm 0.0036$$ (Tampere 1999)



Off peak points measured for the first time

The increase of the central value from preliminary to final mostly due to inadequate binning causing a bias in the value

15% statistical correlation between b and c asymmetries explains the shift in AFB(b)

Systematic errors

Source	$\Delta A(b)(\%)$	$\Delta A(c)(\%)$
BR's	0.034	0.189
Detector	0.015	0.088
Lepton modeling	0.090	0.210
Bkg asymmetries	0.002	0.072
B and D physics	0.032	0.166
Mixing	0.132	0.113
Total	0.169	0.369

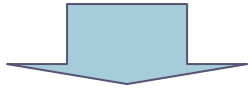
- Main systematic error on $A_{FB}(b)$ is due to statistical error on χ
  - the other systematics are fully correlated and partially cancel out in the $A_{FB}(b)$ measurement for BR's and modeling uncertainties

Checks

- Measurement on electrons and muons separately
- Simultaneous fit of asymmetries and mixing
- Fit in high b(c)-purity samples
- Simultaneous fit of semileptonic BR's and fakes rates

$\Rightarrow$ Described in details in CERN-EP/2001-097

None of these checks showed significant deviations from reference results and input values



Fit is robust and simulation is reliable

The LEP and SLD combination

- A fit is performed to the most relevant heavy flavour electroweak quantities:

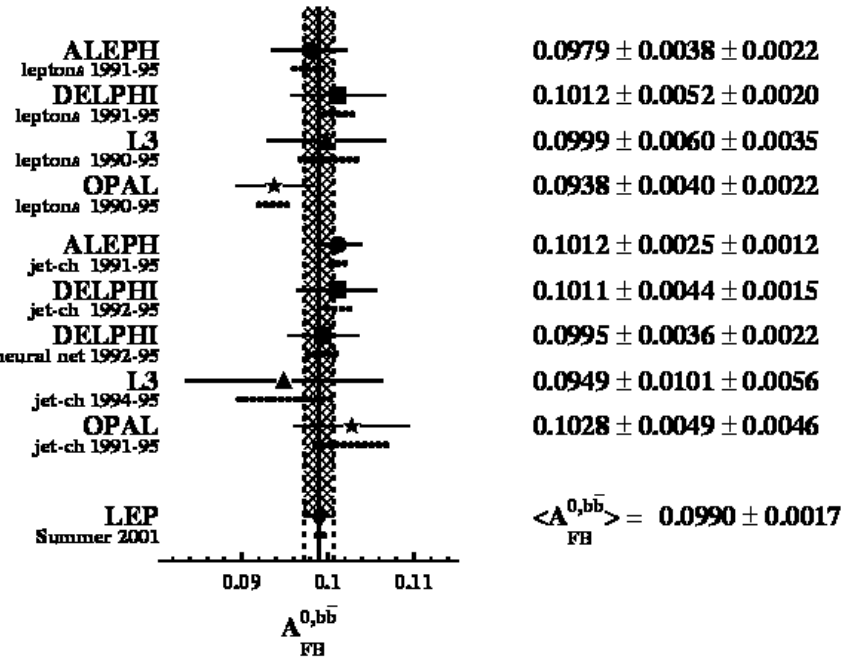
  R_b, R_c, $A_{FB}(b)$, $A_{FB}(c)$, $A_{LR}(b)$ and $A_{LR}(c)$

  - Measurements are corrected to common physics input parameters (BR's, fragmentation, etc.)
  - Statistical and systematic correlations are taken into account.

See next talk !

Results of the combination

Summer 2001



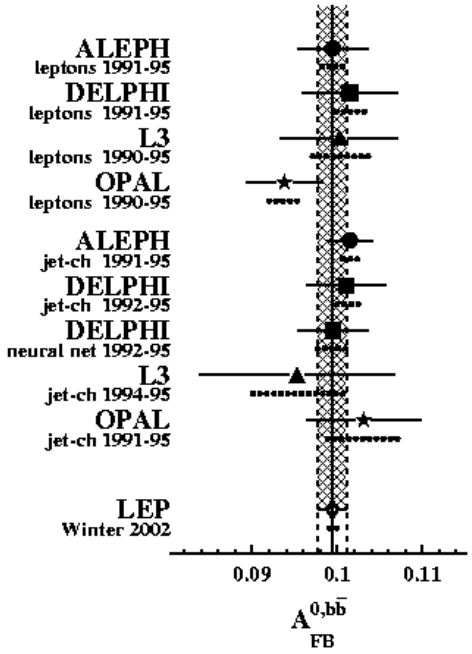
$0.0979 \pm 0.0038 \pm 0.0022$
$0.1012 \pm 0.0052 \pm 0.0020$
$0.0999 \pm 0.0060 \pm 0.0035$
$0.0938 \pm 0.0040 \pm 0.0022$
$0.1012 \pm 0.0025 \pm 0.0012$
$0.1011 \pm 0.0044 \pm 0.0015$
$0.0995 \pm 0.0036 \pm 0.0022$
$0.0949 \pm 0.0101 \pm 0.0056$
$0.1028 \pm 0.0049 \pm 0.0046$

$\langle A_{FB}^{0,b\bar{b}} \rangle = 0.0990 \pm 0.0017$

$A_{FB}^{0}(b) = 0.0990 \pm 0.0017$

$A_{FB}^{0}(c) = 0.0685 \pm 0.0034$

Winter 2002



$0.0995 \pm 0.0038 \pm 0.0017$
$0.1015 \pm 0.0052 \pm 0.0020$ ☆
$0.1002 \pm 0.0060 \pm 0.0035$
$0.0938 \pm 0.0040 \pm 0.0022$ ☆
$0.1015 \pm 0.0025 \pm 0.0012$
$0.1011 \pm 0.0044 \pm 0.0015$ ☆
$0.0995 \pm 0.0036 \pm 0.0022$
$0.0953 \pm 0.0101 \pm 0.0056$
$0.1031 \pm 0.0049 \pm 0.0046$

$\langle A_{FB}^{0,b\bar{b}} \rangle = 0.0994 \pm 0.0017$

☆ preliminary

$A_{FB}^{0}(b) = 0.0994 \pm 0.0017$

$A_{FB}^{0}(c) = 0.0707 \pm 0.0034$

In addition to the ALEPH result, other results changed because of their correlation with $A_{FB}(c)$

Error breakdown

Source	ΔA_b(%)	ΔA_c(%)
Statistics	0.16	0.30
Internal systematics	0.06	0.14
Common systematics	0.04	0.07
Total systematics	0.07	0.16
Total	0.17	0.34

Conclusions

New final ALEPH result using leptons

$$A_{FB}^{0}(b) = 0.0998 \pm 0.0040 \pm 0.0017$$

All LEP leptons

$$A_{FB}^{0}(b) = 0.0975 \pm 0.0025$$

All LEP inclusive

$$A_{FB}^{0}(b) = 0.1009 \pm 0.0020$$

All LEP measurement

$$A_{FB}^{0}(b) = 0.0994 \pm 0.0017$$

Average changed by a quarter of a sigma w.r.t. summer 2001

Measurements are internally in agreement