

# $B^\pm / B^0 / B_s^0 / b$ -baryon ADMIXTURE

## $B^\pm / B^0 / B_s^0 / b$ -baryon ADMIXTURE MEAN LIFE

Each measurement of the  $B$  mean life is an average over an admixture of various bottom mesons and baryons which decay weakly. Different techniques emphasize different admixtures of produced particles, which could result in a different  $B$  mean life.

“OUR EVALUATION” is an average using rescaled values of the data listed below. The average and rescaling were performed by the Heavy Flavor Averaging Group (HFAG) and are described at <http://www.slac.stanford.edu/xorg/hfag/>. The averaging/rescaling procedure takes into account corrections between the measurements and asymmetric lifetime errors, but ignores the small differences due to different techniques.

VALUE ( $10^{-12}$ s)	EVTS	DOCUMENT ID	TECN	COMMENT
<b>1.564 ± 0.014 OUR EVALUATION</b>				
$1.533 \pm 0.015^{+0.035}_{-0.031}$		1 ABE	98B CDF	$p\bar{p}$ at 1.8 TeV
$1.549 \pm 0.009 \pm 0.015$		2 ACCIARRI	98 L3	$e^+e^- \rightarrow Z$
$1.611 \pm 0.010 \pm 0.027$		3 ACKERSTAFF	97F OPAL	$e^+e^- \rightarrow Z$
$1.582 \pm 0.011 \pm 0.027$		3 ABREU	96E DLPH	$e^+e^- \rightarrow Z$
$1.533 \pm 0.013 \pm 0.022$	19.8k	4 BUSKULIC	96F ALEP	$e^+e^- \rightarrow Z$
$1.564 \pm 0.030 \pm 0.036$		5 ABE,K	95B SLD	$e^+e^- \rightarrow Z$
$1.542 \pm 0.021 \pm 0.045$		6 ABREU	94L DLPH	$e^+e^- \rightarrow Z$
$1.523 \pm 0.034 \pm 0.038$	5372	7 ACTON	93L OPAL	$e^+e^- \rightarrow Z$
$1.511 \pm 0.022 \pm 0.078$		8 BUSKULIC	93O ALEP	$e^+e^- \rightarrow Z$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
$1.575 \pm 0.010 \pm 0.026$		9 ABREU	96E DLPH	$e^+e^- \rightarrow Z$
$1.50^{+0.24}_{-0.21} \pm 0.03$		10 ABREU	94P DLPH	$e^+e^- \rightarrow Z$
$1.46 \pm 0.06 \pm 0.06$	5344	11 ABE	93J CDF	Repl. by ABE 98B
$1.23^{+0.14}_{-0.13} \pm 0.15$	188	12 ABREU	93D DLPH	Sup. by ABREU 94L
$1.49 \pm 0.11 \pm 0.12$	253	13 ABREU	93G DLPH	Sup. by ABREU 94L
$1.51^{+0.16}_{-0.14} \pm 0.11$	130	14 ACTON	93C OPAL	$e^+e^- \rightarrow Z$
$1.535 \pm 0.035 \pm 0.028$	7357	7 ADRIANI	93K L3	Repl. by ACCIARRI 98
$1.28 \pm 0.10$		15 ABREU	92 DLPH	Sup. by ABREU 94L
$1.37 \pm 0.07 \pm 0.06$	1354	16 ACTON	92 OPAL	Sup. by ACTON 93L
$1.49 \pm 0.03 \pm 0.06$		17 BUSKULIC	92F ALEP	Sup. by BUSKULIC 96F
$1.35^{+0.19}_{-0.17} \pm 0.05$		18 BUSKULIC	92G ALEP	$e^+e^- \rightarrow Z$
$1.32 \pm 0.08 \pm 0.09$	1386	19 ADEVA	91H L3	Sup. by ADRIANI 93K
$1.32^{+0.31}_{-0.25} \pm 0.15$	37	20 ALEXANDER	91G OPAL	$e^+e^- \rightarrow Z$
$1.29 \pm 0.06 \pm 0.10$	2973	21 DECAMP	91C ALEP	Sup. by BUSKULIC 92F
$1.36^{+0.25}_{-0.23}$		22 HAGEMANN	90 JADE	$E_{cm}^{ee} = 35$ GeV

1.13 ±0.15		<sup>23</sup> LYONS	90	RVUE	
1.35 ±0.10 ±0.24		BRAUNSCH...	89B	TASS	$E_{cm}^{ee} = 35$ GeV
0.98 ±0.12 ±0.13		ONG	89	MRK2	$E_{cm}^{ee} = 29$ GeV
1.17 <sup>+0.27</sup> <sub>-0.22</sub> <sup>+0.17</sup> <sub>-0.16</sub>		KLEM	88	DLCO	$E_{cm}^{ee} = 29$ GeV
1.29 ±0.20 ±0.21		<sup>24</sup> ASH	87	MAC	$E_{cm}^{ee} = 29$ GeV
1.02 <sup>+0.42</sup> <sub>-0.39</sub>	301	<sup>25</sup> BROM	87	HRS	$E_{cm}^{ee} = 29$ GeV

<sup>1</sup> Measured using inclusive  $J/\psi(1S) \rightarrow \mu^+ \mu^-$  vertex.

<sup>2</sup> ACCIARRI 98 uses inclusively reconstructed secondary vertex and lepton impact parameter.

<sup>3</sup> ACKERSTAFF 97F uses inclusively reconstructed secondary vertices.

<sup>4</sup> BUSKULIC 96F analyzed using 3D impact parameter.

<sup>5</sup> ABE,K 95B uses an inclusive topological technique.

<sup>6</sup> ABREU 94L uses charged particle impact parameters. Their result from inclusively reconstructed secondary vertices is superseded by ABREU 96E.

<sup>7</sup> ACTON 93L and ADRIANI 93K analyzed using lepton ( $e$  and  $\mu$ ) impact parameter at  $Z$ .

<sup>8</sup> BUSKULIC 930 analyzed using dipole method.

<sup>9</sup> Combines ABREU 96E secondary vertex result with ABREU 94L impact parameter result.

<sup>10</sup> From proper time distribution of  $b \rightarrow J/\psi(1S)$  anything.

<sup>11</sup> ABE 93J analyzed using  $J/\psi(1S) \rightarrow \mu\mu$  vertices.

<sup>12</sup> ABREU 93D data analyzed using  $D/D^* \ell$  anything event vertices.

<sup>13</sup> ABREU 93G data analyzed using charged and neutral vertices.

<sup>14</sup> ACTON 93C analysed using  $D/D^* \ell$  anything event vertices.

<sup>15</sup> ABREU 92 is combined result of muon and hadron impact parameter analyses. Hadron tracks gave  $(12.7 \pm 0.4 \pm 1.2) \times 10^{-13}$  s for an admixture of  $B$  species weighted by production fraction and mean charge multiplicity, while muon tracks gave  $(13.0 \pm 1.0 \pm 0.8) \times 10^{-13}$  s for an admixture weighted by production fraction and semileptonic branching fraction.

<sup>16</sup> ACTON 92 is combined result of muon and electron impact parameter analyses.

<sup>17</sup> BUSKULIC 92F uses the lepton impact parameter distribution for data from the 1991 run.

<sup>18</sup> BUSKULIC 92G use  $J/\psi(1S)$  tags to measure the average  $b$  lifetime. This is comparable to other methods only if the  $J/\psi(1S)$  branching fractions of the different  $b$ -flavored hadrons are in the same ratio.

<sup>19</sup> Using  $Z \rightarrow e^+ X$  or  $\mu^+ X$ , ADEVA 91H determined the average lifetime for an admixture of  $B$  hadrons from the impact parameter distribution of the lepton.

<sup>20</sup> Using  $Z \rightarrow J/\psi(1S) X$ ,  $J/\psi(1S) \rightarrow \ell^+ \ell^-$ , ALEXANDER 91G determined the average lifetime for an admixture of  $B$  hadrons from the decay point of the  $J/\psi(1S)$ .

<sup>21</sup> Using  $Z \rightarrow e X$  or  $\mu X$ , DECAMP 91C determines the average lifetime for an admixture of  $B$  hadrons from the signed impact parameter distribution of the lepton.

<sup>22</sup> HAGEMANN 90 uses electrons and muons in an impact parameter analysis.

<sup>23</sup> LYONS 90 combine the results of the  $B$  lifetime measurements of ONG 89, BRAUNSCHWEIG 89B, KLEM 88, and ASH 87, and JADE data by private communication. They use statistical techniques which include variation of the error with the mean life, and possible correlations between the systematic errors. This result is not independent of the measured results used in our average.

<sup>24</sup> We have combined an overall scale error of 15% in quadrature with the systematic error of  $\pm 0.7$  to obtain  $\pm 2.1$  systematic error.

<sup>25</sup> Statistical and systematic errors were combined by BROM 87.

## CHARGED $b$ -HADRON ADMIXTURE MEAN LIFE

VALUE ( $10^{-12}$ s)	DOCUMENT ID	TECN	COMMENT
<b><math>1.72 \pm 0.08 \pm 0.06</math></b>	<sup>26</sup> ADAM	95	DLPH $e^+ e^- \rightarrow Z$
<sup>26</sup> ADAM 95 data analyzed using vertex-charge technique to tag $b$ -hadron charge.			

## NEUTRAL $b$ -HADRON ADMIXTURE MEAN LIFE

VALUE ( $10^{-12}$ s)	DOCUMENT ID	TECN	COMMENT
<b><math>1.58 \pm 0.11 \pm 0.09</math></b>	<sup>27</sup> ADAM	95	DLPH $e^+ e^- \rightarrow Z$
<sup>27</sup> ADAM 95 data analyzed using vertex-charge technique to tag $b$ -hadron charge.			

## MEAN LIFE RATIO $\tau_{\text{charged } b\text{-hadron}}/\tau_{\text{neutral } b\text{-hadron}}$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>1.09^{+0.11}_{-0.10} \pm 0.08</math></b>	<sup>28</sup> ADAM	95	DLPH $e^+ e^- \rightarrow Z$
<sup>28</sup> ADAM 95 data analyzed using vertex-charge technique to tag $b$ -hadron charge.			

$$|\Delta\tau_b|/\tau_{b,\bar{b}}$$

$\tau_{b,\bar{b}}$  and  $|\Delta\tau_b|$  are the mean life average and difference between  $b$  and  $\bar{b}$  hadrons.

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>-0.001 \pm 0.012 \pm 0.008</math></b>	<sup>29</sup> ABBIENDI	99J	OPAL $e^+ e^- \rightarrow Z$
<sup>29</sup> Data analyzed using both the jet charge and the charge of secondary vertex in the opposite hemisphere.			

## $\bar{b}$ PRODUCTION FRACTIONS AND DECAY MODES

The branching fraction measurements are for an admixture of  $B$  mesons and baryons at energies above the  $\Upsilon(4S)$ . Only the highest energy results (LEP, Tevatron,  $Sp\bar{p}S$ ) are used in the branching fraction averages. In the following, we assume that the production fractions are the same at the LEP and at the Tevatron.

For inclusive branching fractions, *e.g.*,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

The modes below are listed for a  $\bar{b}$  initial state.  $b$  modes are their charge conjugates. Reactions indicate the weak decay vertex and do not include mixing.

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level
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## PRODUCTION FRACTIONS

The production fractions for weakly decaying  $b$ -hadrons at high energy have been calculated from the best values of mean lives, mixing parameters, and branching fractions in this edition by the Heavy Flavor Averaging Group (HFAG) as described in the note “ $B^0$ - $\bar{B}^0$  Mixing” in the  $B^0$  Particle Listings. Values assume

$$\begin{aligned} B(\bar{b} \rightarrow B^+) &= B(\bar{b} \rightarrow B^0) \\ B(\bar{b} \rightarrow B^+) + B(\bar{b} \rightarrow B^0) + B(\bar{b} \rightarrow B_s^0) + B(b \rightarrow b\text{-baryon}) &= 100 \%. \end{aligned}$$

The notation for production fractions varies in the literature ( $f_d$ ,  $d_{B^0}$ ,  $f(b \rightarrow \bar{B}^0)$ ,  $\text{Br}(b \rightarrow \bar{B}^0)$ ). We use our own branching fraction notation here,  $B(\bar{b} \rightarrow B^0)$ .

$\Gamma_1$	$B^+$	( 39.7 $\pm$ 1.0 ) %
$\Gamma_2$	$B^0$	( 39.7 $\pm$ 1.0 ) %
$\Gamma_3$	$B_s^0$	( 10.7 $\pm$ 1.1 ) %
$\Gamma_4$	$b$ -baryon	( 9.9 $\pm$ 1.7 ) %
$\Gamma_5$	$B_c$	—

## DECAY MODES

### Semileptonic and leptonic modes

$\Gamma_6$	$\nu$ anything	( 23.1 $\pm$ 1.5 ) %	
$\Gamma_7$	$\ell^+ \nu_\ell$ anything	[a] ( 10.68 $\pm$ 0.22 ) %	
$\Gamma_8$	$e^+ \nu_e$ anything	( 10.86 $\pm$ 0.35 ) %	
$\Gamma_9$	$\mu^+ \nu_\mu$ anything	( 10.95 $^{+0.29}_{-0.25}$ ) %	
$\Gamma_{10}$	$D^- \ell^+ \nu_\ell$ anything	[a] ( 2.3 $\pm$ 0.4 ) %	S=1.7
$\Gamma_{11}$	$D^- \pi^+ \ell^+ \nu_\ell$ anything	( 4.9 $\pm$ 1.9 ) $\times 10^{-3}$	
$\Gamma_{12}$	$D^- \pi^- \ell^+ \nu_\ell$ anything	( 2.6 $\pm$ 1.6 ) $\times 10^{-3}$	
$\Gamma_{13}$	$\bar{D}^0 \ell^+ \nu_\ell$ anything	[a] ( 6.90 $\pm$ 0.35 ) %	
$\Gamma_{14}$	$\bar{D}^0 \pi^- \ell^+ \nu_\ell$ anything	( 1.07 $\pm$ 0.27 ) %	
$\Gamma_{15}$	$\bar{D}^0 \pi^+ \ell^+ \nu_\ell$ anything	( 2.3 $\pm$ 1.6 ) $\times 10^{-3}$	
$\Gamma_{16}$	$D^{*-} \ell^+ \nu_\ell$ anything	[a] ( 2.75 $\pm$ 0.19 ) %	
$\Gamma_{17}$	$D^{*-} \pi^+ \ell^+ \nu_\ell$ anything	( 4.8 $\pm$ 1.0 ) $\times 10^{-3}$	
$\Gamma_{18}$	$D^{*-} \pi^- \ell^+ \nu_\ell$ anything	( 6 $\pm$ 7 ) $\times 10^{-4}$	
$\Gamma_{19}$	$\bar{D}_j^0 \ell^+ \nu_\ell$ anything	[a,b]	
$\Gamma_{20}$	$D_j^- \ell^+ \nu_\ell$ anything	[a,b] seen	
$\Gamma_{21}$	$\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell$ anything		
$\Gamma_{22}$	$D_2^*(2460)^- \ell^+ \nu_\ell$ anything	seen	
$\Gamma_{23}$	charmless $\ell \bar{\nu}_\ell$	[a] ( 1.7 $\pm$ 0.5 ) $\times 10^{-3}$	
$\Gamma_{24}$	$\tau^+ \nu_\tau$ anything	( 2.48 $\pm$ 0.26 ) %	
$\Gamma_{25}$	$D^{*-} \tau \nu_\tau$ anything	( 9 $\pm$ 4 ) $\times 10^{-3}$	
$\Gamma_{26}$	$\bar{c} \rightarrow \ell^- \bar{\nu}_\ell$ anything	[a] ( 8.0 $\pm$ 0.4 ) %	
$\Gamma_{27}$	$c \rightarrow \ell^+ \nu$ anything	( 1.6 $^{+0.4}_{-0.5}$ ) %	

### Charmed meson and baryon modes

$\Gamma_{28}$	$\bar{D}^0$ anything	( 61.0 $\pm$ 3.2 ) %	
$\Gamma_{29}$	$D^0 D_s^\pm$ anything	[c] ( 9.1 $\pm$ 3.9 $\pm$ 2.8 ) %	
$\Gamma_{30}$	$D^\mp D_s^\pm$ anything	[c] ( 4.0 $\pm$ 2.3 $\pm$ 1.8 ) %	
$\Gamma_{31}$	$\bar{D}^0 D^0$ anything	[c] ( 5.1 $\pm$ 2.0 $\pm$ 1.8 ) %	
$\Gamma_{32}$	$D^0 D^\pm$ anything	[c] ( 2.7 $\pm$ 1.8 $\pm$ 1.6 ) %	
$\Gamma_{33}$	$D^\pm D^\mp$ anything	[c] < 9 $\times 10^{-3}$	CL=90%
$\Gamma_{34}$	$D^0$ anything		
$\Gamma_{35}$	$D^+$ anything		
$\Gamma_{36}$	$D^-$ anything	( 23.1 $\pm$ 2.2 ) %	
$\Gamma_{37}$	$D^*(2010)^+$ anything	( 17.3 $\pm$ 2.0 ) %	
$\Gamma_{38}$	$D_1(2420)^0$ anything	( 5.0 $\pm$ 1.5 ) %	
$\Gamma_{39}$	$D^*(2010)^\mp D_s^\pm$ anything	[c] ( 3.3 $\pm$ 1.6 $\pm$ 1.3 ) %	
$\Gamma_{40}$	$D^0 D^*(2010)^\pm$ anything	[c] ( 3.0 $\pm$ 1.1 $\pm$ 0.9 ) %	
$\Gamma_{41}$	$D^*(2010)^\pm D^\mp$ anything	[c] ( 2.5 $\pm$ 1.2 $\pm$ 1.0 ) %	
$\Gamma_{42}$	$D^*(2010)^\pm D^*(2010)^\mp$ anything	[c] ( 1.2 $\pm$ 0.4 ) %	
$\Gamma_{43}$	$D_2^*(2460)^0$ anything	( 4.7 $\pm$ 2.7 ) %	
$\Gamma_{44}$	$D_s^-$ anything	( 18 $\pm$ 5 ) %	
$\Gamma_{45}$	$D_s^+$ anything	( 10.1 $\pm$ 3.1 ) %	
$\Gamma_{46}$	$\Lambda_c^+$ anything	( 9.7 $\pm$ 2.9 ) %	
$\Gamma_{47}$	$\bar{c}/c$ anything	[d] (116.6 $\pm$ 3.3 ) %	

### Charmonium modes

$\Gamma_{48}$	$J/\psi(1S)$ anything	( 1.16 $\pm$ 0.10 ) %	
$\Gamma_{49}$	$\psi(2S)$ anything	( 4.8 $\pm$ 2.4 ) $\times 10^{-3}$	
$\Gamma_{50}$	$\chi_{c1}(1P)$ anything	( 1.5 $\pm$ 0.5 ) %	

### K or K\* modes

$\Gamma_{51}$	$\bar{s}\gamma$	( 3.1 $\pm$ 1.1 ) $\times 10^{-4}$	
$\Gamma_{52}$	$\bar{s}\bar{\nu}\nu$	< 6.4 $\times 10^{-4}$	CL=90%
$\Gamma_{53}$	$K^\pm$ anything	( 74 $\pm$ 6 ) %	
$\Gamma_{54}$	$K_S^0$ anything	( 29.0 $\pm$ 2.9 ) %	

### Pion modes

$\Gamma_{55}$	$\pi^\pm$ anything	(397 $\pm$ 21 ) %	
$\Gamma_{56}$	$\pi^0$ anything	[d] (278 $\pm$ 60 ) %	
$\Gamma_{57}$	$\phi$ anything	( 2.82 $\pm$ 0.23 ) %	

### Baryon modes

$\Gamma_{58}$	$p/\bar{p}$ anything	( 13.1 $\pm$ 1.1 ) %	
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**Other modes**

$\Gamma_{59}$	charged anything	[d]	$(497 \pm 7) \%$
$\Gamma_{60}$	hadron <sup>+</sup> hadron <sup>-</sup>		$(1.7 \pm_{-0.7}^{+1.0}) \times 10^{-5}$
$\Gamma_{61}$	charmless		$(7 \pm 21) \times 10^{-3}$

**Baryon modes**

$\Gamma_{62}$	$\Lambda/\bar{\Lambda}$ anything		$(5.9 \pm 0.6) \%$
$\Gamma_{63}$	<i>b</i> -baryon anything		$(10.2 \pm 2.8) \%$

**$\Delta B = 1$  weak neutral current (*B1*) modes**

$\Gamma_{64}$	$e^+e^-$ anything				
$\Gamma_{65}$	$\mu^+\mu^-$ anything	<i>B1</i>	$< 3.2$	$\times 10^{-4}$	CL=90%
$\Gamma_{66}$	$\nu\bar{\nu}$ anything				

- [a] An  $\ell$  indicates an  $e$  or a  $\mu$  mode, not a sum over these modes.
- [b]  $D_j$  represents an unresolved mixture of pseudoscalar and tensor  $D^{**}$  ( $P$ -wave) states.
- [c] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [d] Inclusive branching fractions have a multiplicity definition and can be greater than 100%.

**$B^\pm/B^0/B_s^0/b$ -baryon ADMIXTURE BRANCHING RATIOS**

**$\Gamma(B^+)/\Gamma_{\text{total}}$**   **$\Gamma_1/\Gamma$**   
 "OUR EVALUATION" is an average using rescaled values of the data listed below and from the best values of mean lives, mixing parameters, and branching fractions in this edition by the Heavy Flavor Averaging Group (AFAG) as described at <http://www.slac.stanford.edu/xorg/hfag/>.

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.397 ± 0.010 OUR EVALUATION</b>			
<b>0.4099 ± 0.0082 ± 0.0111</b>	<sup>30</sup> ABDALLAH	03K DLPH	$e^+e^- \rightarrow Z$

<sup>30</sup> The analysis is based on a neural network, to estimate the charge of the weakly-decaying *b* hadron by distinguishing its decay products from particles produced at the primary vertex.

<b><math>\Gamma(B_s^0)/[\Gamma(B^+) + \Gamma(B^0)]</math></b>	<b><math>\Gamma_3/(\Gamma_1 + \Gamma_2)</math></b>		
VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.21 ± 0.04 OUR AVERAGE</b>			
0.213 ± 0.068	<sup>31</sup> AFFOLDER	00E CDF	$p\bar{p}$ at 1.8 TeV
0.21 ± 0.036 $^{+0.038}_{-0.030}$	<sup>32</sup> ABE	99P CDF	$\bar{p}p$ at 1.8 TeV

<sup>31</sup> AFFOLDER 00E uses several electron-charm final states in  $b \rightarrow ce^-X$ .  
<sup>32</sup> ABE 99P uses the numbers of  $K^*(892)^0$ ,  $K^*(892)^+$ , and  $\phi(1020)$  events produced in association with the double semileptonic decays  $b \rightarrow c\mu^-X$  with  $c \rightarrow s\mu^+X$ .

$\Gamma(b\text{-baryon})/[\Gamma(B^+) + \Gamma(B^0)]$   $\Gamma_4/(\Gamma_1+\Gamma_2)$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.118±0.042</b>	<sup>33</sup> AFFOLDER	00E CDF	$p\bar{p}$ at 1.8 TeV

<sup>33</sup> AFFOLDER 00E uses several electron-charm final states in  $b \rightarrow c e^- X$ .

$\Gamma(\nu\text{ anything})/\Gamma_{\text{total}}$   $\Gamma_6/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.2308±0.0077±0.0124</b>	<sup>34,35</sup> ACCIARRI	96C L3	$e^+ e^- \rightarrow Z$

<sup>34</sup> ACCIARRI 96C assumes relative  $b$  semileptonic decay rates  $e:\mu:\tau$  of 1:1:0.25. Based on missing-energy spectrum.

<sup>35</sup> Assumes Standard Model value for  $R_B$ .

$\Gamma(\ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_7/\Gamma$

“OUR EVALUATION” is an average of the data listed below performed by the LEP Electroweak Working Group as described in the “Note on the Z boson” in the Z Particle Listings.

VALUE	DOCUMENT ID	TECN	COMMENT
<b>0.1068±0.0022 OUR EVALUATION</b>			
<b>0.1064±0.0016 OUR AVERAGE</b>			

0.1070±0.0010±0.0035	<sup>36</sup> HEISTER	02G ALEP	$e^+ e^- \rightarrow Z$
0.1070±0.0008 <sup>+0.0037</sup> <sub>-0.0049</sub>	<sup>37</sup> ABREU	01L DLPH	$e^+ e^- \rightarrow Z$
0.1083±0.0010 <sup>+0.0028</sup> <sub>-0.0024</sub>	<sup>38</sup> ABBIENDI	00E OPAL	$e^+ e^- \rightarrow Z$
0.1016±0.0013±0.0030	<sup>39</sup> ACCIARRI	00 L3	$e^+ e^- \rightarrow Z$
0.1085±0.0012±0.0047	<sup>40,41</sup> ACCIARRI	96C L3	$e^+ e^- \rightarrow Z$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.1106±0.0039±0.0022	<sup>42</sup> ABREU	95D DLPH	$e^+ e^- \rightarrow Z$
0.114 ±0.003 ±0.004	<sup>43</sup> BUSKULIC	94G ALEP	$e^+ e^- \rightarrow Z$
0.100 ±0.007 ±0.007	<sup>44</sup> ABREU	93C DLPH	$e^+ e^- \rightarrow Z$
0.105 ±0.006 ±0.005	<sup>45</sup> AKERS	93B OPAL	Repl. by ABBIENDI 00E

<sup>36</sup> Uses the combination of lepton transverse momentum spectrum and the correlation between the charge of the lepton and opposite jet charge. The first error is statistic and the second error is the total systematic error including the modeling.

<sup>37</sup> The experimental systematic and model uncertainties are combined in quadrature.

<sup>38</sup> ABBIENDI 00E result is determined by comparing the distribution of several kinematic variables of leptonic events in a lifetime tagged  $Z \rightarrow b\bar{b}$  sample using artificial neural network techniques. The first error is statistic; the second error is the total systematic error.

<sup>39</sup> ACCIARRI 00 result obtained from a combined fit of  $R_b = \Gamma(Z \rightarrow b\bar{b})/\Gamma(Z \rightarrow \text{hadrons})$  and  $B(b \rightarrow \ell \nu X)$ , using double-tagging method.

<sup>40</sup> ACCIARRI 96C result obtained by a fit to the single lepton spectrum.

<sup>41</sup> Assumes Standard Model value for  $R_B$ .

<sup>42</sup> ABREU 95D give systematic errors  $\pm 0.0019$  (model) and  $0.0012$  ( $R_C$ ). We combine these in quadrature.

<sup>43</sup> BUSKULIC 94G uses  $e$  and  $\mu$  events. This value is from a global fit to the lepton  $p$  and  $p_T$  (relative to jet) spectra which also determines the  $b$  and  $c$  production fractions, the fragmentation functions, and the forward-backward asymmetries. This branching ratio depends primarily on the ratio of dileptons to single leptons at high  $p_T$ , but the lower  $p_T$  portion of the lepton spectrum is included in the global fit to reduce the model dependence. The model dependence is  $\pm 0.0026$  and is included in the systematic error.

<sup>44</sup> ABREU 93C event count includes  $ee$  events. Combining  $ee$ ,  $\mu\mu$ , and  $e\mu$  events, they obtain  $0.100 \pm 0.007 \pm 0.007$ .

<sup>45</sup> AKERS 93B analysis performed using single and dilepton events.

$\Gamma(e^+ \nu_e \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_8/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.1086 ± 0.0035 OUR AVERAGE</b>				
0.1078 ± 0.0008 <sup>+0.0050</sup> / <sub>-0.0046</sub>		46 ABBIENDI	00E OPAL	$e^+ e^- \rightarrow Z$
0.1089 ± 0.0020 ± 0.0051		47,48 ACCIARRI	96C L3	$e^+ e^- \rightarrow Z$
0.107 ± 0.015 ± 0.007	260	49 ABREU	93C DLPH	$e^+ e^- \rightarrow Z$
0.138 ± 0.032 ± 0.008		50 ADEVA	91C L3	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.086 ± 0.027 ± 0.008		51 ABE	93E VNS	$E_{\text{cm}}^{ee} = 58 \text{ GeV}$
0.109 <sup>+0.014</sup> / <sub>-0.013</sub> ± 0.0055	2719	52 AKERS	93B OPAL	Repl. by ABBI- ENDI 00E
0.111 ± 0.028 ± 0.026		BEHREND	90D CELL	$E_{\text{cm}}^{ee} = 43 \text{ GeV}$
0.150 ± 0.011 ± 0.022		BEHREND	90D CELL	$E_{\text{cm}}^{ee} = 35 \text{ GeV}$
0.112 ± 0.009 ± 0.011		ONG	88 MRK2	$E_{\text{cm}}^{ee} = 29 \text{ GeV}$
0.149 <sup>+0.022</sup> / <sub>-0.019</sub>		PAL	86 DLCO	$E_{\text{cm}}^{ee} = 29 \text{ GeV}$
0.110 ± 0.018 ± 0.010		AIHARA	85 TPC	$E_{\text{cm}}^{ee} = 29 \text{ GeV}$
0.111 ± 0.034 ± 0.040		ALTHOFF	84J TASS	$E_{\text{cm}}^{ee} = 34.6 \text{ GeV}$
0.146 ± 0.028		KOOP	84 DLCO	Repl. by PAL 86
0.116 ± 0.021 ± 0.017		NELSON	83 MRK2	$E_{\text{cm}}^{ee} = 29 \text{ GeV}$

<sup>46</sup> ABBIENDI 00E result is determined by comparing the distribution of several kinematic variables of leptonic events in a lifetime tagged  $Z \rightarrow b\bar{b}$  sample using artificial neural network techniques. The first error is statistic; the second error is the total systematic error.

<sup>47</sup> ACCIARRI 96C result obtained by a fit to the single lepton spectrum.

<sup>48</sup> Assumes Standard Model value for  $R_B$ .

<sup>49</sup> ABREU 93C event count includes  $ee$ ,  $\mu\mu$ , and  $e\mu$  events. Combining  $ee$ ,  $\mu\mu$ , and  $e\mu$  events, they obtain  $0.100 \pm 0.007 \pm 0.007$ .

<sup>50</sup> ADEVA 91C measure the average  $B(b \rightarrow eX)$  branching ratio using single and double tagged  $b$  enhanced  $Z$  events. Combining  $e$  and  $\mu$  results, they obtain  $0.113 \pm 0.010 \pm 0.006$ . Constraining the initial number of  $b$  quarks by the Standard Model prediction ( $378 \pm 3 \text{ MeV}$ ) for the decay of the  $Z$  into  $b\bar{b}$ , the electron result gives  $0.112 \pm 0.004 \pm 0.008$ . They obtain  $0.119 \pm 0.003 \pm 0.006$  when  $e$  and  $\mu$  results are combined. Used to measure the  $b\bar{b}$  width itself, this electron result gives  $370 \pm 12 \pm 24 \text{ MeV}$  and combined with the muon result gives  $385 \pm 7 \pm 22 \text{ MeV}$ .

<sup>51</sup> ABE 93E experiment also measures forward-backward asymmetries and fragmentation functions for  $b$  and  $c$ .

<sup>52</sup> AKERS 93B analysis performed using single and dilepton events.

$\Gamma(\mu^+ \nu_\mu \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_9/\Gamma$

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.1095 <sup>+0.0029</sup>/<sub>-0.0025</sub> OUR AVERAGE</b>				
0.1096 ± 0.0008 <sup>+0.0034</sup> / <sub>-0.0027</sub>		53 ABBIENDI	00E OPAL	$e^+ e^- \rightarrow Z$
0.1082 ± 0.0015 ± 0.0059		54,55 ACCIARRI	96C L3	$e^+ e^- \rightarrow Z$
0.110 ± 0.012 ± 0.007	656	56 ABREU	93C DLPH	$e^+ e^- \rightarrow Z$
0.113 ± 0.012 ± 0.006		57 ADEVA	91C L3	$e^+ e^- \rightarrow Z$

• • • We do not use the following data for averages, fits, limits, etc. • • •

0.122 ±0.006 ±0.007		55 UENO	96 AMY	$e^+e^-$ at 57.9 GeV
0.101 $\begin{smallmatrix} +0.010 \\ -0.009 \end{smallmatrix}$ ±0.0055	4248	58 AKERS	93B OPAL	Repl. by ABBI- ENDI 00E
0.104 ±0.023 ±0.016		BEHREND	90D CELL	$E_{cm}^{ee} = 43$ GeV
0.148 ±0.010 ±0.016		BEHREND	90D CELL	$E_{cm}^{ee} = 35$ GeV
0.118 ±0.012 ±0.010		ONG	88 MRK2	$E_{cm}^{ee} = 29$ GeV
0.117 ±0.016 ±0.015		BARTEL	87 JADE	$E_{cm}^{ee} = 34.6$ GeV
0.114 ±0.018 ±0.025		BARTEL	85J JADE	Repl. by BARTEL 87
0.117 ±0.028 ±0.010		ALTHOFF	84G TASS	$E_{cm}^{ee} = 34.5$ GeV
0.105 ±0.015 ±0.013		ADEVA	83B MRKJ	$E_{cm}^{ee} = 33-38.5$ GeV
0.155 $\begin{smallmatrix} +0.054 \\ -0.029 \end{smallmatrix}$		FERNANDEZ	83D MAC	$E_{cm}^{ee} = 29$ GeV

<sup>53</sup> ABBIENDI 00E result is determined by comparing the distribution of several kinematic variables of leptonic events in a lifetime tagged  $Z \rightarrow b\bar{b}$  sample using artificial neural network techniques. The first error is statistic; the second error is the total systematic error.

<sup>54</sup> ACCIARRI 96C result obtained by a fit to the single lepton spectrum.

<sup>55</sup> Assumes Standard Model value for  $R_B$ .

<sup>56</sup> ABREU 93C event count includes  $\mu\mu$  events. Combining  $ee$ ,  $\mu\mu$ , and  $e\mu$  events, they obtain  $0.100 \pm 0.007 \pm 0.007$ .

<sup>57</sup> ADEVA 91C measure the average  $B(b \rightarrow eX)$  branching ratio using single and double tagged  $b$  enhanced  $Z$  events. Combining  $e$  and  $\mu$  results, they obtain  $0.113 \pm 0.010 \pm 0.006$ . Constraining the initial number of  $b$  quarks by the Standard Model prediction ( $378 \pm 3$  MeV) for the decay of the  $Z$  into  $b\bar{b}$ , the muon result gives  $0.123 \pm 0.003 \pm 0.006$ . They obtain  $0.119 \pm 0.003 \pm 0.006$  when  $e$  and  $\mu$  results are combined. Used to measure the  $b\bar{b}$  width itself, this muon result gives  $394 \pm 9 \pm 22$  MeV and combined with the electron result gives  $385 \pm 7 \pm 22$  MeV.

<sup>58</sup> AKERS 93B analysis performed using single and dilepton events.

**$\Gamma(D^- \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{10}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.023 ±0.004 OUR AVERAGE</b>	Error includes scale factor of 1.7.		
0.0272 ±0.0028 ±0.0018	<sup>59</sup> ABREU	00R DLPH	$e^+e^- \rightarrow Z$
0.0198 ±0.0025 ±0.0013	<sup>60</sup> AKERS	95Q OPAL	$e^+e^- \rightarrow Z$

<sup>59</sup> ABREU 00R reports their experiment's uncertainties  $\pm 0.0019 \pm 0.0016 \pm 0.0018$ , where the first error is statistical, the second is systematic, and the third is the uncertainty due to the  $D$  branching fraction. We combine first two in quadrature.

<sup>60</sup> AKERS 95Q reports  $[B(\bar{b} \rightarrow D^- \ell^+ \nu_\ell \text{ anything}) \times B(D^+ \rightarrow K^- \pi^+ \pi^+)] = (1.82 \pm 0.20 \pm 0.12) \times 10^{-3}$ . We divide by our best value  $B(D^+ \rightarrow K^- \pi^+ \pi^+) = (9.2 \pm 0.6) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

**$\Gamma(D^- \pi^+ \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{11}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0049 ±0.0018 ±0.0007</b>	ABREU	00R DLPH	$e^+e^- \rightarrow Z$

**$\Gamma(D^- \pi^- \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{12}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0026 ±0.0015 ±0.0004</b>	ABREU	00R DLPH	$e^+e^- \rightarrow Z$

$\Gamma(\overline{D}^0 \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{13}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0690 ± 0.0035 OUR AVERAGE</b>			
0.0704 ± 0.0040 ± 0.0017	<sup>61</sup> ABREU	00R DLPH	$e^+ e^- \rightarrow Z$
0.066 ± 0.006 <sup>+0.002</sup> <sub>-0.001</sub>	<sup>62</sup> AKERS	95Q OPAL	$e^+ e^- \rightarrow Z$

<sup>61</sup> ABREU 00R reports their experiment's uncertainties  $\pm 0.0034 \pm 0.0036 \pm 0.0017$ , where the first error is statistical, the second is systematic, and the third is the uncertainty due to the  $D$  branching fraction. We combine first two in quadrature.

<sup>62</sup> AKERS 95Q reports  $[B(\overline{b} \rightarrow \overline{D}^0 \ell^+ \nu_\ell \text{ anything}) \times B(D^0 \rightarrow K^- \pi^+)] = (2.52 \pm 0.14 \pm 0.17) \times 10^{-3}$ . We divide by our best value  $B(D^0 \rightarrow K^- \pi^+) = (3.80 \pm 0.09) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\overline{D}^0 \pi^- \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{14}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0107 ± 0.0025 ± 0.0011</b>	ABREU	00R DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(\overline{D}^0 \pi^+ \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{15}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0023 ± 0.0015 ± 0.0004</b>	ABREU	00R DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(D^{*-} \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{16}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0275 ± 0.0019 OUR AVERAGE</b>			
0.0275 ± 0.0021 ± 0.0009	<sup>63</sup> ABREU	00R DLPH	$e^+ e^- \rightarrow Z$
0.0276 ± 0.0027 ± 0.0011	<sup>64</sup> AKERS	95Q OPAL	$e^+ e^- \rightarrow Z$

<sup>63</sup> ABREU 00R reports their experiment's uncertainties  $\pm 0.0017 \pm 0.0013 \pm 0.0009$ , where the first error is statistical, the second is systematic, and the third is the uncertainty due to the  $D$  branching fraction. We combine first two in quadrature.

<sup>64</sup> AKERS 95Q reports  $[B(\overline{b} \rightarrow D^{*} \ell^+ \nu_\ell X) \times B(D^{*+} \rightarrow D^0 \pi^+) \times B(D^0 \rightarrow K^- \pi^+)] = ((7.53 \pm 0.47 \pm 0.56) \times 10^{-4})$  and uses  $B(D^{*+} \rightarrow D^0 \pi^+) = 0.681 \pm 0.013$  and  $B(D^0 \rightarrow K^- \pi^+) = 0.0401 \pm 0.0014$  to obtain the above result. The first error is the experiments error and the second error is the systematic error from the  $D^{*+}$  and  $D^0$  branching ratios.

$\Gamma(D^{*-} \pi^+ \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{17}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0048 ± 0.0009 ± 0.0005</b>	ABREU	00R DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(D^{*-} \pi^- \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{18}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0006 ± 0.0007 ± 0.0002</b>	ABREU	00R DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(\overline{D}_j^0 \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{19}/\Gamma$

$D_j$  represents an unresolved mixture of pseudoscalar and tensor  $D^{**}$  ( $P$ -wave) states.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
seen	<sup>65</sup> ABBIENDI	03M OPAL	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
seen	<sup>66</sup> AKERS	95Q OPAL	Repl. by ABBIENDI 03M

<sup>65</sup> The product branching ratio for decays into the  $\bar{D}_1^0$  state is measured to be  $B(b \rightarrow \bar{D}_1^0 \ell^+ \nu_\ell X) \times B(\bar{D}_1^0 \rightarrow D^{*-} \pi^+) = (2.64 \pm 0.79 \pm 0.39) \times 10^{-3}$ .

<sup>66</sup> AKERS 95Q quotes the product branching ratio  $B(\bar{b} \rightarrow \bar{D}_j^0 \ell^+ \nu_\ell X) B(\bar{D}_j^0 \rightarrow D^{*+} \pi^-) = ((6.1 \pm 1.3 \pm 1.3) \times 10^{-3})$ .

### $\Gamma(D_j^- \ell^+ \nu_\ell \text{anything})/\Gamma_{\text{total}}$ $\Gamma_{20}/\Gamma$

$D_j$  represents an unresolved mixture of pseudoscalar and tensor  $D^{**}$  ( $P$ -wave) states.

VALUE	DOCUMENT ID	TECN	COMMENT
<b>seen</b>	<sup>67</sup> AKERS	95Q OPAL	$e^+ e^- \rightarrow Z$

<sup>67</sup> AKERS 95Q quotes the product branching ratio  $B(\bar{b} \rightarrow D_j^- \ell^+ \nu_\ell \text{anything}) B(D_j^- \rightarrow D^0 \pi^-) = ((7.0 \pm 1.9_{-1.3}^{+1.2}) \times 10^{-3})$ .

### $\Gamma(\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell \text{anything})/\Gamma_{\text{total}}$ $\Gamma_{21}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
not seen	<sup>68</sup> ABBIENDI	03M OPAL	$e^+ e^- \rightarrow Z$

• • • We do not use the following data for averages, fits, limits, etc. • • •

seen	<sup>69</sup> AKERS	95Q OPAL	Repl. by ABBIENDI 03M
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<sup>68</sup> No evidence is found for such decay and set a limit on  $B(b \rightarrow \bar{D}_2^*(2460)^0 \ell^+ \nu_\ell X) \times B(\bar{D}_2^*(2460)^0 \rightarrow D^{*-} \pi^+) < 1.4 \times 10^{-3}$  at 90% CL.

<sup>69</sup> AKERS 95Q quotes the product branching ratio  $B(\bar{b} \rightarrow \bar{D}_2^*(2460)^0 \ell^+ \nu_\ell \text{anything}) B(D_2^*(2460)^0 \rightarrow D^+ \pi^-) = (1.6 \pm 0.7 \pm 0.3) \times 10^{-3}$ .

### $\Gamma(D_2^*(2460)^- \ell^+ \nu_\ell \text{anything})/\Gamma_{\text{total}}$ $\Gamma_{22}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>seen</b>	<sup>70</sup> AKERS	95Q OPAL	$e^+ e^- \rightarrow Z$

<sup>70</sup> AKERS 95Q quotes the product branching ratio  $B(\bar{b} \rightarrow D_2^*(2460)^- \ell^+ \nu_\ell \text{anything}) B(D_2^*(2460)^+ \rightarrow D^0 \pi^-) = 4.2 \pm 1.3_{-1.2}^{+0.7}$ .

### $\Gamma(\text{charmless } \ell \bar{\nu}_\ell)/\Gamma_{\text{total}}$ $\Gamma_{23}/\Gamma$

"OUR EVALUATION" is an average of the data listed below performed by the LEP Heavy Flavour Steering Group. The averaging procedure takes into account correlations between the measurements.

VALUE	DOCUMENT ID	TECN	COMMENT
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**0.00171 ± 0.00052 OUR EVALUATION**

**0.0017 ± 0.0004 OUR AVERAGE**

0.00163 ± 0.00053 $_{-0.00062}^{+0.00055}$	<sup>71</sup> ABBIENDI	01R OPAL	$e^+ e^- \rightarrow Z$
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0.00157 ± 0.00035 ± 0.00055	<sup>72</sup> ABREU	00D DLPH	$e^+ e^- \rightarrow Z$
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0.00173 ± 0.00055 ± 0.00055	<sup>73</sup> BARATE	99G ALEP	$e^+ e^- \rightarrow Z$
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0.0033 ± 0.0010 ± 0.0017	<sup>74</sup> ACCIARRI	98K L3	$e^+ e^- \rightarrow Z$
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<sup>71</sup> Obtained from the best fit of the MC simulated events to the data based on the  $b \rightarrow X_u \ell \nu$  neutral network output distributions.

<sup>72</sup> ABREU 00D result obtained from a fit to the numbers of decays in  $b \rightarrow u$  enriched and depleted samples and their lepton spectra, and assuming  $|V_{cb}| = 0.0384 \pm 0.0033$  and  $\tau_b = 1.564 \pm 0.014$  ps.

<sup>73</sup> Uses lifetime tagged  $b\bar{b}$  sample.

<sup>74</sup> ACCIARRI 98K assumes  $R_b = 0.2174 \pm 0.0009$  at  $Z$  decay.

**$\Gamma(\tau^+ \nu_\tau \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{24}/\Gamma$**

<u>VALUE (units <math>10^{-2}</math>)</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2.48 ± 0.26 OUR AVERAGE</b>				
2.78 ± 0.18 ± 0.51		75 ABBIENDI	01Q OPAL	$e^+ e^- \rightarrow Z$
2.43 ± 0.20 ± 0.25		76 BARATE	01E ALEP	$e^+ e^- \rightarrow Z$
1.7 ± 0.5 ± 1.1		77,78 ACCIARRI	96C L3	$e^+ e^- \rightarrow Z$
2.4 ± 0.7 ± 0.8	1032	79 ACCIARRI	94C L3	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.75 ± 0.30 ± 0.37	405	80 BUSKULIC	95 ALEP	Repl. by BARATE 01E
4.08 ± 0.76 ± 0.62		BUSKULIC	93B ALEP	Repl. by BUSKULIC 95

<sup>75</sup> ABBIENDI 01Q uses a missing energy technique.

<sup>76</sup> The energy-flow and  $b$ -tagging algorithms were used.

<sup>77</sup> ACCIARRI 96C result obtained from missing energy spectrum.

<sup>78</sup> Assumes Standard Model value for  $R_B$ .

<sup>79</sup> This is a direct result using tagged  $b\bar{b}$  events at the  $Z$ , but species are not separated.

<sup>80</sup> BUSKULIC 95 uses missing-energy technique.

**$\Gamma(D^{*-} \tau \nu_\tau \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{25}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>(0.88 \pm 0.31 \pm 0.28) \times 10^{-2}</math></b>	81 BARATE	01E ALEP	$e^+ e^- \rightarrow Z$

<sup>81</sup> The energy-flow and  $b$ -tagging algorithms were used.

**$\Gamma(\bar{b} \rightarrow \bar{c} \rightarrow \ell^- \bar{\nu}_\ell \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_{26}/\Gamma$**

“OUR EVALUATION” is an average of the data listed below performed by the LEP Electroweak Working Group as described in the “Note on the  $Z$  boson” in the  $Z$  Particle Listings.

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.0801 ± 0.0036 OUR EVALUATION</b>			
<b>0.0817 ± 0.0020 OUR AVERAGE</b>			

0.0818 ± 0.0015 <sup>+0.0024</sup> <sub>-0.0026</sub>	82 HEISTER	02G ALEP	$e^+ e^- \rightarrow Z$
0.0798 ± 0.0022 <sup>+0.0025</sup> <sub>-0.0029</sub>	83 ABREU	01L DLPH	$e^+ e^- \rightarrow Z$
0.0840 ± 0.0016 <sup>+0.0039</sup> <sub>-0.0036</sub>	84 ABBIENDI	00E OPAL	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.0770 ± 0.0097 ± 0.0046	85 ABREU	95D DLPH	$e^+ e^- \rightarrow Z$
0.082 ± 0.003 ± 0.012	86 BUSKULIC	94G ALEP	$e^+ e^- \rightarrow Z$
0.077 ± 0.004 ± 0.007	87 AKERS	93B OPAL	Repl. by ABBIENDI 00E

<sup>82</sup> Uses the combination of lepton transverse momentum spectrum and the correlation between the charge of the lepton and opposite jet charge. The first error is statistic and the second error is the total systematic error including the modeling.

<sup>83</sup> The experimental systematic and model uncertainties are combined in quadrature.

<sup>84</sup> ABBIENDI 00E result is determined by comparing the distribution of several kinematic variables of leptonic events in a lifetime tagged  $Z \rightarrow b\bar{b}$  sample using artificial neural network techniques. The first error is statistic; the second error is the total systematic error.

<sup>85</sup> ABREU 95D give systematic errors ±0.0033 (model) and 0.0032 ( $R_c$ ). We combine these in quadrature. This result is from the same global fit as their  $\Gamma(\bar{b} \rightarrow \ell^+ \nu_\ell X)$  data.

<sup>86</sup> BUSKULIC 94G uses  $e$  and  $\mu$  events. This value is from the same global fit as their  $\Gamma(\bar{b} \rightarrow \ell^+ \nu_\ell \text{ anything})/\Gamma_{\text{total}}$  data.

<sup>87</sup> AKERS 93B analysis performed using single and dilepton events.

$\Gamma(c \rightarrow \ell^+ \nu \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{27}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.0161 \pm 0.0020 \begin{smallmatrix} +0.0034 \\ -0.0047 \end{smallmatrix}$	88 ABREU	01L DLPH	$e^+ e^- \rightarrow Z$	

<sup>88</sup> The experimental systematic and model uncertainties are combined in quadrature.

$\Gamma(\bar{D}^0 \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{28}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.610 \pm 0.029 \begin{smallmatrix} +0.015 \\ -0.014 \end{smallmatrix}$	89 BUSKULIC	96Y ALEP	$e^+ e^- \rightarrow Z$	

<sup>89</sup> BUSKULIC 96Y reports  $0.605 \pm 0.024 \pm 0.016$  for  $B(D^0 \rightarrow K^- \pi^+) = 0.0383$ . We rescale to our best value  $B(D^0 \rightarrow K^- \pi^+) = (3.80 \pm 0.09) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(D^0 D_s^\pm \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{29}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.091 \begin{smallmatrix} +0.020 +0.034 \\ -0.018 -0.022 \end{smallmatrix}$	90 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>90</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^\mp D_s^\pm \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{30}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.040 \begin{smallmatrix} +0.017 +0.016 \\ -0.014 -0.011 \end{smallmatrix}$	91 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>91</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$[\Gamma(D^0 D_s^\pm \text{ anything}) + \Gamma(D^\mp D_s^\pm \text{ anything})]/\Gamma_{\text{total}}$				$(\Gamma_{29} + \Gamma_{30})/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.131 \begin{smallmatrix} +0.026 +0.048 \\ -0.022 -0.031 \end{smallmatrix}$	92 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>92</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(\bar{D}^0 D^0 \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{31}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.051 \begin{smallmatrix} +0.016 +0.012 \\ -0.014 -0.011 \end{smallmatrix}$	93 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>93</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^0 D^\pm \text{ anything})/\Gamma_{\text{total}}$				$\Gamma_{32}/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.027 \begin{smallmatrix} +0.015 +0.010 \\ -0.013 -0.009 \end{smallmatrix}$	94 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>94</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$[\Gamma(\bar{D}^0 D^0 \text{ anything}) + \Gamma(D^0 D^\pm \text{ anything})]/\Gamma_{\text{total}}$				$(\Gamma_{31} + \Gamma_{32})/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.078 \begin{smallmatrix} +0.020 +0.018 \\ -0.018 -0.016 \end{smallmatrix}$	95 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$	

<sup>95</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^\pm D^\mp \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{33}/\Gamma$

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>&lt;0.009</b>	90	BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$

$[\Gamma(D^0 \text{ anything}) + \Gamma(D^+ \text{ anything})]/\Gamma_{\text{total}}$   $(\Gamma_{34} + \Gamma_{35})/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.093 \pm 0.017 \pm 0.014</math></b>	<sup>96</sup> ABDALLAH	03E DLPH	$e^+ e^- \rightarrow Z$

<sup>96</sup> The second error is the total of systematic uncertainties including the branching fractions used in the measurement.

$\Gamma(D^- \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{36}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.231 \pm 0.016 \pm 0.015</math></b>	<sup>97</sup> BUSKULIC	96Y ALEP	$e^+ e^- \rightarrow Z$

<sup>97</sup> BUSKULIC 96Y reports  $0.234 \pm 0.013 \pm 0.010$  for  $B(D^+ \rightarrow K^- \pi^+ \pi^+) = 0.091$ . We rescale to our best value  $B(D^+ \rightarrow K^- \pi^+ \pi^+) = (9.2 \pm 0.6) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(D^*(2010)^+ \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{37}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.173 \pm 0.016 \pm 0.012</math></b>	<sup>98</sup> ACKERSTAFF	98E OPAL	$e^+ e^- \rightarrow Z$

<sup>98</sup> Uses lepton tags to select  $Z \rightarrow b\bar{b}$  events.

$\Gamma(D_1(2420)^0 \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{38}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.050 \pm 0.014 \pm 0.006</math></b>	<sup>99</sup> ACKERSTAFF	97W OPAL	$e^+ e^- \rightarrow Z$

<sup>99</sup> ACKERSTAFF 97W assumes  $B(D_2^*(2460)^0 \rightarrow D^{*+} \pi^-) = 0.21 \pm 0.04$  and  $\Gamma_{b\bar{b}}/\Gamma_{\text{hadrons}} = 0.216$  at  $Z$  decay.

$\Gamma(D^*(2010)^\mp D_s^\pm \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{39}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.033^{+0.010+0.012}_{-0.009-0.009}</math></b>	<sup>100</sup> BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$

<sup>100</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^0 D^*(2010)^\pm \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{40}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.030^{+0.009+0.007}_{-0.008-0.005}</math></b>	<sup>101</sup> BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$

<sup>101</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^*(2010)^\pm D^\mp \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{41}/\Gamma$

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.025^{+0.010+0.006}_{-0.009-0.005}</math></b>	<sup>102</sup> BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$

<sup>102</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D^*(2010)^\pm D^*(2010)^\mp \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{42}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$0.012^{+0.004}_{-0.003} \pm 0.002$	103 BARATE	98Q ALEP	$e^+ e^- \rightarrow Z$

<sup>103</sup> The systematic error includes the uncertainties due to the charm branching ratios.

$\Gamma(D_2^*(2460)^0 \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{43}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$0.047 \pm 0.024 \pm 0.013$	104 ACKERSTAFF 97W	OPAL	$e^+ e^- \rightarrow Z$

<sup>104</sup> ACKERSTAFF 97W assumes  $B(D_2^*(2460)^0 \rightarrow D^{*+} \pi^-) = 0.21 \pm 0.04$  and  $\Gamma_{b\bar{b}}/\Gamma_{\text{hadrons}} = 0.216$  at  $Z$  decay.

$\Gamma(D_s^- \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{44}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$0.18 \pm 0.02 \pm 0.04$	105 BUSKULIC	96Y ALEP	$e^+ e^- \rightarrow Z$

<sup>105</sup> BUSKULIC 96Y reports  $0.183 \pm 0.019 \pm 0.009$  for  $B(D_s^+ \rightarrow \phi \pi^+) = 0.036$ . We rescale to our best value  $B(D_s^+ \rightarrow \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(D_s^+ \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{45}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$0.101 \pm 0.010 \pm 0.029$	106 ABDALLAH	03E DLPH	$e^+ e^- \rightarrow Z$

<sup>106</sup> The second error is the total of systematic uncertainties including the branching fractions used in the measurement.

$\Gamma(b \rightarrow \Lambda_c^+ \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{46}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$0.097 \pm 0.013 \pm 0.025$	107 BUSKULIC	96Y ALEP	$e^+ e^- \rightarrow Z$

<sup>107</sup> BUSKULIC 96Y reports  $0.110 \pm 0.014 \pm 0.006$  for  $B(\Lambda_c^+ \rightarrow p K^- \pi^+) = 0.044$ . We rescale to our best value  $B(\Lambda_c^+ \rightarrow p K^- \pi^+) = (5.0 \pm 1.3) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\bar{c}/c \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{47}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>1.166 ± 0.033 OUR AVERAGE</b>			
$1.166 \pm 0.031 \pm 0.080$	108 ABREU	00 DLPH	$e^+ e^- \rightarrow Z$
$1.147 \pm 0.041$	109 ABREU	98D DLPH	$e^+ e^- \rightarrow Z$
$1.230 \pm 0.036 \pm 0.065$	110 BUSKULIC	96Y ALEP	$e^+ e^- \rightarrow Z$

<sup>108</sup> Evaluated via summation of exclusive and inclusive channels.

<sup>109</sup> ABREU 98D results are extracted from a fit to the  $b$ -tagging probability distribution based on the impact parameter.

<sup>110</sup> BUSKULIC 96Y assumes PDG 96 production fractions for  $B^0$ ,  $B^+$ ,  $B_s^-$ ,  $b$  baryons, and PDG 96 branching ratios for charm decays. This is sum of their inclusive  $\bar{D}^0$ ,  $D^-$ ,  $\bar{D}_s^-$ , and  $\Lambda_c$  branching ratios, corrected to include inclusive  $\Xi_c$  and charmonium.

**$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$**   **$\Gamma_{48}/\Gamma$**

<u>VALUE (units <math>10^{-2}</math>)</u>	<u>CL%</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**1.16 ± 0.10 OUR AVERAGE**

1.12 ± 0.12 ± 0.10			111 ABREU	94P DLPH	$e^+e^- \rightarrow Z$
1.16 ± 0.16 ± 0.14		121	112 ADRIANI	93J L3	$e^+e^- \rightarrow Z$
1.21 ± 0.13 ± 0.08			BUSKULIC	92G ALEP	$e^+e^- \rightarrow Z$

• • • We do not use the following data for averages, fits, limits, etc. • • •

1.3 ± 0.2 ± 0.2			113 ADRIANI	92 L3	$e^+e^- \rightarrow Z$
< 4.9	90		MATTEUZZI	83 MRK2	$E_{\text{cm}}^{ee} = 29 \text{ GeV}$

111 ABREU 94P is an inclusive measurement from  $b$  decays at the  $Z$ . Uses  $J/\psi(1S) \rightarrow e^+e^-$  and  $\mu^+\mu^-$  channels. Assumes  $\Gamma(Z \rightarrow b\bar{b})/\Gamma_{\text{hadron}} = 0.22$ .

112 ADRIANI 93J is an inclusive measurement from  $b$  decays at the  $Z$ . Uses  $J/\psi(1S) \rightarrow \mu^+\mu^-$  and  $J/\psi(1S) \rightarrow e^+e^-$  channels.

113 ADRIANI 92 measurement is an inclusive result for  $B(Z \rightarrow J/\psi(1S)X) = (4.1 \pm 0.7 \pm 0.3) \times 10^{-3}$  which is used to extract the  $b$ -hadron contribution to  $J/\psi(1S)$  production.

**$\Gamma(\psi(2S)\text{anything})/\Gamma_{\text{total}}$**   **$\Gamma_{49}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**0.0048 ± 0.0022 ± 0.0010** 114 ABREU 94P DLPH  $e^+e^- \rightarrow Z$

114 ABREU 94P is an inclusive measurement from  $b$  decays at the  $Z$ . Uses  $\psi(2S) \rightarrow J/\psi(1S)\pi^+\pi^-$ ,  $J/\psi(1S) \rightarrow \mu^+\mu^-$  channels. Assumes  $\Gamma(Z \rightarrow b\bar{b})/\Gamma_{\text{hadron}} = 0.22$ .

**$\Gamma(\chi_{c1}(1P)\text{anything})/\Gamma_{\text{total}}$**   **$\Gamma_{50}/\Gamma$**

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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**0.015 ± 0.005 OUR AVERAGE**

0.012 <sup>+0.006</sup> <sub>-0.005</sub> ± 0.001		115 ABREU	94P DLPH	$e^+e^- \rightarrow Z$
0.021 ± 0.008 ± 0.002	19	116 ADRIANI	93J L3	$e^+e^- \rightarrow Z$

115 ABREU 94P reports  $0.014 \pm 0.006^{+0.004}_{-0.002}$  for  $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = 0.273 \pm 0.016$ . We rescale to our best value  $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = (31.6 \pm 3.3) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes no  $\chi_{c2}(1P)$  and  $\Gamma(Z \rightarrow b\bar{b})/\Gamma_{\text{hadron}} = 0.22$ .

116 ADRIANI 93J reports  $0.024 \pm 0.009 \pm 0.002$  for  $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = 0.273 \pm 0.016$ . We rescale to our best value  $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = (31.6 \pm 3.3) \times 10^{-2}$ . Our first error is their experiment's error and our second error is the systematic error from using our best value.

**$\Gamma(\chi_{c1}(1P)\text{anything})/\Gamma(J/\psi(1S)\text{anything})$**   **$\Gamma_{50}/\Gamma_{48}$**

<u>VALUE</u>	<u>EVTS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
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• • • We do not use the following data for averages, fits, limits, etc. • • •

1.92 ± 0.82	121	117 ADRIANI	93J L3	$e^+e^- \rightarrow Z$
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117 ADRIANI 93J is a ratio of inclusive measurements from  $b$  decays at the  $Z$  using only the  $J/\psi(1S) \rightarrow \mu^+\mu^-$  channel since some systematics cancel.

$\Gamma(\bar{3}\gamma)/\Gamma_{\text{total}}$   $\Gamma_{51}/\Gamma$

VALUE (units $10^{-4}$ )	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>3.11 \pm 0.80 \pm 0.72</math></b>		118 BARATE	98I ALEP	$e^+ e^- \rightarrow Z$

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 5.4	90	119 ADAM	96D DLPH	$e^+ e^- \rightarrow Z$
< 12	90	120 ADRIANI	93L L3	$e^+ e^- \rightarrow Z$

118 BARATE 98I uses lifetime tagged  $Z \rightarrow b\bar{b}$  sample.

119 ADAM 96D assumes  $f_{B^0} = f_{B^-} = 0.39$  and  $f_{B_s} = 0.12$ .

120 ADRIANI 93L result is for  $\bar{b} \rightarrow \bar{3}\gamma$  is performed inclusively.

$\Gamma(\bar{3}\nu)/\Gamma_{\text{total}}$   $\Gamma_{52}/\Gamma$

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
<b><math>&lt; 6.4 \times 10^{-4}</math></b>	90	121 BARATE	01E ALEP	$e^+ e^- \rightarrow Z$

121 The energy-flow and  $b$ -tagging algorithms were used.

$\Gamma(K^\pm \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{53}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>0.74 \pm 0.06</math> OUR AVERAGE</b>			
$0.72 \pm 0.02 \pm 0.06$	BARATE	98V ALEP	$e^+ e^- \rightarrow Z$
$0.88 \pm 0.05 \pm 0.18$	ABREU	95C DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(K_S^0 \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{54}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>0.290 \pm 0.011 \pm 0.027</math></b>	ABREU	95C DLPH	$e^+ e^- \rightarrow Z$

$\Gamma(\pi^\pm \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{55}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>3.97 \pm 0.02 \pm 0.21</math></b>	BARATE	98V ALEP	$e^+ e^- \rightarrow Z$

$\Gamma(\pi^0 \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{56}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>2.78 \pm 0.15 \pm 0.60</math></b>	122 ADAM	96 DLPH	$e^+ e^- \rightarrow Z$

122 ADAM 96 measurement obtained from a fit to the rapidity distribution of  $\pi^{0's}$  in  $Z \rightarrow b\bar{b}$  events.

$\Gamma(\phi \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{57}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>0.0282 \pm 0.0013 \pm 0.0019</math></b>	ABBIENDI	00Z OPAL	$e^+ e^- \rightarrow Z$

$\Gamma(\rho/\bar{\rho} \text{ anything})/\Gamma_{\text{total}}$   $\Gamma_{58}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
<b><math>0.131 \pm 0.011</math> OUR AVERAGE</b>			
$0.131 \pm 0.004 \pm 0.011$	BARATE	98V ALEP	$e^+ e^- \rightarrow Z$
$0.141 \pm 0.018 \pm 0.056$	ABREU	95C DLPH	$e^+ e^- \rightarrow Z$

**$\Gamma(\text{charged anything})/\Gamma_{\text{total}}$**   **$\Gamma_{59}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>4.97 \pm 0.03 \pm 0.06</math></b>	123 ABREU	98H DLPH	$e^+ e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$5.84 \pm 0.04 \pm 0.38$	ABREU	95C DLPH	Repl. by ABREU 98H
123 ABREU 98H measurement excludes the contribution from $K^0$ and $\Lambda$ decay.			

**$\Gamma(\text{hadron}^+ \text{hadron}^-)/\Gamma_{\text{total}}$**   **$\Gamma_{60}/\Gamma$**

<u>VALUE (units <math>10^{-5}</math>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>1.7^{+1.0}_{-0.7} \pm 0.2</math></b>	124,125 BUSKULIC	96V ALEP	$e^+ e^- \rightarrow Z$
124 BUSKULIC 96V assumes PDG 96 production fractions for $B^0$ , $B^+$ , $B_s$ , $b$ baryons.			
125 Average branching fraction of weakly decaying $B$ hadrons into two long-lived charged hadrons, weighted by their production cross section and lifetimes.			

**$\Gamma(\text{charmless})/\Gamma_{\text{total}}$**   **$\Gamma_{61}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.007 \pm 0.021</math></b>	126 ABREU	98D DLPH	$e^+ e^- \rightarrow Z$
126 ABREU 98D results are extracted from a fit to the $b$ -tagging probability distribution based on the impact parameter. The expected hidden charm contribution of $0.026 \pm 0.004$ has been subtracted.			

**$\Gamma(\Lambda/\bar{\Lambda}\text{anything})/\Gamma_{\text{total}}$**   **$\Gamma_{62}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.059 \pm 0.006</math> OUR AVERAGE</b>			
$0.0587 \pm 0.0046 \pm 0.0048$	ACKERSTAFF	97N OPAL	$e^+ e^- \rightarrow Z$
$0.059 \pm 0.007 \pm 0.009$	ABREU	95C DLPH	$e^+ e^- \rightarrow Z$

**$\Gamma(b\text{-baryon anything})/\Gamma_{\text{total}}$**   **$\Gamma_{63}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>0.102 \pm 0.007 \pm 0.027</math></b>	127 BARATE	98V ALEP	$e^+ e^- \rightarrow Z$
127 BARATE 98V assumes $B(B_s \rightarrow pX) = 8 \pm 4\%$ and $B(b\text{-baryon} \rightarrow pX) = 58 \pm 6\%$ .			

**$\Gamma(\mu^+ \mu^- \text{anything})/\Gamma_{\text{total}}$**   **$\Gamma_{65}/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt; 3.2 \times 10^{-4}</math></b>	90	ABBOTT	98B D0	$p\bar{p}$ 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$< 5.0 \times 10^{-5}$	90	128 ALBAJAR	91C UA1	$E_{\text{cm}}^{p\bar{p}} = 630$ GeV
$< 0.02$	95	ALTHOFF	84G TASS	$E_{\text{cm}}^{e^+e^-} = 34.5$ GeV
$< 0.007$	95	ADEVA	83 MRKJ	$E_{\text{cm}}^{e^+e^-} = 30\text{--}38$ GeV
$< 0.007$	95	BARTEL	83B JADE	$E_{\text{cm}}^{e^+e^-} = 33\text{--}37$ GeV
128 Both ABBOTT 98B and GLENN 98 claim that the efficiency quoted in ALBAJAR 91C was overestimated by a large factor.				

**$[\Gamma(e^+ e^- \text{anything}) + \Gamma(\mu^+ \mu^- \text{anything})]/\Gamma_{\text{total}}$**   **$(\Gamma_{64} + \Gamma_{65})/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$< 0.008$	90	MATTEUZZI	83 MRK2	$E_{\text{cm}}^{e^+e^-} = 29$ GeV

$\Gamma(\nu\bar{\nu}\text{anything})/\Gamma_{\text{total}}$

$\Gamma_{66}/\Gamma$

VALUE	DOCUMENT ID	TECN	COMMENT
$<3.9 \times 10^{-4}$	129 GROSSMAN	96 RVUE	$e^+e^- \rightarrow Z$
129 GROSSMAN 96 limit is derived from the ALEPH BUSKULIC 95 limit $B(B^+ \rightarrow \tau^+\nu_\tau)$ $<1.8 \times 10^{-3}$ at CL=90% using conservative simplifying assumptions.			

**$\chi_b$  AT HIGH ENERGY**

For a discussion of  $B-\bar{B}$  mixing, see the note on  $B^0-\bar{B}^0$  Mixing" in the  $B^0$  Particle Listings.

$\chi_b$  is the average  $B-\bar{B}$  mixing parameter at high-energy  $\chi_b=f'_d\chi_d + f'_s\chi_s$  where  $f'_d$  and  $f'_s$  are the fractions of  $B^0$  and  $B_s^0$  hadrons in an unbiased sample of semileptonic  $b$ -hadron decays.

"OUR EVALUATION" is an average of the data listed below. Performed by the LEP Electroweak Working Group as described in the "Note on the Z boson" in the Z Particle Listings.

VALUE	CL%	EVTS	DOCUMENT ID	TECN	COMMENT
<b>0.1257±0.0042 OUR EVALUATION</b>					
<b>0.127 ±0.004 OUR AVERAGE</b>					
0.1312±0.0049±0.0042			130	ABBIENDI	04E OPAL $e^+e^- \rightarrow Z$
0.127 ±0.013 ±0.006			131	ABREU	01L DLPH $e^+e^- \rightarrow Z$
0.1192±0.0068±0.0051			132	ACCIARRI	99D L3 $e^+e^- \rightarrow Z$
0.131 ±0.020 ±0.016			133	ABE	97I CDF $p\bar{p}$ 1.8 TeV
0.121 ±0.016 ±0.006			134	ABREU	94J DLPH $e^+e^- \rightarrow Z$
0.114 ±0.014 ±0.008			135	BUSKULIC	94G ALEP $e^+e^- \rightarrow Z$
0.129 ±0.022			136	BUSKULIC	92B ALEP $e^+e^- \rightarrow Z$
0.176 ±0.031 ±0.032		1112	137	ABE	91G CDF $p\bar{p}$ 1.8 TeV
0.148 ±0.029 ±0.017			138	ALBAJAR	91D UA1 $p\bar{p}$ 630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.1107±0.0062±0.0055			139	ALEXANDER	96 OPAL Rep. by ABBI- ENDI 04E
0.136 ±0.037 ±0.040			140	UENO	96 AMY $e^+e^-$ at 57.9 GeV
0.144 ±0.014 $\begin{smallmatrix} +0.017 \\ -0.011 \end{smallmatrix}$			141	ABREU	94F DLPH Sup. by ABREU 94J
0.131 ±0.014			142	ABREU	94J DLPH $e^+e^- \rightarrow Z$
0.123 ±0.012 ±0.008				ACCIARRI	94D L3 Repl. by AC- CIARRI 99D
0.157 ±0.020 ±0.032			143	ALBAJAR	94 UA1 $\sqrt{s} = 630$ GeV
0.121 $\begin{smallmatrix} +0.044 \\ -0.040 \end{smallmatrix}$ ±0.017		1665	144	ABREU	93C DLPH Sup. by ABREU 94J
0.143 $\begin{smallmatrix} +0.022 \\ -0.021 \end{smallmatrix}$ ±0.007			145	AKERS	93B OPAL Sup. by ALEXAN- DER 96
0.145 $\begin{smallmatrix} +0.041 \\ -0.035 \end{smallmatrix}$ ±0.018			146	ACTON	92C OPAL $e^+e^- \rightarrow Z$

0.121 ±0.017 ±0.006		147 ADEVA	92C L3	Sup. by AC-CIARRI 94D
0.132 ±0.22 +0.015 -0.012	823	148 DECAMP	91 ALEP	$e^+e^- \rightarrow Z$
0.178 +0.049 -0.040 ±0.020		149 ADEVA	90P L3	$e^+e^- \rightarrow Z$
0.17 +0.15 -0.08		150,151 WEIR	90 MRK2	$e^+e^-$ 29 GeV
0.21 +0.29 -0.15		150 BAND	88 MAC	$E_{cm}^{ee} = 29$ GeV
>0.02	90	150 BAND	88 MAC	$E_{cm}^{ee} = 29$ GeV
0.121 ±0.047		150,152 ALBAJAR	87C UA1	Repl. by AL-BAJAR 91D
<0.12	90	150,153 SCHAAD	85 MRK2	$E_{cm}^{ee} = 29$ GeV

130 The average  $B$  mixing parameter is determined simultaneously with  $b$  and  $c$  forward-backward asymmetries in the fit.

131 The experimental systematic and model uncertainties are combined in quadrature.

132 ACCIARRI 99D uses maximum-likelihood fits to extract  $\chi_b$  as well as the  $A_{FB}^b$  in  $Z \rightarrow b\bar{b}$  events containing prompt leptons.

133 Uses di-muon events.

134 This ABREU 94J result is from 5182  $\ell\ell$  and 279  $\Lambda\ell$  events. The systematic error includes 0.004 for model dependence.

135 BUSKULIC 94G data analyzed using  $ee$ ,  $e\mu$ , and  $\mu\mu$  events.

136 BUSKULIC 92B uses a jet charge technique combined with electrons and muons.

137 ABE 91G measurement of  $\chi$  is done with  $e\mu$  and  $ee$  events.

138 ALBAJAR 91D measurement of  $\chi$  is done with dimuons.

139 ALEXANDER 96 uses a maximum likelihood fit to simultaneously extract  $\chi$  as well as the forward-backward asymmetries in  $e^+e^- \rightarrow Z \rightarrow b\bar{b}$  and  $c\bar{c}$ .

140 UENO 96 extracted  $\chi$  from the energy dependence of the forward-backward asymmetry.

141 ABREU 94F uses the average electric charge sum of the jets recoiling against a  $b$ -quark jet tagged by a high  $p_T$  muon. The result is for  $\bar{\chi} = f_d\chi_d + 0.9f_s\chi_s$ .

142 This ABREU 94J result combines  $\ell\ell$ ,  $\Lambda\ell$ , and jet-charge  $\ell$  (ABREU 94F) analyses. It is for  $\bar{\chi} = f_d\chi_d + 0.96f_s\chi_s$ .

143 ALBAJAR 94 uses dimuon events. Not independent of ALBAJAR 91D.

144 ABREU 93C data analyzed using  $ee$ ,  $e\mu$ , and  $\mu\mu$  events.

145 AKERS 93B analysis performed using dilepton events.

146 ACTON 92C uses electrons and muons. Superseded by AKERS 93B.

147 ADEVA 92C uses electrons and muons.

148 DECAMP 91 done with opposite and like-sign dileptons. Superseded by BUSKULIC 92B.

149 ADEVA 90P measurement uses  $ee$ ,  $\mu\mu$ , and  $e\mu$  events from 118k events at the  $Z$ . Superseded by ADEVA 92C.

150 These experiments are not in the average because the combination of  $B_s$  and  $B_d$  mesons which they see could differ from those at higher energy.

151 The WEIR 90 measurement supersedes the limit obtained in SCHAAD 85. The 90% CL are 0.06 and 0.38.

152 ALBAJAR 87C measured  $\chi = (\bar{B}^0 \rightarrow B^0 \rightarrow \mu^+ X)$  divided by the average production weighted semileptonic branching fraction for  $B$  hadrons at 546 and 630 GeV.

153 Limit is average probability for hadron containing  $B$  quark to produce a positive lepton.

## $B^\pm/B^0/B_s^0/b$ -baryon ADMIXTURE REFERENCES

ABBIENDI	04E	PL B577 18	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABBIENDI	03M	EPJ C30 467	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABDALLAH	03E	PL B561 26	J. Abdallah <i>et al.</i>	(DELPHI Collab.)
ABDALLAH	03K	PL B576 29	J. Abdallah <i>et al.</i>	(DELPHI Collab.)
HEISTER	02G	EPJ C22 613	A. Heister <i>et al.</i>	(ALEPH Collab.)
ABBIENDI	01Q	PL B520 1	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABBIENDI	01R	EPJ C21 399	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABREU	01L	EPJ C20 455	P. Abreu <i>et al.</i>	(DELPHI Collab.)
BARATE	01E	EPJ C19 213	R. Barate <i>et al.</i>	(ALEPH Collab.)
ABBIENDI	00E	EPJ C13 225	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABBIENDI	00Z	PL B492 13	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABREU	00	EPJ C12 225	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	00D	PL B478 14	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	00R	PL B475 407	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACCIARRI	00	EPJ C13 47	M. Acciari <i>et al.</i>	(L3 Collab.)
AFFOLDER	00E	PRL 84 1663	T. Affolder <i>et al.</i>	(CDF Collab.)
ABBIENDI	99J	EPJ C12 609	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABE	99P	PR D60 092005	F. Abe <i>et al.</i>	(CDF Collab.)
ACCIARRI	99D	PL B448 152	M. Acciari <i>et al.</i>	(L3 Collab.)
BARATE	99G	EPJ C6 555	R. Barate <i>et al.</i>	(ALEPH Collab.)
ABBOTT	98B	PL B423 419	B. Abbott <i>et al.</i>	(D0 Collab.)
ABE	98B	PR D57 5382	F. Abe <i>et al.</i>	(CDF Collab.)
ABREU	98D	PL B426 193	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	98H	PL B425 399	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACCIARRI	98	PL B416 220	M. Acciari <i>et al.</i>	(L3 Collab.)
ACCIARRI	98K	PL B436 174	M. Acciari <i>et al.</i>	(L3 Collab.)
ACKERSTAFF	98E	EPJ C1 439	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
BARATE	98I	PL B429 169	R. Barate <i>et al.</i>	(ALEPH Collab.)
BARATE	98Q	EPJ C4 387	R. Barate <i>et al.</i>	(ALEPH Collab.)
BARATE	98V	EPJ C5 205	R. Barate <i>et al.</i>	(ALEPH Collab.)
GLENN	98	PRL 80 2289	S. Glenn <i>et al.</i>	(CLEO Collab.)
ABE	97I	PR D55 2546	F. Abe <i>et al.</i>	(CDF Collab.)
ACKERSTAFF	97F	ZPHY C73 397	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
ACKERSTAFF	97N	ZPHY C74 423	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
ACKERSTAFF	97W	ZPHY C76 425	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
ABREU	96E	PL B377 195	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACCIARRI	96C	ZPHY C71 379	M. Acciari <i>et al.</i>	(L3 Collab.)
ADAM	96	ZPHY C69 561	W. Adam <i>et al.</i>	(DELPHI Collab.)
ADAM	96D	ZPHY C72 207	W. Adam <i>et al.</i>	(DELPHI Collab.)
ALEXANDER	96	ZPHY C70 357	G. Alexander <i>et al.</i>	(OPAL Collab.)
BUSKULIC	96F	PL B369 151	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
BUSKULIC	96V	PL B384 471	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
BUSKULIC	96Y	PL B388 648	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
GROSSMAN	96	NP B465 369	Y. Grossman, Z. Ligeti, E. Nardi	(REHO, CIT)
Also	96B	NP B480 753 (erratum)	Y. Grossman, Z. Ligeti, E. Nardi	
PDG	96	PR D54 1	R. M. Barnett <i>et al.</i>	
UENO	96	PL B381 365	K. Ueno <i>et al.</i>	(AMY Collab.)
ABE,K	95B	PRL 75 3624	K. Abe <i>et al.</i>	(SLD Collab.)
ABREU	95C	PL B347 447	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	95D	ZPHY C66 323	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ADAM	95	ZPHY C68 363	W. Adam <i>et al.</i>	(DELPHI Collab.)
AKERS	95Q	ZPHY C67 57	R. Akers <i>et al.</i>	(OPAL Collab.)
BUSKULIC	95	PL B343 444	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABREU	94F	PL B322 459	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	94J	PL B332 488	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	94L	ZPHY C63 3	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	94P	PL B341 109	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACCIARRI	94C	PL B332 201	M. Acciari <i>et al.</i>	(L3 Collab.)
ACCIARRI	94D	PL B335 542	M. Acciari <i>et al.</i>	(L3 Collab.)
ALBAJAR	94	ZPHY C61 41	C. Albajar <i>et al.</i>	(UA1 Collab.)
BUSKULIC	94G	ZPHY C62 179	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABE	93E	PL B313 288	K. Abe <i>et al.</i>	(VENUS Collab.)
ABE	93J	PRL 71 3421	F. Abe <i>et al.</i>	(CDF Collab.)
ABREU	93C	PL B301 145	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	93D	ZPHY C57 181	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	93G	PL B312 253	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACTON	93C	PL B307 247	P.D. Acton <i>et al.</i>	(OPAL Collab.)
ACTON	93L	ZPHY C60 217	P.D. Acton <i>et al.</i>	(OPAL Collab.)

ADRIANI	93J	PL B317 467	O. Adriani <i>et al.</i>	(L3 Collab.)
ADRIANI	93K	PL B317 474	O. Adriani <i>et al.</i>	(L3 Collab.)
ADRIANI	93L	PL B317 637	O. Adriani <i>et al.</i>	(L3 Collab.)
AKERS	93B	ZPHY C60 199	R. Akers <i>et al.</i>	(OPAL Collab.)
BUSKULIC	93B	PL B298 479	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
BUSKULIC	93O	PL B314 459	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABREU	92	ZPHY C53 567	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ACTON	92	PL B274 513	D.P. Acton <i>et al.</i>	(OPAL Collab.)
ACTON	92C	PL B276 379	D.P. Acton <i>et al.</i>	(OPAL Collab.)
ADEVA	92C	PL B288 395	B. Adeva <i>et al.</i>	(L3 Collab.)
ADRIANI	92	PL B288 412	O. Adriani <i>et al.</i>	(L3 Collab.)
BUSKULIC	92B	PL B284 177	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
BUSKULIC	92F	PL B295 174	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
BUSKULIC	92G	PL B295 396	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABE	91G	PRL 67 3351	F. Abe <i>et al.</i>	(CDF Collab.)
ADEVA	91C	PL B261 177	B. Adeva <i>et al.</i>	(L3 Collab.)
ADEVA	91H	PL B270 111	B. Adeva <i>et al.</i>	(L3 Collab.)
ALBAJAR	91C	PL B262 163	C. Albajar <i>et al.</i>	(UA1 Collab.)
ALBAJAR	91D	PL B262 171	C. Albajar <i>et al.</i>	(UA1 Collab.)
ALEXANDER	91G	PL B266 485	G. Alexander <i>et al.</i>	(OPAL Collab.)
DECAMP	91	PL B258 236	D. Decamp <i>et al.</i>	(ALEPH Collab.)
DECAMP	91C	PL B257 492	D. Decamp <i>et al.</i>	(ALEPH Collab.)
ADEVA	90P	PL B252 703	B. Adeva <i>et al.</i>	(L3 Collab.)
BEHREND	90D	ZPHY C47 333	H.J. Behrend <i>et al.</i>	(CELLO Collab.)
HAGEMANN	90	ZPHY C48 401	J. Hagemann <i>et al.</i>	(JADE Collab.)
LYONS	90	PR D41 982	L. Lyons, A.J. Martin, D.H. Saxon	(OXF, BRIS+)
WEIR	90	PL B240 289	A.J. Weir <i>et al.</i>	(Mark II Collab.)
BRAUNSCH...	89B	ZPHY C44 1	R. Braunschweig <i>et al.</i>	(TASSO Collab.)
ONG	89	PRL 62 1236	R.A. Ong <i>et al.</i>	(Mark II Collab.)
BAND	88	PL B200 221	H.R. Band <i>et al.</i>	(MAC Collab.)
KLEM	88	PR D37 41	D.E. Klem <i>et al.</i>	(DELCO Collab.)
ONG	88	PRL 60 2587	R.A. Ong <i>et al.</i>	(Mark II Collab.)
ALBAJAR	87C	PL B186 247	C. Albajar <i>et al.</i>	(UA1 Collab.)
ASH	87	PRL 58 640	W.W. Ash <i>et al.</i>	(MAC Collab.)
BARTEL	87	ZPHY C33 339	W. Bartel <i>et al.</i>	(JADE Collab.)
BROM	87	PL B195 301	J.M. Brom <i>et al.</i>	(HRS Collab.)
PAL	86	PR D33 2708	T. Pal <i>et al.</i>	(DELCO Collab.)
AIHARA	85	ZPHY C27 39	H. Aihara <i>et al.</i>	(TPC Collab.)
BARTEL	85J	PL 163B 277	W. Bartel <i>et al.</i>	(JADE Collab.)
SCHAAD	85	PL 160B 188	T. Schaad <i>et al.</i>	(Mark II Collab.)
ALTHOFF	84G	ZPHY C22 219	M. Althoff <i>et al.</i>	(TASSO Collab.)
ALTHOFF	84J	PL 146B 443	M. Althoff <i>et al.</i>	(TASSO Collab.)
KOOP	84	PRL 52 970	D.E. Koop <i>et al.</i>	(DELCO Collab.)
ADEVA	83	PRL 50 799	B. Adeva <i>et al.</i>	(Mark-J Collab.)
ADEVA	83B	PRL 51 443	B. Adeva <i>et al.</i>	(Mark-J Collab.)
BARTEL	83B	PL 132B 241	W. Bartel <i>et al.</i>	(JADE Collab.)
FERNANDEZ	83D	PRL 50 2054	E. Fernandez <i>et al.</i>	(MAC Collab.)
MATTEUZZI	83	PL 129B 141	C. Matteuzzi <i>et al.</i>	(Mark II Collab.)
NELSON	83	PRL 50 1542	M.E. Nelson <i>et al.</i>	(Mark II Collab.)