Heavy quark production in e+e- annihilation above the Z pole.

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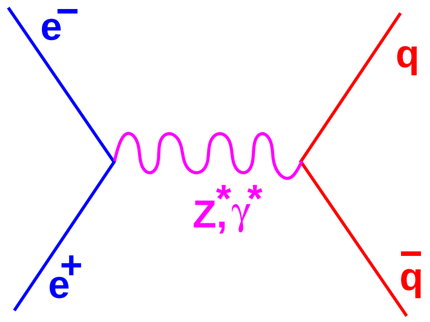
5th International Conference on Hyperons, Charm, and Beauty Hadrons, BEACH 2002
Vancouver, BC Canada
June 25 - 29, 2002

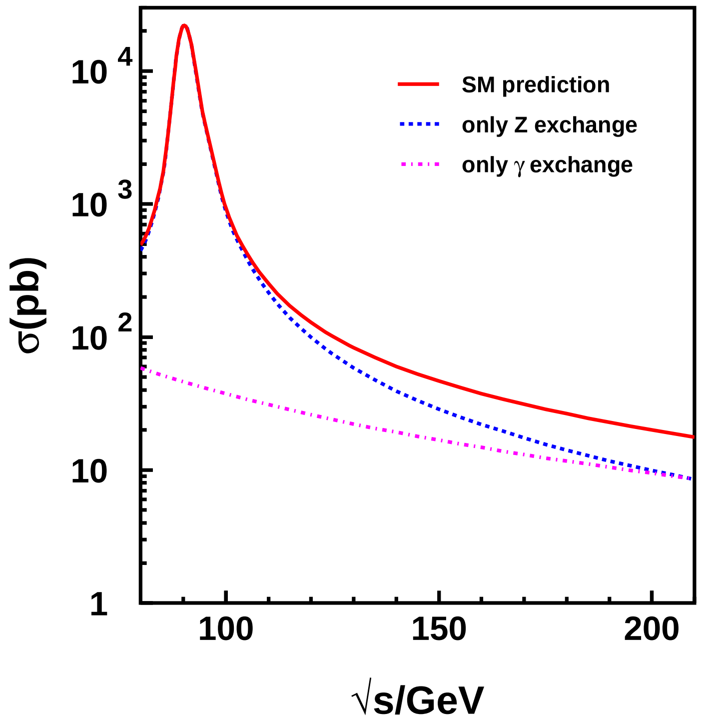
Subject: fractions and asymmetries of heavy quarks (b,c) at LEPII.

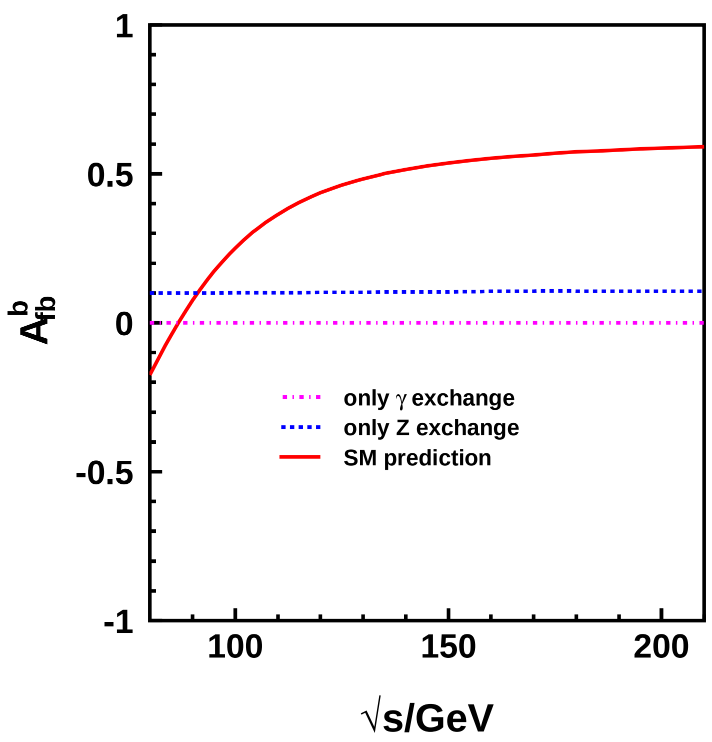


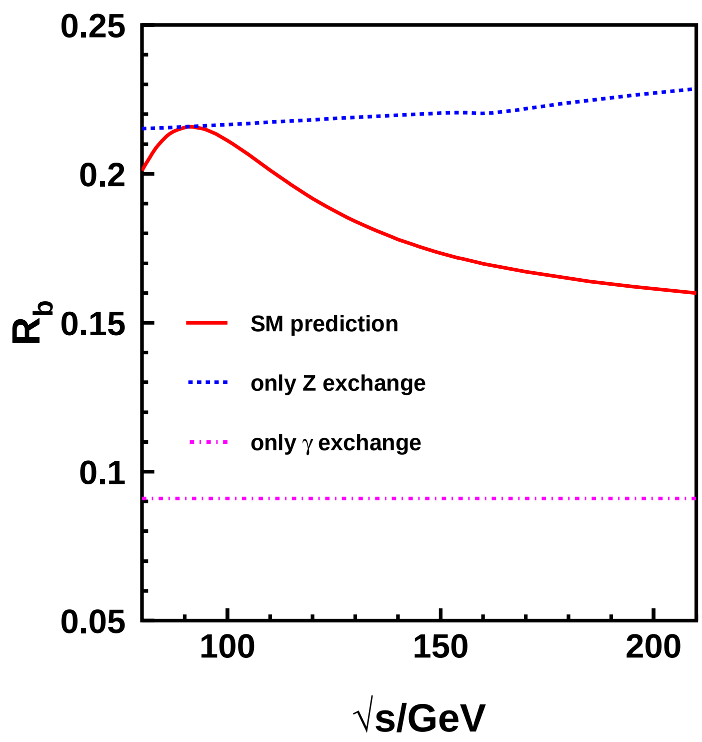
$$\sigma_{had} = \sum_q \sigma_{q\bar{q}}$$

$$R_b = \frac{\sigma_{b\bar{b}}}{\sigma_{had}}$$

$$A^b_{fb} = \frac{\sigma^f_{b\bar{b}} - \sigma^b_{b\bar{b}}}{\sigma_{b\bar{b}}}$$

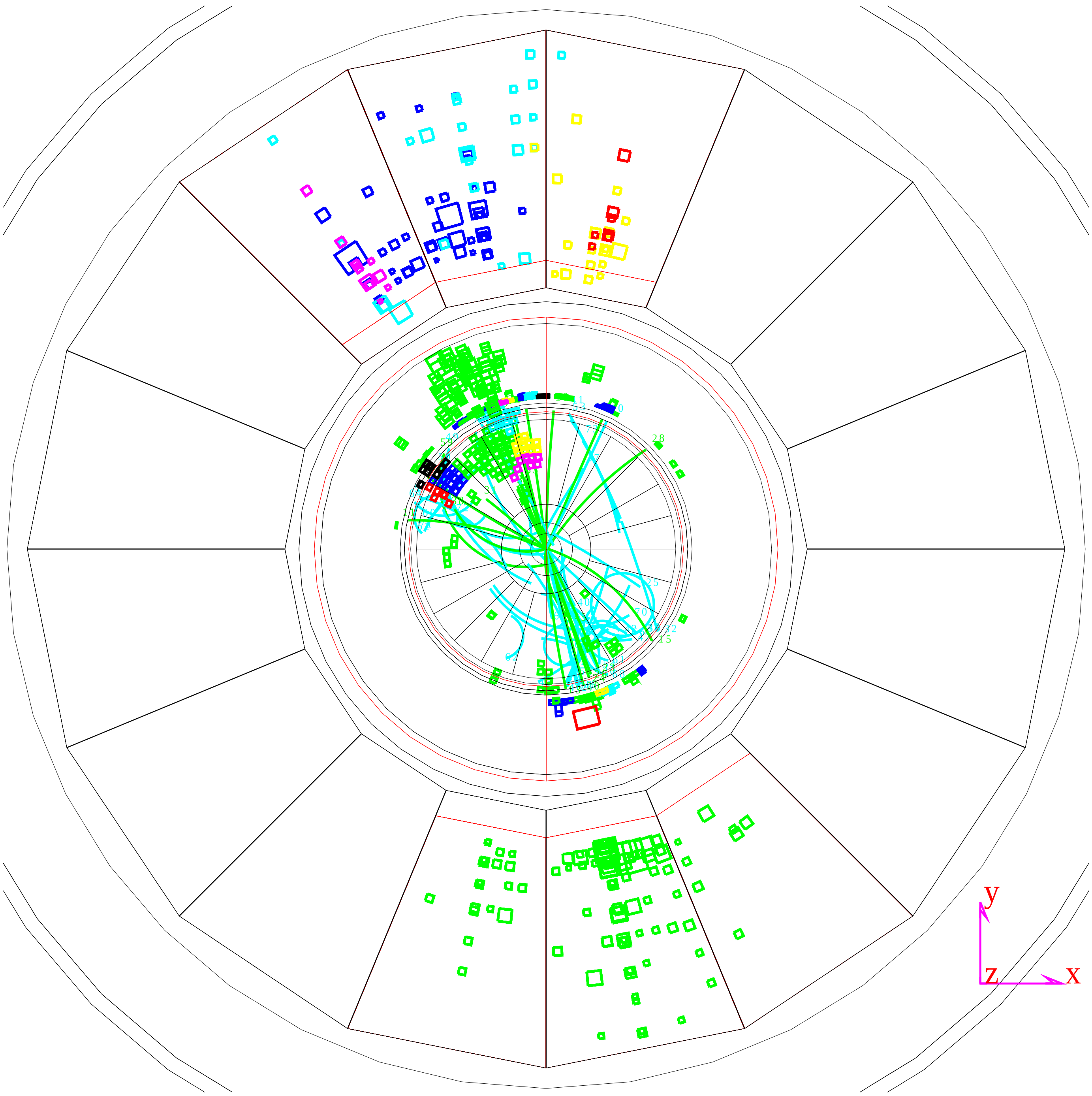






L3 $q\bar{q}$-event.

Run # 700701 Event # 2359 Total Energy : 211.50 GeV



Transverse Imbalance :	.0390	**Longitudinal Imbalance :**	-.0773
Thrust : .9121	**Major :** .2250	**Minor :** .0630	
Event DAQ Time :	*980627 204617*		

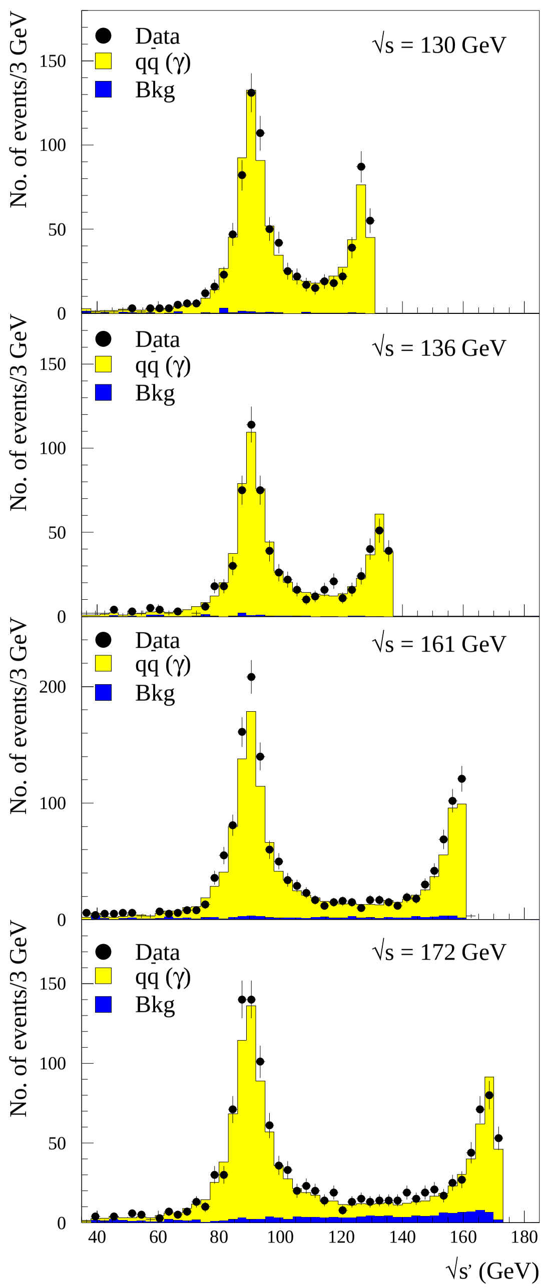
Effective center-of-mass energy $\sqrt{s'}$

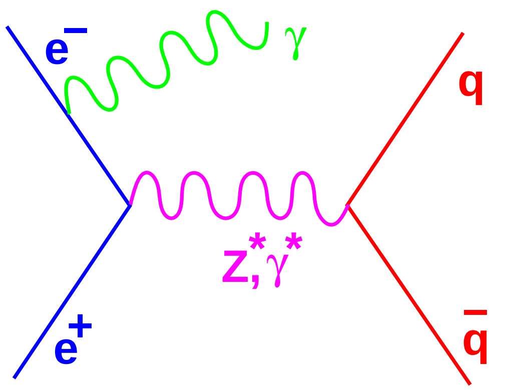
$$s' = s - 2E_\gamma\sqrt{s}$$

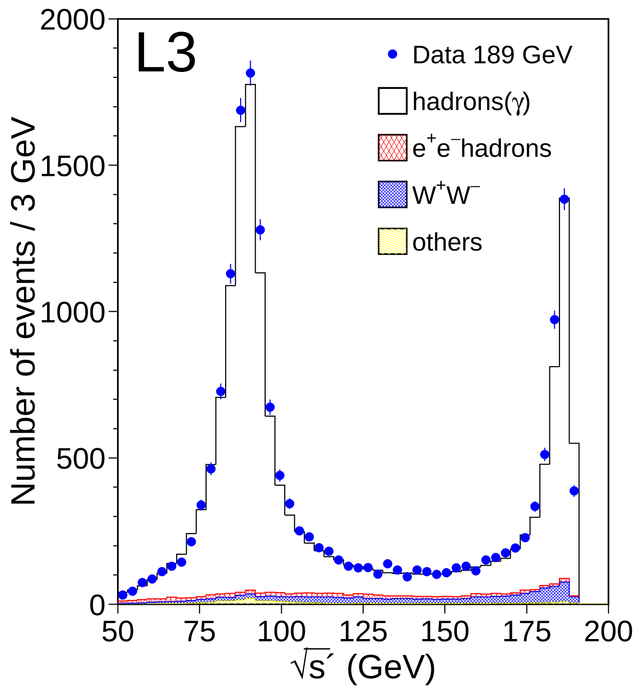
$$E_\gamma = \sqrt{s}\cdot\frac{|\sin(\theta_1+\theta_2)|}{\sin\theta_1+\sin\theta_2+|\sin(\theta_1+\theta_2)|}$$

$$\text{Cut}: \quad \sqrt{s'}/\sqrt{s} > 0.85$$

DELPHI



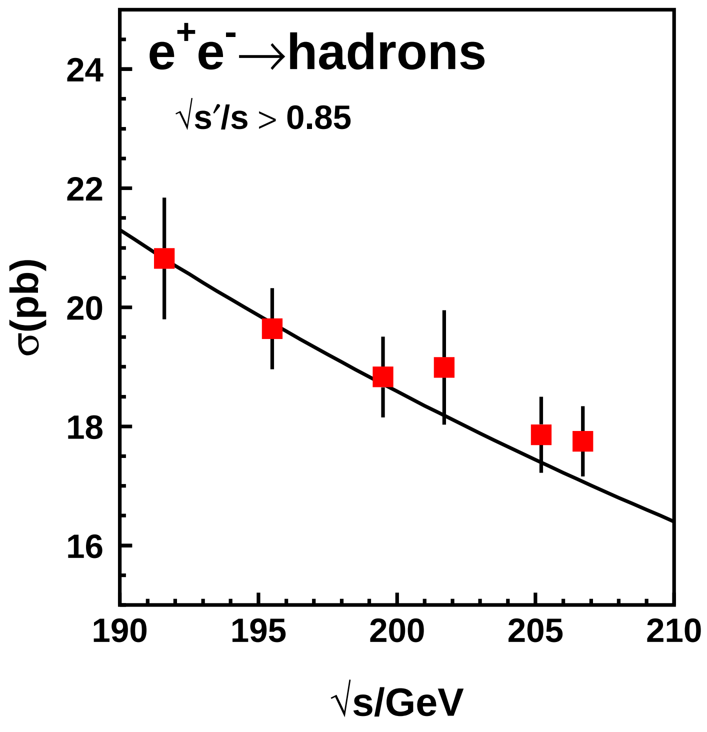


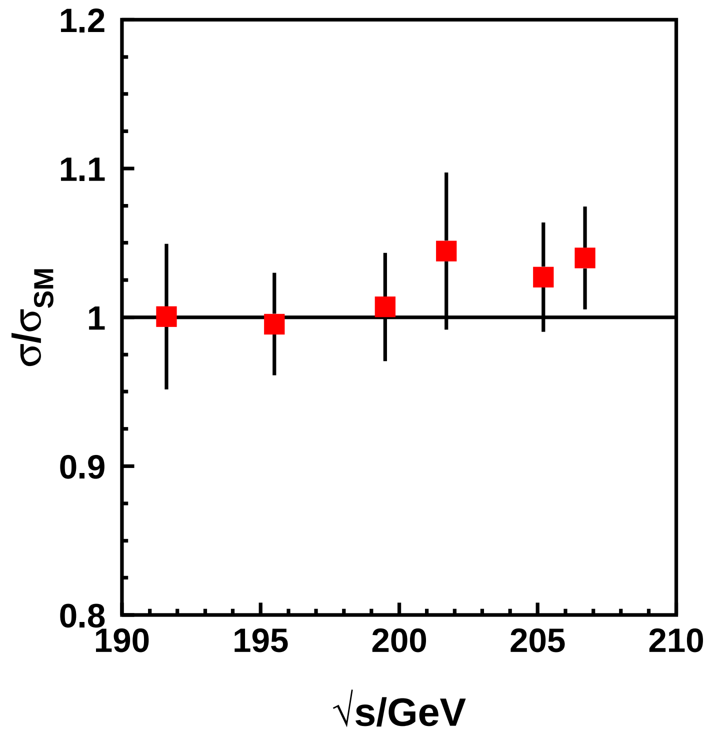


Hadron selection

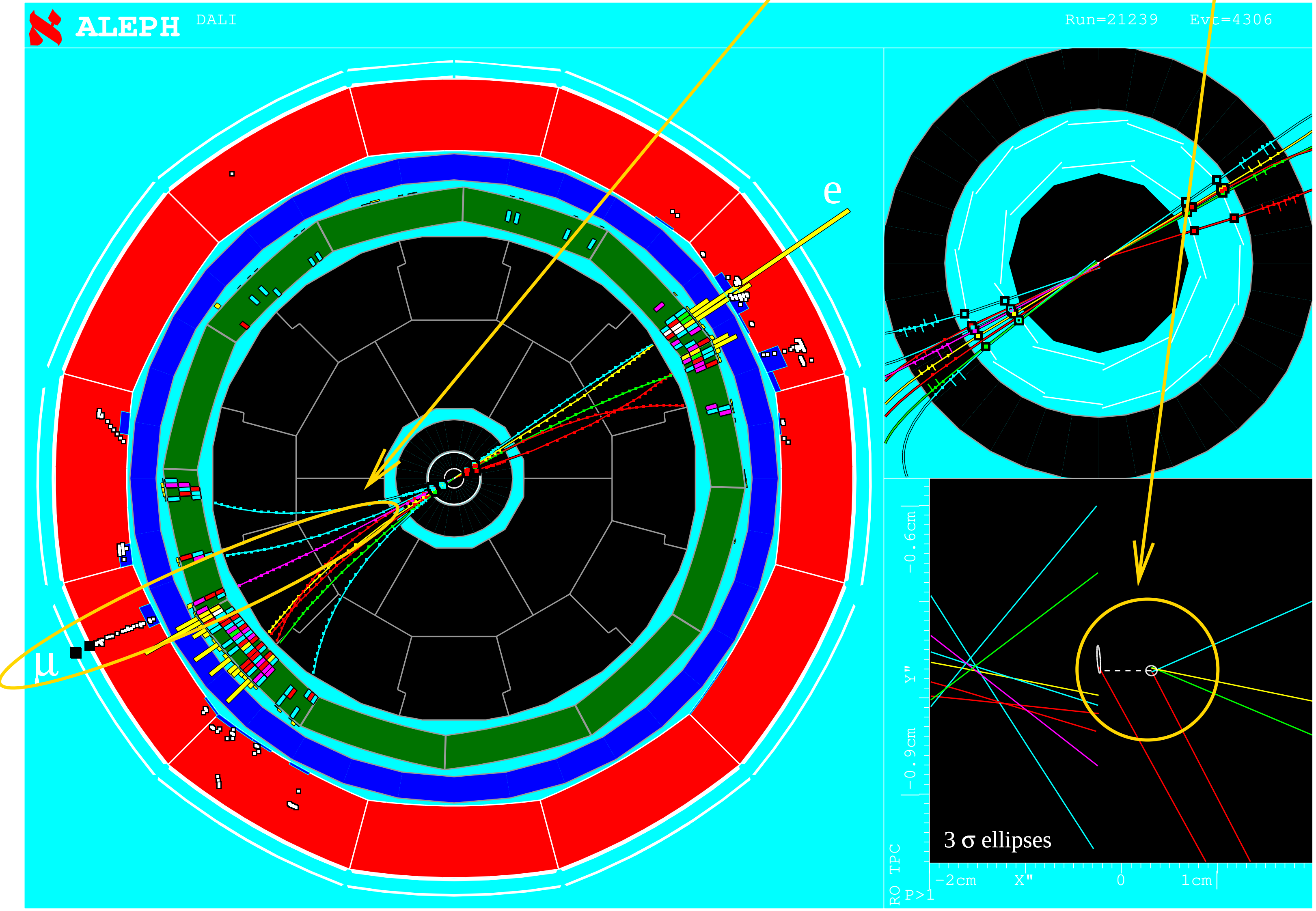
$\Downarrow$

L3 preliminary



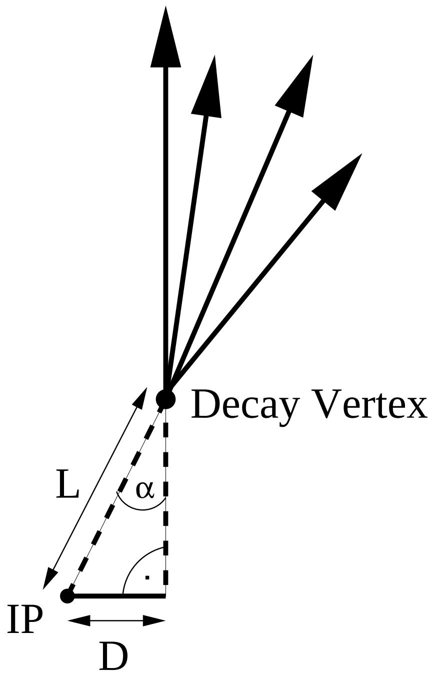


Identify b quarks with hard leptons and displaced vertices

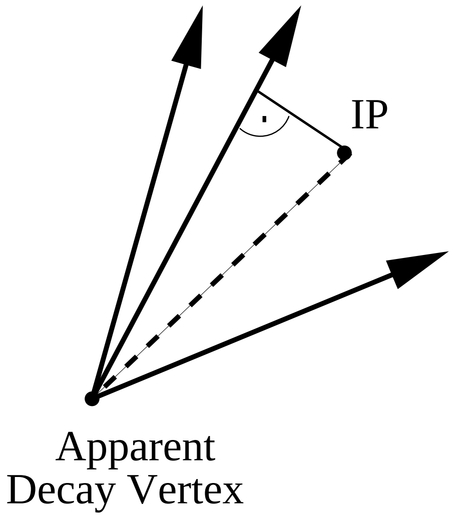


ALEPH B-tagged event

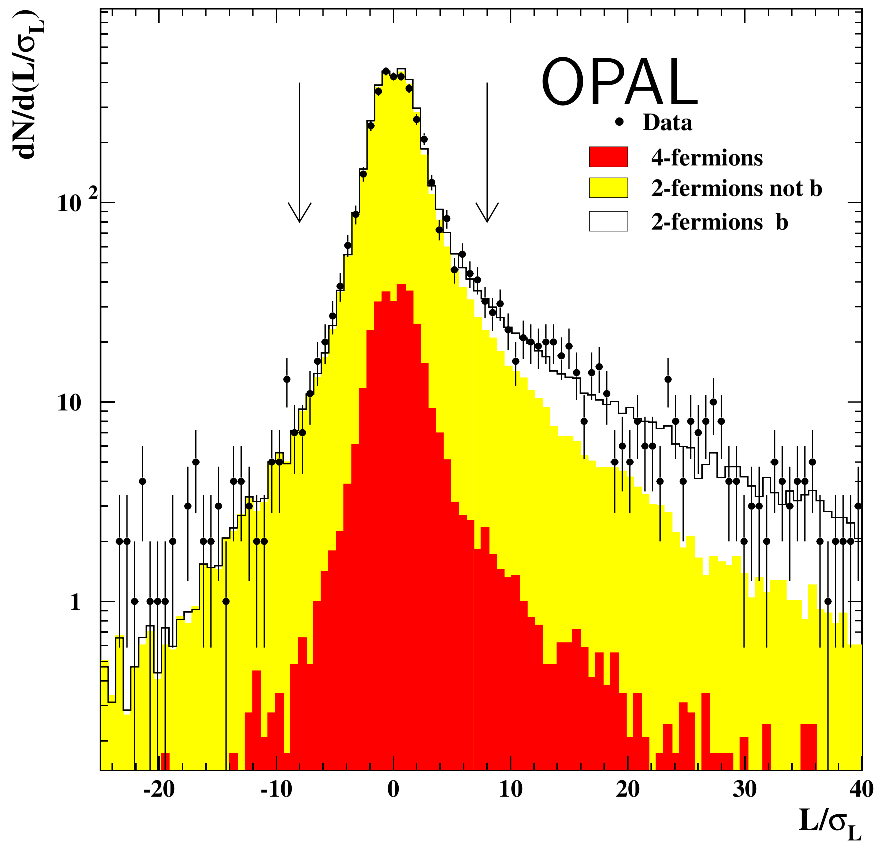
B-tagging



Decay Vertex
L
α
IP
D



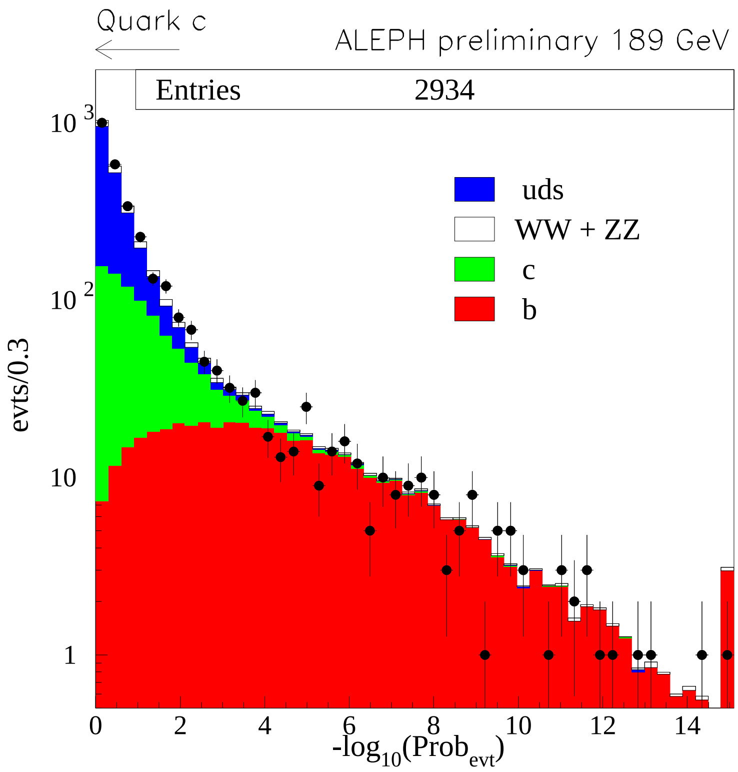
IP
Apparent
Decay Vertex

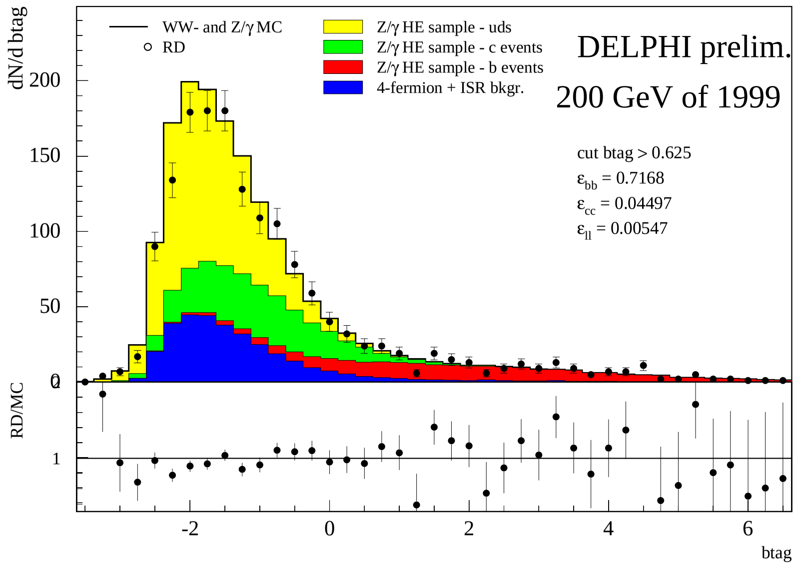


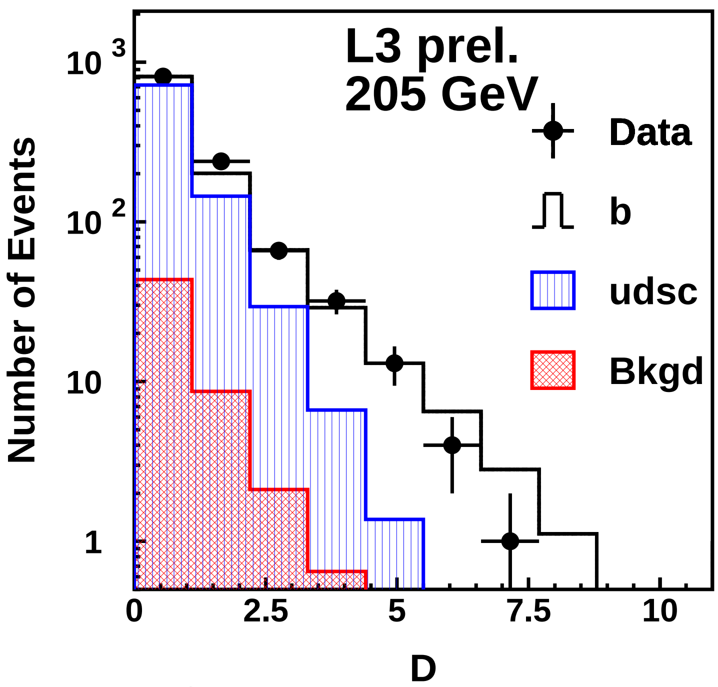
OPAL
Data
4-fermions
2-fermions not b
2-fermions b
dN/d(L/σ_L)
L/σ_L

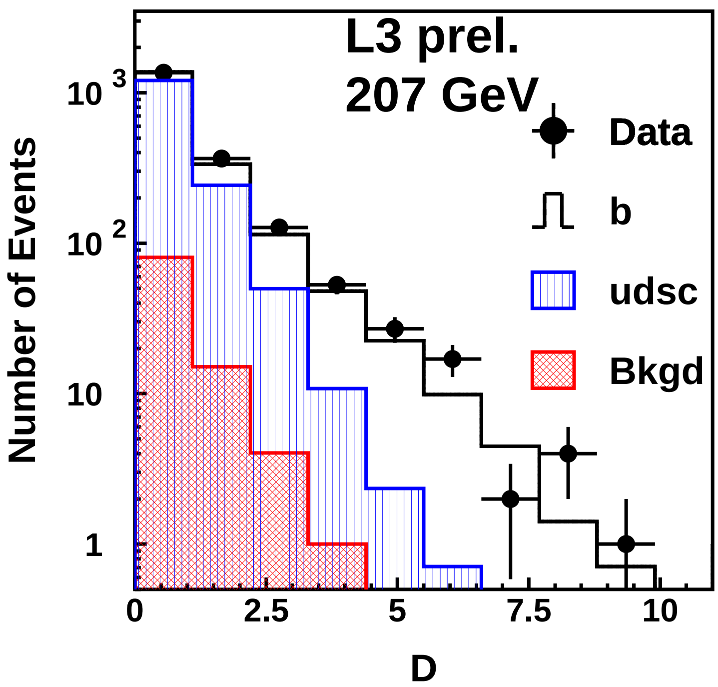
B-tagging

$D = -log_{10}(Prob_{evt})$ - discriminating variable



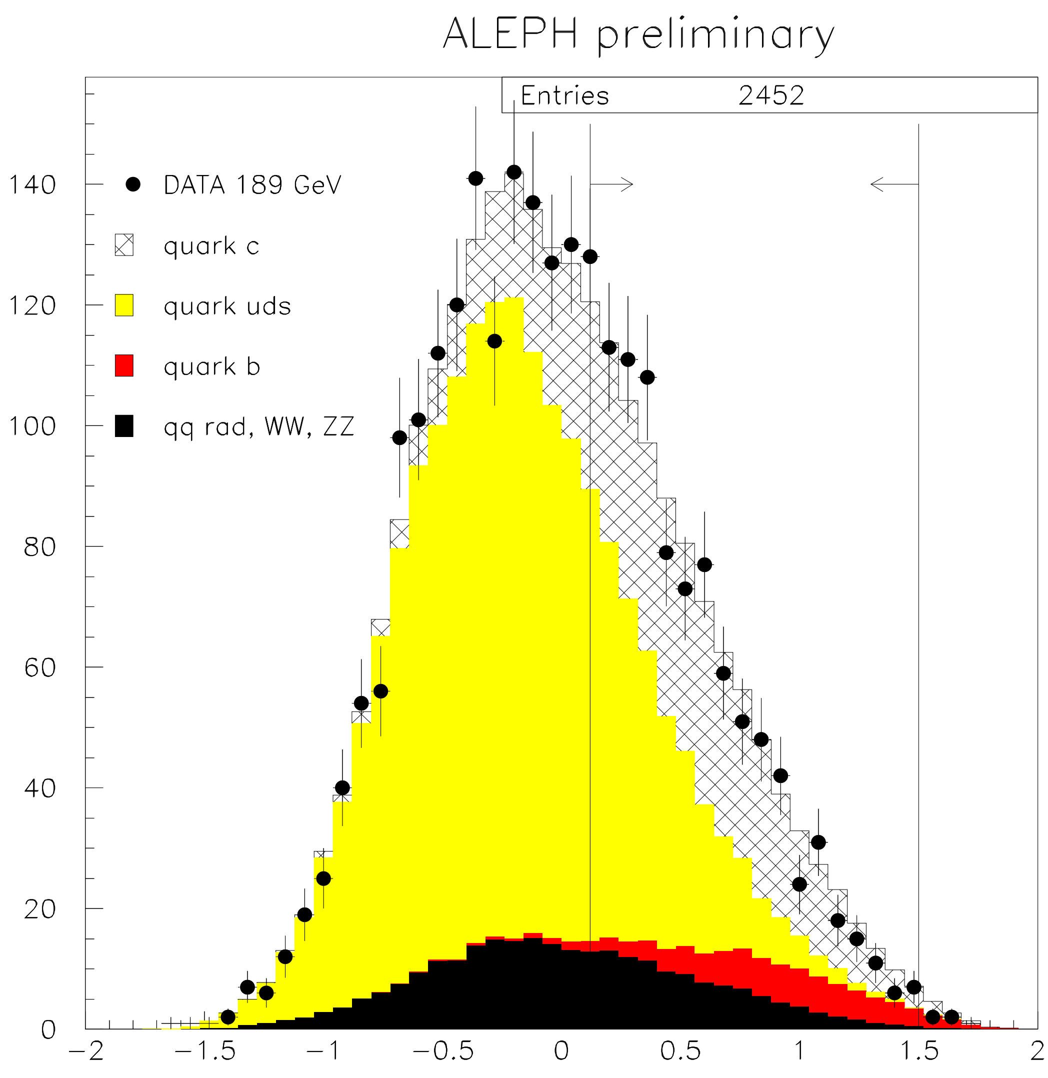




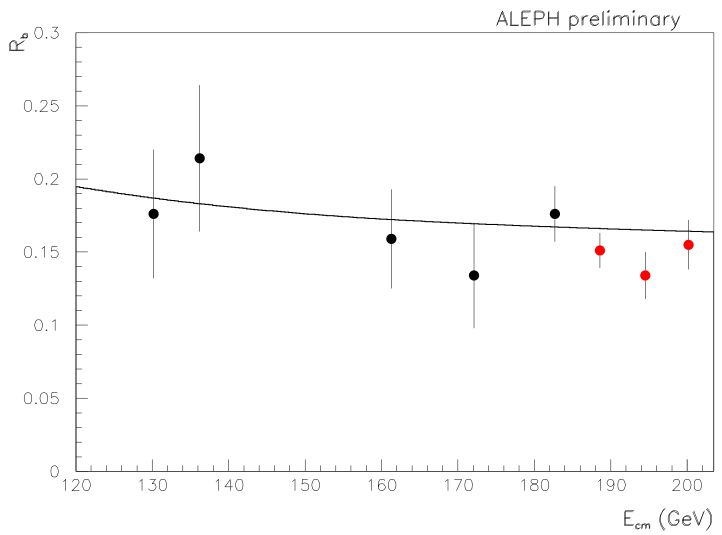


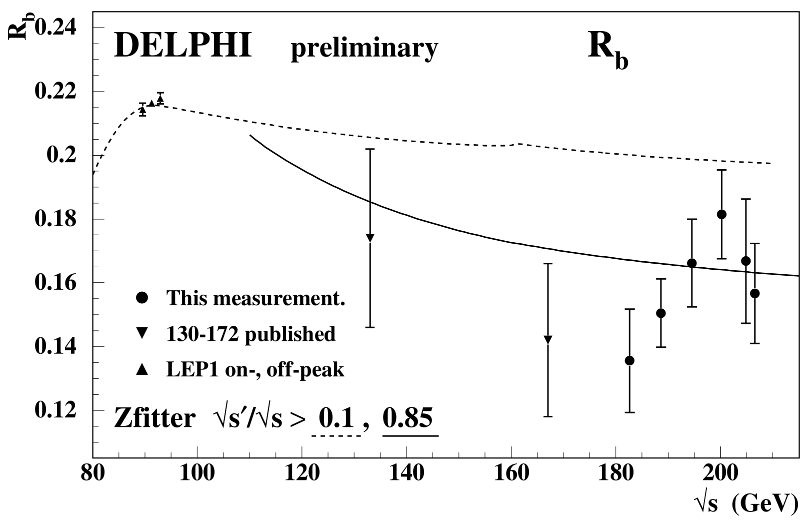
$c\bar{c}$ selection

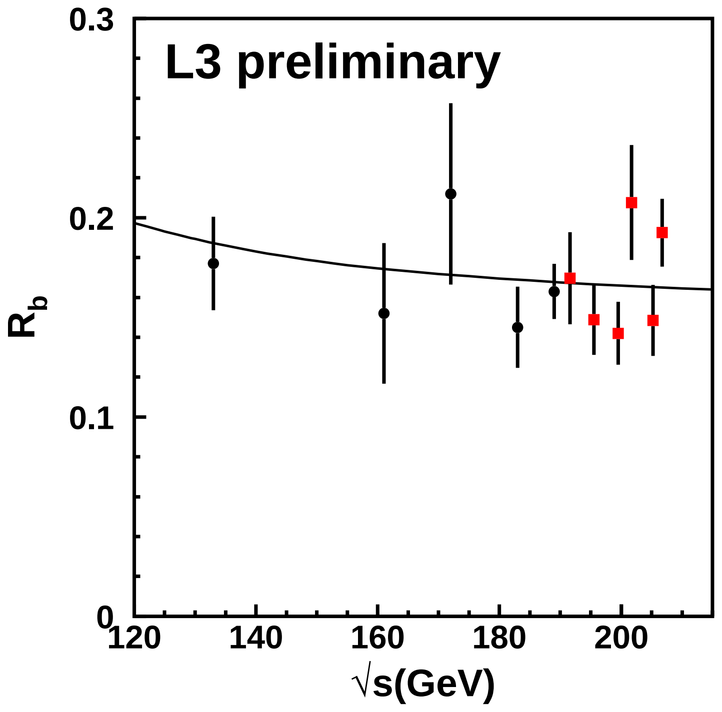
NN output summed over the 2 jets.

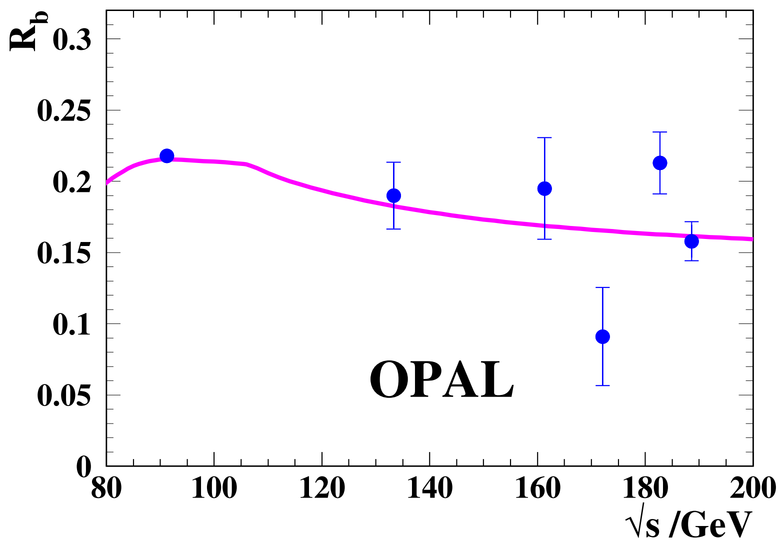


R_b measurements



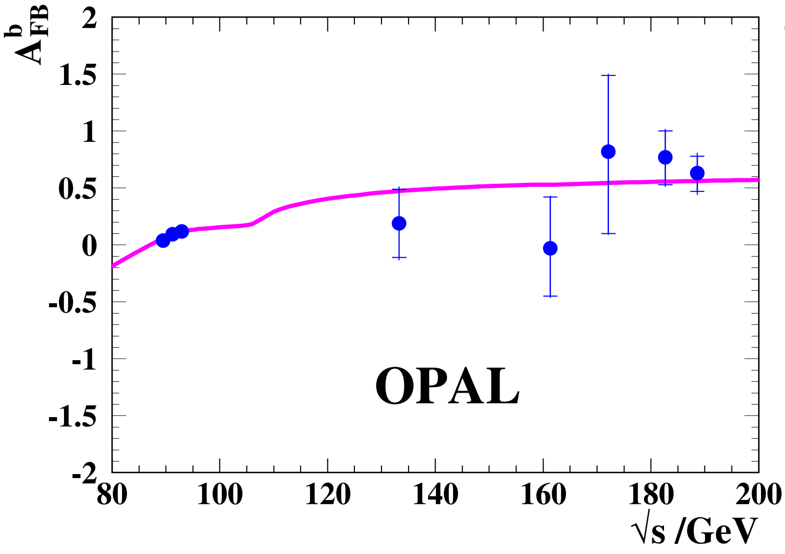


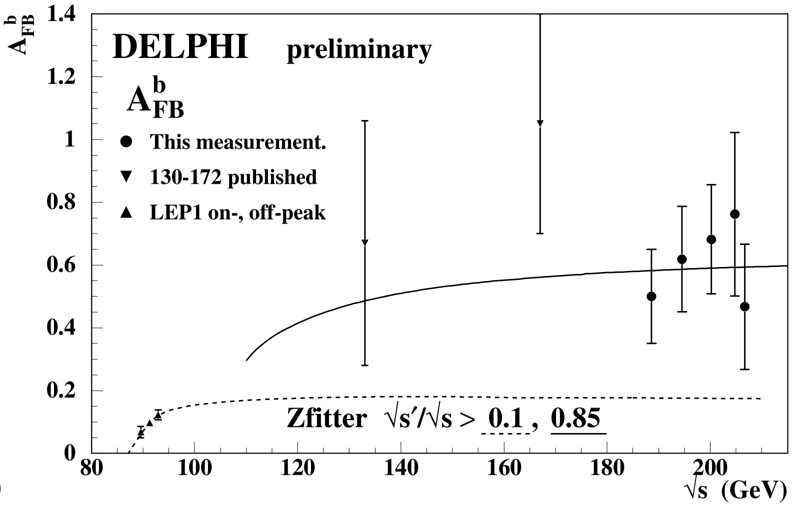


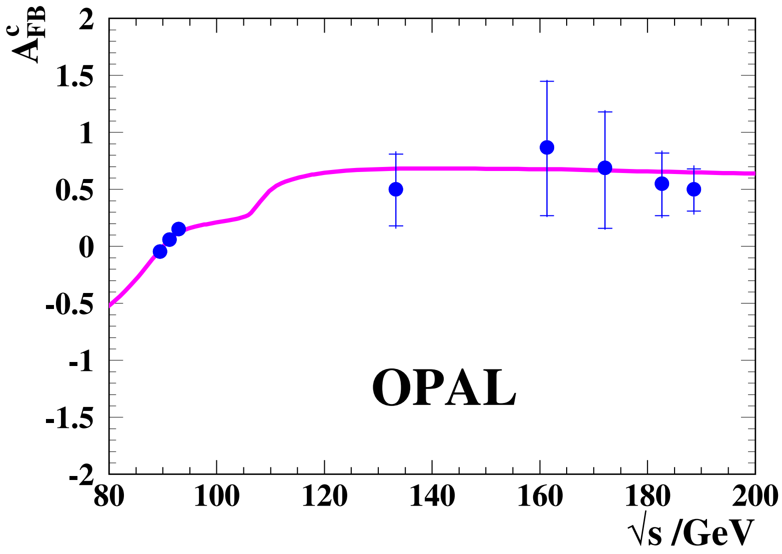


Asymmetries

To measure forward-backward asymmetries:
1) Jet charge.
2) Hemisphere charge.
3) Hard lepton charge.







Available measurements

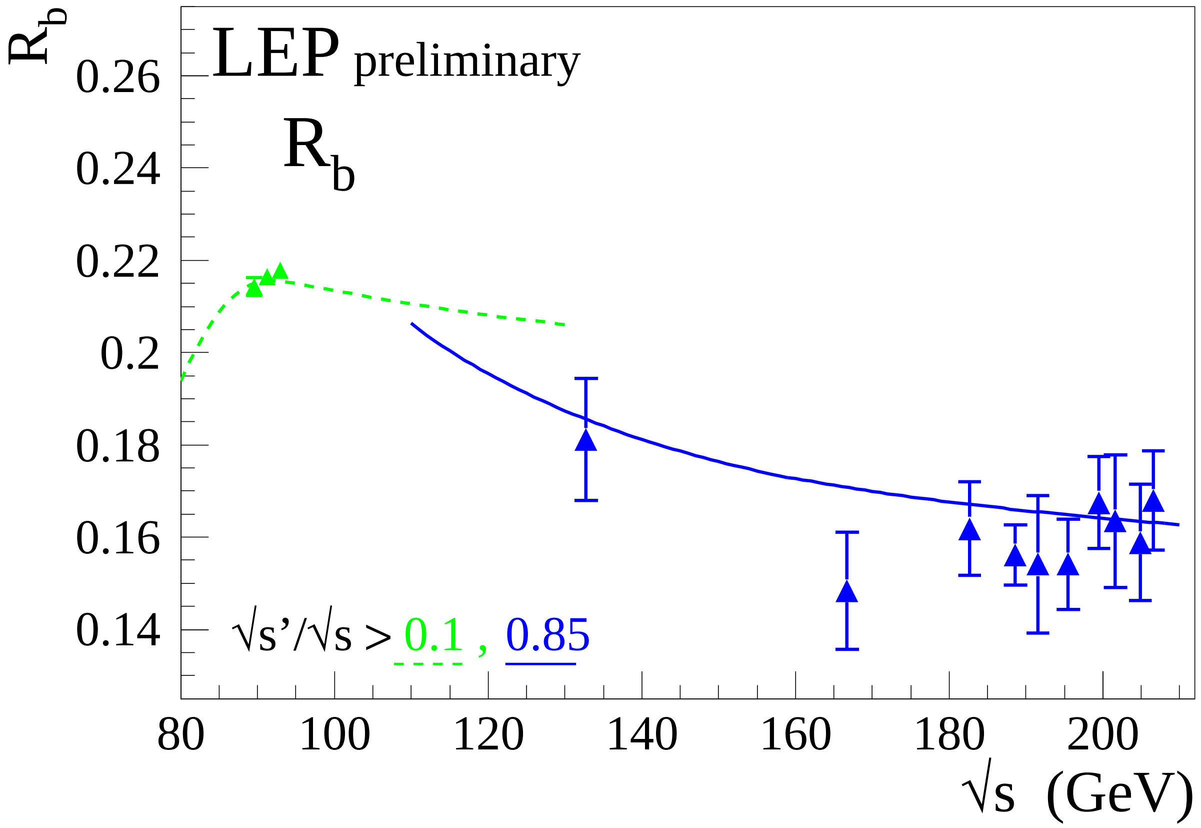
$\sqrt{s}$ (GeV)	R_b				R_c			
	A	D	L	O	A	D	L	O
133	F	F	F	F	-	-	-	-
167	F	F	F	F	-	-	-	-
183	F	P	F	F	F	-	-	-
189	P	P	F	F	P	-	-	-
192 to 202	P	P	P	-	-	-	-	-
205 and 207	-	P	P	-	-	-	-	-

$\sqrt{s}$ (GeV)	A_{fb}^{bb}				$A_{fb}^{c\bar{c}}$			
	A	D	L	O	A	D	L	O
133	-	F	-	F	-	F	-	F
167	-	F	-	F	-	F	-	F
183	F	-	-	F	P	-	-	F
189	P	P	F	F	P	-	-	F
192 to 202	P	P	-	-	-	-	-	-
205 and 207	-	P	-	-	-	-	-	-

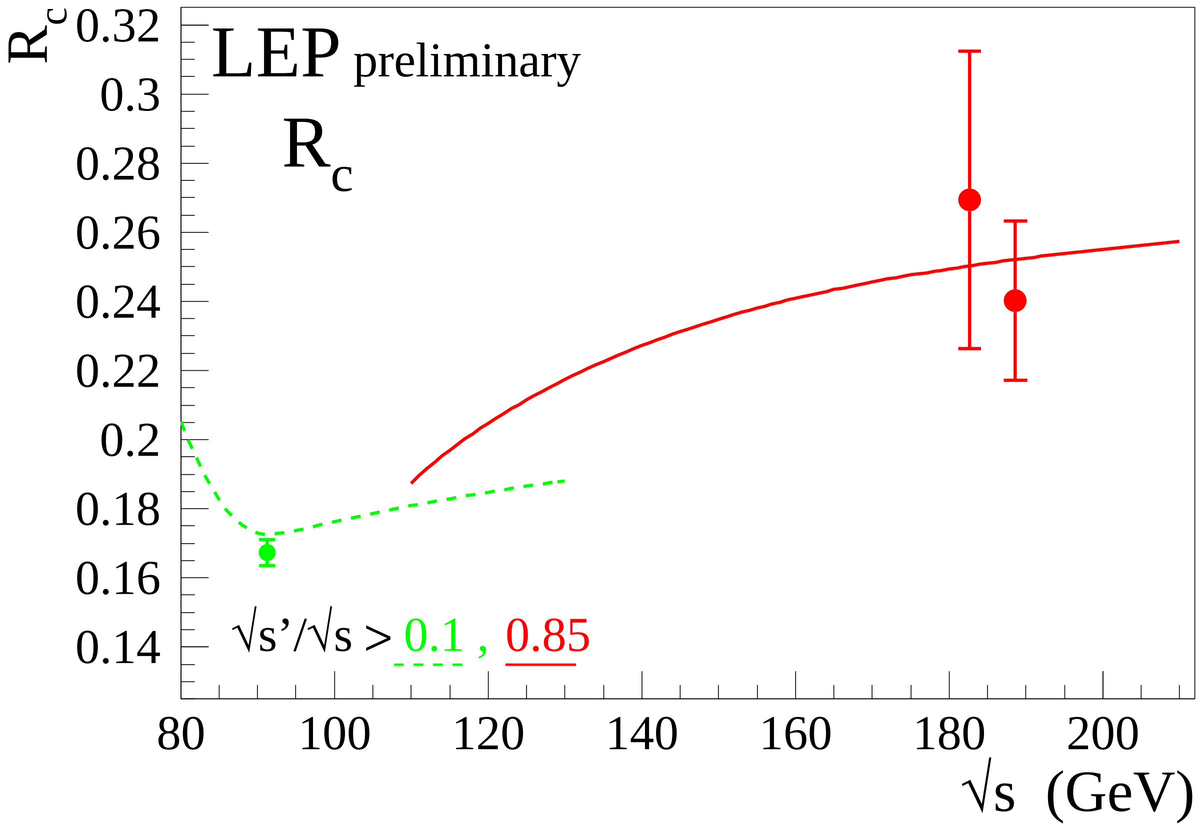
Combined LEP results

$\sqrt{s}$ (GeV)	R_b	R_c	$A_{fb}^{b\bar{b}}$	$A_{fb}^{c\bar{c}}$
133	0.1811 ± 0.0132 (0.1853)	- -	0.358 ± 0.251 (0.487)	0.577 ± 0.314 (0.681)
167	0.1484 ± 0.0127 (0.1708)	- -	0.620 ± 0.254 (0.561)	0.915 ± 0.344 (0.671)
183	0.1619 ± 0.0101 (0.1671)	0.269 ± 0.043 (0.250)	0.528 ± 0.155 (0.578)	0.658 ± 0.209 (0.656)
189	0.1562 ± 0.0065 (0.1660)	0.240 ± 0.023 (0.252)	0.488 ± 0.094 (0.583)	0.446 ± 0.151 (0.649)
192	0.1541 ± 0.0149 (0.1655)	- -	0.422 ± 0.267 (0.585)	- -
196	0.1542 ± 0.0098 (0.1648)	- -	0.531 ± 0.151 (0.587)	- -
200	0.1675 ± 0.0100 (0.1642)	- -	0.589 ± 0.150 (0.590)	- -
202	0.1635 ± 0.0143 (0.1638)	- -	0.604 ± 0.241 (0.593)	- -
205	0.1588 ± 0.0126 (0.1634)	- -	0.728 ± 0.258 (0.594)	- -
207	0.1680 ± 0.0108 (0.1632)	- -	0.447 ± 0.200 (0.593)	- -

R combined

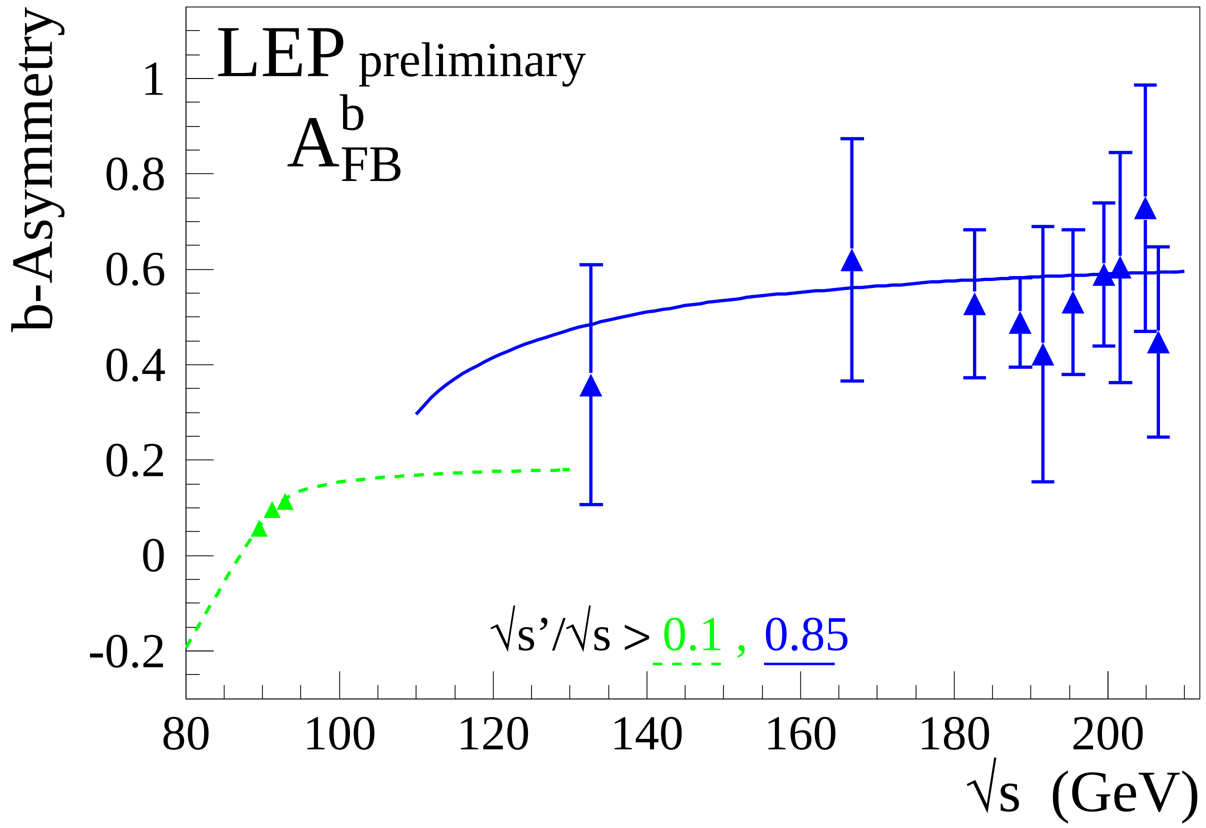


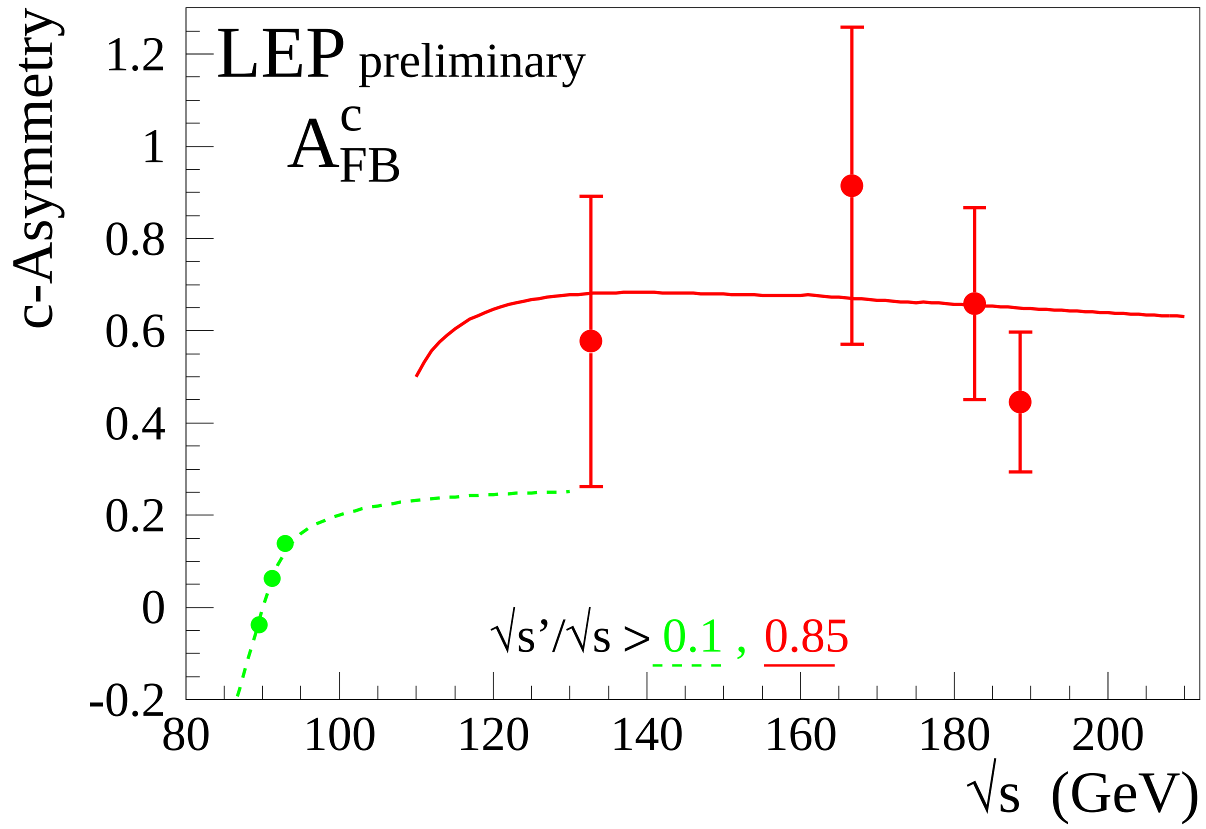
R_b
LEP preliminary
R_b
0.26
0.24
0.22
0.2
0.18
0.16
0.14
$\sqrt{s'}/\sqrt{s} > 0.1$, 0.85
80
100
120
140
160
180
200
$\sqrt{s}$ (GeV)



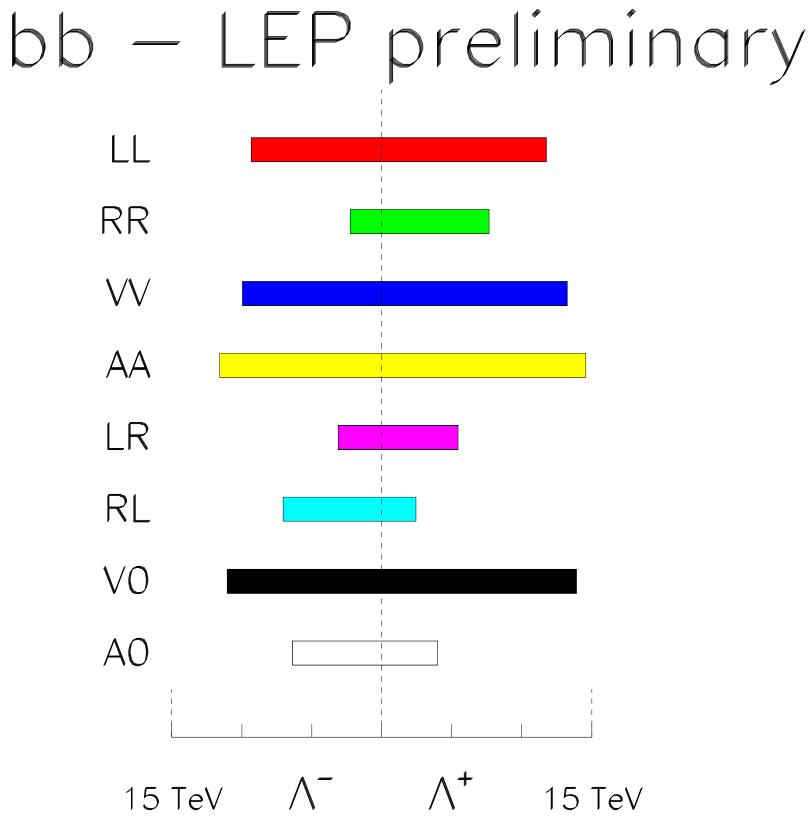
R_c
LEP preliminary
R_c
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
$\sqrt{s'}/\sqrt{s} > 0.1$, 0.85
80
100
120
140
160
180
200
$\sqrt{s}$ (GeV)

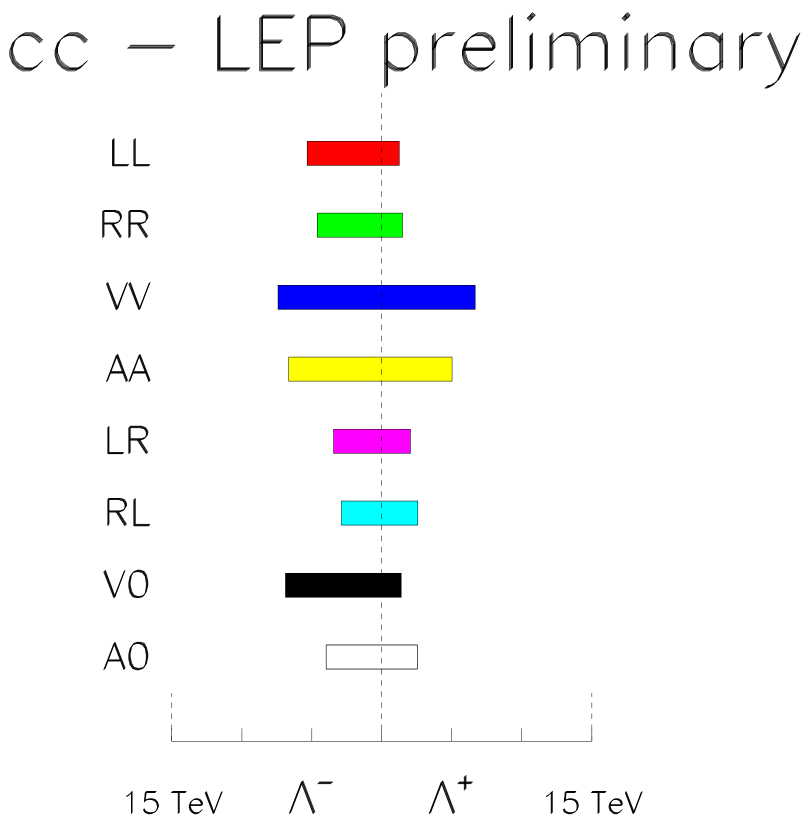
A_{fb} combined





Contact interactions for b and c quarks





Conclusions

- The results from the four LEP experiments are in good agreement with each other.
- A prelimanary combination of the LEPII $e^+e^- \longrightarrow b\bar{b},\ c\bar{c}$ results at energies from 130 to 207 GeV has been made.
- Data agree with the Standard Model predictions.
- Limits on the scale of contact interactions between electrons and $b\bar{b}$ and $c\bar{c}$ final states have been determined.
- New updates from the experiments are expected this summer.