Citation: D.E. Groom *et al.* (Particle Data Group), Eur. Phys. Jour. **C15**, 1 (2000) (URL: http://pdg.lbl.gov)

B_s^0

$I(J^P) = 0(0^-)$

I, *J*, *P* need confirmation. Quantum numbers shown are quark-model predictions.

B_s^0 MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
5369.6± 2.4 OUR UNCHECKED FIT					
5369.6± 2.4 OUR AVERAGE					
5369.9± 2.3±1.3	32	[1] ABE	96B	CDF	$p\overline{p}$ at 1.8 TeV
5374 ±16 ±2	3	ABREU	94D	DLPH	$e^+e^- \rightarrow Z$
5359 ±19 ±7	1	[1] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
5368.6± 5.6±1.5	2	BUSKULIC	93G	ALEP	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5370 ±40	6	[2] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
5383.3± 4.5±5.0	14	ABE	93F	CDF	Repl by ABE 96B

[1] From the decay $B_s \rightarrow J/\psi(1S)\phi$.

[2] From the decay $B_s \rightarrow D_s^- \pi^+$.

$m_{B_s^0} - m_B$

m_B is the average of our B masses $(m_{B^\pm}+m_{B^0})/2$.

VALUE (MeV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
90.4±2.4 OUR UNCHECKED FIT					
89.7±2.7±1.2		ABE	96B	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
80 to 130	68	LEE-FRANZINI	90	CSB2	$e^+e^- \rightarrow \Upsilon(5S)$

$m_{B_{sH}^0} - m_{B_{sL}^0}$

See the B_s^0-$\overline{B}_s^0$ MIXING section near the end of these B_s^0 Listings.

B_s^0 MEAN LIFE

"OUR EVALUATION" is an average of the data listed below performed by the LEP B Lifetimes Working Group as described in our review "Production and Decay of b-flavored Hadrons" in the $B^{\pm}$ Section of the Listings. The averaging procedure takes into account correlations between the measurements and asymmetric lifetime errors.

VALUE (10^{-12} s)	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
1.493±0.062 OUR EVALUATION				
Average is meaningless.		[$(1.54 \pm 0.07) \times 10^{-12}$ s OUR 1998 AVERAGE]		
$1.36 \pm 0.09 {}^{+0.06}_{-0.05}$		[3] ABE 99D	CDF	$p\overline{p}$ at 1.8 TeV
$1.34 {}^{+0.23}_{-0.19} \pm 0.05$		[4] ABE 98B	CDF	$p\overline{p}$ at 1.8 TeV
$1.72 {}^{+0.20}_{-0.19} {}^{+0.18}_{-0.17}$		[5] ACKERSTAFF 98F	OPAL	$e^+e^- \rightarrow Z$
$1.50 {}^{+0.16}_{-0.15} \pm 0.04$		[3] ACKERSTAFF 98G	OPAL	$e^+e^- \rightarrow Z$
$1.47 \pm 0.14 \pm 0.08$		[6] BARATE 98C	ALEP	$e^+e^- \rightarrow Z$
$1.56 {}^{+0.29}_{-0.26} {}^{+0.08}_{-0.07}$		[3] ABREU 96F	DLPH	$e^+e^- \rightarrow Z$
$1.65 {}^{+0.34}_{-0.31} \pm 0.12$		[6] ABREU 96F	DLPH	$e^+e^- \rightarrow Z$
$1.76 \pm 0.20 {}^{+0.15}_{-0.10}$		[7] ABREU 96F	DLPH	$e^+e^- \rightarrow Z$
$1.60 \pm 0.26 {}^{+0.13}_{-0.15}$		[8] ABREU 96F	DLPH	$e^+e^- \rightarrow Z$
$1.54 {}^{+0.14}_{-0.13} \pm 0.04$		[3] BUSKULIC 96M	ALEP	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.51 ± 0.11		[9] BARATE 98C	ALEP	$e^+e^- \rightarrow Z$
$1.34 {}^{+0.23}_{-0.19} \pm 0.05$		[10] ABE 96N	CDF	Repl. by ABE 98B
1.67 ± 0.14		[11] ABREU 96F	DLPH	$e^+e^- \rightarrow Z$
$1.61 {}^{+0.30}_{-0.29} {}^{+0.18}_{-0.16}$	90	[6] BUSKULIC 96E	ALEP	Repl. by BARATE 98C
$1.42 {}^{+0.27}_{-0.23} \pm 0.11$	76	[3] ABE 95R	CDF	Repl. by ABE 99D
$1.74 {}^{+1.08}_{-0.69} \pm 0.07$	8	[12] ABE 95R	CDF	Sup. by ABE 96N
$1.54 {}^{+0.25}_{-0.21} \pm 0.06$	79	[3] AKERS 95G	OPAL	Repl. by ACKERSTAFF 98G
$1.59 {}^{+0.17}_{-0.15} \pm 0.03$	134	[3] BUSKULIC 95O	ALEP	Sup. by BUSKULIC 96M
0.96 ± 0.37	41	[13] ABREU 94E	DLPH	Sup. by ABREU 96F
$1.92 {}^{+0.45}_{-0.35} \pm 0.04$	31	[3] BUSKULIC 94C	ALEP	Sup. by BUSKULIC 95O
$1.13 {}^{+0.35}_{-0.26} \pm 0.09$	22	[3] ACTON 93H	OPAL	Sup. by AKERS 95G

[3] Measured using $D_s^- \ell^+$ vertices.

[4] Measured using fully reconstructed $B_s \rightarrow J/\psi(1S)\phi$ decay.

[5] ACKERSTAFF 98F use fully reconstructed $D_s^- \rightarrow \phi\pi^-$ and $D_s^- \rightarrow K^{*0}K^-$ in the inclusive B_s^0 decay.

[6] Measured using D_s hadron vertices.

[7] Measured using $\phi\ell$ vertices.

[8] Measured using inclusive D_s vertices.

[9] Combined results from $D_s^- \ell^+$ and D_s hadron.

[10] ABE 96N uses 58 ± 12 exclusive $B_s \rightarrow J/\psi(1S)\phi$ events.

[11] Combined result for the four ABREU 96F methods.

[12] Exclusive reconstruction of $B_s \rightarrow \psi\phi$.

[13] ABREU 94E uses the flight-distance distribution of D_s vertices, ϕ-lepton vertices, and $D_s \mu$ vertices.

$\left|\Delta\Gamma_{B_s^0}\right| / \Gamma_{B_s^0}$

$\Gamma_{B_s^0}$ and $\left|\Delta\Gamma_{B_s^0}\right|$ are the decay rate average and difference between two B_s^0 *CP* eigenstates.

The first "OUR EVALUATION," < 0.33 (CL=95%), also provided by the LEP B Oscillation Working Group, including the assumption of $\Gamma_s = \frac{1}{\tau_{B_d}}$.

The second "OUR EVALUATION," < 0.65 (CL=95%), is an average of all available B_s semi-leptonic lifetime measurements with the $\Delta\Gamma_{B_s^0}/\Gamma_s$ analyses performed by the LEP B Osciallation Working Group as described in our "Review on B-$\overline{B}$ Mixing" in the B^0 Section of these Listings.

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.65 (CL = 95%) OUR EVALUATION					
<0.33 (CL = 95%) OUR EVALUATION					
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.83	95	[14] ABE	99D	CDF	$p\overline{p}$ at 1.8 TeV
<0.67	95	[15] ACCIARRI	98S	L3	$e^+e^- \rightarrow Z$

[14] ABE 99D assumes $\tau_{B_s^0} = 1.55 \pm 0.05$ ps.

[15] ACCIARRI 98S assumes $\tau_{B_s^0} = 1.49 \pm 0.06$ ps and PDG 98 values of b production fraction.

B_s^0 DECAY MODES

These branching fractions all scale with B($\overline{b} \rightarrow B_s^0$), the LEP B_s^0 production fraction. The first four were evaluated using B($\overline{b} \rightarrow B_s^0$) = (10.7 ± 1.4)% and the rest assume B($\overline{b} \rightarrow B_s^0$) = 12%.

The branching fraction B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$anything) is not a pure measurement since the measured product branching fraction B($\overline{b} \rightarrow B_s^0$) × B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$anything) was used to determine B($\overline{b} \rightarrow B_s^0$), as described in the note on "Production and Decay of b-Flavored Hadrons."

	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	D_s^- anything		$(92 \pm 31)\ \%$	
Γ_2	$D_s^- \ell^+ \nu_\ell$ anything	[a]	$(8.1 \pm 2.4)\ \%$	
Γ_3	$D_s^- \pi^+$		$< 13\ \%$	
Γ_4	$D_s^{(*)+} D_s^{(*)-}$		$< 21.8\ \%$	90%
Γ_5	$J/\psi(1S)\phi$		$(9.3 \pm 3.3) \times 10^{-4}$	
Γ_6	$J/\psi(1S)\pi^0$		$< 1.2 \times 10^{-3}$	90%
Γ_7	$J/\psi(1S)\eta$		$< 3.8 \times 10^{-3}$	90%
Γ_8	$\psi(2S)\phi$		seen	
Γ_9	$\pi^+\pi^-$		$< 1.7 \times 10^{-4}$	90%
Γ_{10}	$\pi^0\pi^0$		$< 2.1 \times 10^{-4}$	90%
Γ_{11}	$\eta\pi^0$		$< 1.0 \times 10^{-3}$	90%
Γ_{12}	$\eta\eta$		$< 1.5 \times 10^{-3}$	90%
Γ_{13}	$\pi^+ K^-$		$< 2.1 \times 10^{-4}$	90%
Γ_{14}	$K^+ K^-$		$< 5.9 \times 10^{-5}$	90%
Γ_{15}	$p\overline{p}$		$< 5.9 \times 10^{-5}$	90%
Γ_{16}	$\gamma\gamma$		$< 1.48 \times 10^{-4}$	90%
Γ_{17}	$\phi\gamma$		$< 7 \times 10^{-4}$	90%

Lepton Family number (*LF*) violating modes or $\Delta B = 1$ weak neutral current (*B1*) modes

				Fraction	
Γ_{18}	$\mu^+\mu^-$	*B1*		$< 2.0 \times 10^{-6}$	90%
Γ_{19}	$e^+ e^-$	*B1*		$< 5.4 \times 10^{-5}$	90%
Γ_{20}	$e^\pm \mu^\mp$	*LF*	[b]	$< 6.1 \times 10^{-6}$	90%
Γ_{21}	$\phi\nu\overline{\nu}$	*B1*		$< 5.4 \times 10^{-3}$	90%

[a] Not a pure measurement. See note at head of B_s^0 Decay Modes.

[b] The value is for the sum of the charge states or particle/antiparticle states indicated.

B_s^0 BRANCHING RATIOS

$\Gamma(D_s^-\text{ anything})/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.92±0.31 OUR AVERAGE					
0.81±0.24±0.22	90	[16] BUSKULIC	96E	ALEP	$e^+ e^- \rightarrow Z$
1.56±0.58±0.44	147	[17] ACTON	92N	OPAL	$e^+ e^- \rightarrow Z$

[16] BUSKULIC 96E separate $c\overline{c}$ and $b\overline{b}$ sources of D_s^+ mesons using a lifetime tag, subtract generic $\overline{b} \rightarrow W^+ \rightarrow D_s^+$ events, and obtain $B(\overline{b} \rightarrow B_s^0) \times B(B_s^0 \rightarrow D_s^-\text{ anything}) = 0.088 \pm 0.020 \pm 0.020$ assuming $B(D_s \rightarrow \phi\pi) = (3.5 \pm 0.4) \times 10^{-2}$ and PDG 1994 values for the relative partial widths to other D_s channels. We evaluate using our current values $B(\overline{b} \rightarrow B_s^0) = 0.107 \pm 0.014$ and $B(D_s \rightarrow \phi\pi) = 0.036 \pm 0.009$. Our first

error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$).

[17] ACTON 92N assume that excess of 147 ± 48 D_s^0 events over that expected from B^0, B^+, and $c\overline{c}$ is all from B_s^0 decay. The product branching fraction is measured to be B($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^-$ anything)×B($D_s^- \rightarrow \phi\pi^-$) = $(5.9 \pm 1.9 \pm 1.1) \times 10^{-3}$. We evaluate using our current values B($\overline{b} \rightarrow B_s^0$) = 0.107 ± 0.014 and B($D_s \rightarrow \phi\pi$) = 0.036 ± 0.009. Our first error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$).

$\Gamma(D_s^- \ell^+ \nu_\ell \text{anything})/\Gamma_{\text{total}}$ Γ_2/Γ

The values and averages in this section serve only to show what values result if one assumes our B($\overline{b} \rightarrow B_s^0$). They cannot be thought of as measurements since the underlying product branching fractions were also used to determinine B($\overline{b} \rightarrow B_s^0$) as described in the note on "Production and Decay of *b*-Flavored Hadrons."

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.081±0.024 OUR AVERAGE					
0.076±0.012±0.021	134	[18] BUSKULIC	95O	ALEP	$e^+e^- \rightarrow Z$
0.107±0.043±0.029		[19] ABREU	92M	DLPH	$e^+e^- \rightarrow Z$
0.103±0.036±0.028	18	[20] ACTON	92N	OPAL	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.13 ±0.04 ±0.04	27	[21] BUSKULIC	92E	ALEP	$e^+e^- \rightarrow Z$

[18] BUSKULIC 95O use $D_s \ell$ correlations. The measured product branching ratio is B($\overline{b} \rightarrow B_s$) × B($B_s \rightarrow D_s^- \ell^+ \nu_\ell$anything) = $(0.82 \pm 0.09^{+0.13}_{-0.14})$% assuming B($D_s \rightarrow \phi\pi$) = $(3.5 \pm 0.4) \times 10^{-2}$ and PDG 1994 values for the relative partial widths to the six other D_s channels used in this analysis. Combined with results from $\Upsilon(4S)$ experiments this can be used to extract B($\overline{b} \rightarrow B_s$) = $(11.0 \pm 1.2^{+2.5}_{-2.6})$%. We evaluate using our current values B($\overline{b} \rightarrow B_s^0$) = 0.107 ± 0.014 and B($D_s \rightarrow \phi\pi$) = 0.036 ± 0.009. Our first error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$).

[19] ABREU 92M measured muons only and obtained product branching ratio B($Z \rightarrow b$or $\overline{b}$) × B($\overline{b} \rightarrow B_s$) × B($B_s \rightarrow D_s \mu^+ \nu_\mu$anything) × B($D_s \rightarrow \phi\pi$) = $(18 \pm 8) \times 10^{-5}$. We evaluate using our current values B($\overline{b} \rightarrow B_s^0$) = 0.107 ± 0.014 and B($D_s \rightarrow \phi\pi$) = 0.036 ± 0.009. Our first error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$). We use B($Z \rightarrow b$or $\overline{b}$) = 2B($Z \rightarrow b\overline{b}$) = 2×(0.2212 ± 0.0019).

[20] ACTON 92N is measured using $D_s \rightarrow \phi\pi^+$ and $K^*(892)^0 K^+$ events. The product branching fraction measured is measured to be B($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$anything) ×B($D_s^- \rightarrow \phi\pi^-$) = $(3.9 \pm 1.1 \pm 0.8) \times 10^{-4}$. We evaluate using our current values B($\overline{b} \rightarrow B_s^0$) = 0.107 ± 0.014 and B($D_s \rightarrow \phi\pi$) = 0.036 ± 0.009. Our first error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$).

[21] BUSKULIC 92E is measured using $D_s \rightarrow \phi\pi^+$ and $K^*(892)^0 K^+$ events. They use 2.7 ± 0.7% for the $\phi\pi^+$ branching fraction. The average product branching fraction is measured to be B($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$anything) =$0.020 \pm 0.0055^{+0.005}_{-0.006}$. We evaluate using our current values B($\overline{b} \rightarrow B_s^0$) = 0.107 ± 0.014 and B($D_s \rightarrow \phi\pi$) = 0.036 ± 0.009. Our first error is their experiment's and our second error is that due to B($\overline{b} \rightarrow B_s^0$) and B($D_s \rightarrow \phi\pi$). Superseded by BUSKULIC 95O.

$\Gamma(D_s^- \pi^+)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.13	6	[22] AKERS	94J	OPAL	$e^+e^- \to Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	1	BUSKULIC	93G	ALEP	$e^+e^- \to Z$

[22] AKERS 94J sees ≤ 6 events and measures the limit on the product branching fraction $f(\overline{b} \to B_s^0) \cdot \mathrm{B}(B_s^0 \to D_s^- \pi^+) < 1.3\%$ at CL = 90%. We divide by our current value $\mathrm{B}(\overline{b} \to B_s^0) = 0.105$.

$\Gamma(D_s^{(*)+} D_s^{(*)-})/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.218	90	BARATE	98Q	ALEP	$e^+e^- \to Z$

$\Gamma(J/\psi(1S)\phi)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.93±0.28±0.17		[23] ABE	96Q	CDF	$p\overline{p}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<6	1	[24] AKERS	94J	OPAL	$e^+e^- \to Z$
seen	14	[25] ABE	93F	CDF	$p\overline{p}$ at 1.8 TeV
seen	1	[26] ACTON	92N	OPAL	Sup. by AKERS 94J

[23] ABE 96Q assumes $f_u = f_d$ and $f_s/f_u = 0.40 \pm 0.06$. Uses $B \to J/\psi(1S)K$ and $B \to J/\psi(1S)K^*$ branching fractions from PDG 94. They quote two systematic errors, ±0.10 and ±0.14 where the latter is the uncertainty in f_s. We combine in quadrature.

[24] AKERS 94J sees one event and measures the limit on the product branching fraction $f(\overline{b} \to B_s^0) \cdot \mathrm{B}(B_s^0 \to J/\psi(1S)\phi) < 7 \times 10^{-4}$ at CL = 90%. We divide by $\mathrm{B}(\overline{b} \to B_s^0) = 0.112$.

[25] ABE 93F measured using $J/\psi(1S) \to \mu^+\mu^-$ and $\phi \to K^+K^-$.

[26] In ACTON 92N a limit on the product branching fraction is measured to be $f(\overline{b} \to B_s^0) \cdot \mathrm{B}(B_s^0 \to J/\psi(1S)\phi) \leq 0.22 \times 10^{-2}$.

$\Gamma(J/\psi(1S)\pi^0)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*
$<1.2 \times 10^{-3}$	90	[27] ACCIARRI	97C	L3

[27] ACCIARRI 97C assumes B^0 production fraction (39.5 ± 4.0%) and B_s (12.0 ± 3.0%).

$\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*
$<3.8 \times 10^{-3}$	90	[28] ACCIARRI	97C	L3

[28] ACCIARRI 97C assumes B^0 production fraction (39.5 ± 4.0%) and B_s (12.0 ± 3.0%).

$\Gamma(\psi(2S)\phi)/\Gamma_{\text{total}}$ Γ_8/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
seen	1	BUSKULIC	93G	ALEP	$e^+e^- \to Z$

$\Gamma(\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_9/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<1.7 \times 10^{-4}$	90	[29] BUSKULIC 96V	ALEP	$e^+e^- \rightarrow Z$

[29] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.

$\Gamma(\pi^0\pi^0)/\Gamma_{\text{total}}$ Γ_{10}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<2.1 \times 10^{-4}$	90	[30] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

[30] ACCIARRI 95H assumes $f_{B^0} = 39.5 \pm 4.0$ and $f_{B_s} = 12.0 \pm 3.0\%$.

$\Gamma(\eta\pi^0)/\Gamma_{\text{total}}$ Γ_{11}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<1.0 \times 10^{-3}$	90	[31] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

[31] ACCIARRI 95H assumes $f_{B^0} = 39.5 \pm 4.0$ and $f_{B_s} = 12.0 \pm 3.0\%$.

$\Gamma(\eta\eta)/\Gamma_{\text{total}}$ Γ_{12}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<1.5 \times 10^{-3}$	90	[32] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

[32] ACCIARRI 95H assumes $f_{B^0} = 39.5 \pm 4.0$ and $f_{B_s} = 12.0 \pm 3.0\%$.

$\Gamma(\pi^+K^-)/\Gamma_{\text{total}}$ Γ_{13}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<2.1 \times 10^{-4}$	90	[33] BUSKULIC 96V	ALEP	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<2.6 \times 10^{-4}$	90	[34] AKERS 94L	OPAL	$e^+e^- \rightarrow Z$

[33] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.

[34] Assumes B($Z \rightarrow b\overline{b}$) = 0.217 and B^0_d (B^0_s) fraction 39.5% (12%).

$\Gamma(K^+K^-)/\Gamma_{\text{total}}$ Γ_{14}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<5.9 \times 10^{-5}$	90	[35] BUSKULIC 96V	ALEP	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<1.4 \times 10^{-4}$	90	[36] AKERS 94L	OPAL	$e^+e^- \rightarrow Z$

[35] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.

[36] Assumes B($Z \rightarrow b\overline{b}$) = 0.217 and B^0_d (B^0_s) fraction 39.5% (12%).

$\Gamma(p\overline{p})/\Gamma_{\text{total}}$ Γ_{15}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<5.9 \times 10^{-5}$	90	[37] BUSKULIC 96V	ALEP	$e^+e^- \rightarrow Z$

[37] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.

$\Gamma(\gamma\gamma)/\Gamma_{\text{total}}$ Γ_{16}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<14.8 \times 10^{-5}$	90	[38] ACCIARRI 95I	L3	$e^+e^- \rightarrow Z$

[38] ACCIARRI 95I assumes $f_{B^0} = 39.5 \pm 4.0$ and $f_{B_s} = 12.0 \pm 3.0\%$.

$\Gamma(\phi\gamma)/\Gamma_{\text{total}}$ Γ_{17}/Γ

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<7 \times 10^{-4}$	90	[39] ADAM 96D	DLPH	$e^+e^- \rightarrow Z$

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

$\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ Γ_{18}/Γ

Test for $\Delta B = 1$ weak neutral current.

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<2.0 \times 10^{-6}$	90	[40] ABE 98	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<3.8 \times 10^{-5}$	90	[41] ACCIARRI 97B	L3	$e^+e^- \rightarrow Z$
$<8.4 \times 10^{-6}$	90	[42] ABE 96L	CDF	Repl. by ABE 98

[40] ABE 98 assumes production of $\sigma(B^0) = \sigma(B^+)$ and $\sigma(B_s)/\sigma(B^0) = 1/3$. They normalize to their measured $\sigma(B^0, p_T(B) > 6, |y| < 1.0) = 2.39 \pm 0.32 \pm 0.44\,\mu$b.

[41] ACCIARRI 97B assume PDG 96 production fractions for B^+, B^0, B_s, and Λ_b.

[42] ABE 96L assumes B^+/B_s production ratio 3/1. They normalize to their measured $\sigma(B^+, p_T(B) > 6\text{ GeV}/c, |y| < 1) = 2.39 \pm 0.54\,\mu$b.

$\Gamma(e^+e^-)/\Gamma_{\text{total}}$ Γ_{19}/Γ

Test for $\Delta B = 1$ weak neutral current.

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<5.4 \times 10^{-5}$	90	[43] ACCIARRI 97B	L3	$e^+e^- \rightarrow Z$

[43] ACCIARRI 97B assume PDG 96 production fractions for B^+, B^0, B_s, and Λ_b.

$\Gamma(e^\pm\mu^\mp)/\Gamma_{\text{total}}$ Γ_{20}/Γ

test of lepton family number conservation.

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<6.1 \times 10^{-6}$ (CL = 90%) [$<4.1 \times 10^{-5}$ (CL = 90%) OUR 1998 BEST LIMIT]				
$<6.1 \times 10^{-6}$	90	ABE 98V	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<4.1 \times 10^{-5}$	90	[44] ACCIARRI 97B	L3	$e^+e^- \rightarrow Z$

[44] ACCIARRI 97B assume PDG 96 production fractions for B^+, B^0, B_s, and Λ_b.

$\Gamma(\phi\nu\overline{\nu})/\Gamma_{\text{total}}$ Γ_{21}/Γ

Test for $\Delta B = 1$ weak neutral current.

VALUE	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
$<5.4 \times 10^{-3}$	90	[45] ADAM 96D	DLPH	$e^+e^- \rightarrow Z$

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

POLARIZATION IN B_s^0 DECAY

Γ_L/Γ in $B_s^0 \rightarrow J/\psi(1S)\phi$

VALUE	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
$0.56 \pm 0.21^{+0.02}_{-0.04}$	19	ABE 95Z	CDF	$p\overline{p}$ at 1.8 TeV

B^0_s-$\overline{B}^0_s$ MIXING

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

χ_s is a measure of the time-integrated B^0_s-$\overline{B}^0_s$ mixing probability that produced $B^0_s(\overline{B}^0_s)$ decays as a $\overline{B}^0_s(B^0_s)$. Mixing violates $\Delta B \neq 2$ rule.

$$\chi_s = \frac{x_s^2}{2(1+x_s^2)}$$

$$x_s = \frac{\Delta m_{B^0_s}}{\Gamma_{B^0_s}} = (m_{B^0_{sH}} - m_{B^0_{sL}})\,\tau_{B^0_s}\,,$$

where H, L stand for heavy and light states of two B^0_s CP eigenstates and $\tau_{B^0_s} = \frac{1}{0.5(\Gamma_{B^0_{sH}}+\Gamma_{B^0_{sL}})}$.

χ_B at high energy

This is a B-$\overline{B}$ mixing measurement for an admixture of B^0 and B^0_s at high energy.

$\chi_B = f'_d \chi_d + f'_s \chi_s$

where f'_d and f'_s are the branching ratio times production fractions of B^0_d and B^0_s mesons relative to all b-flavored hadrons which decay weakly. Mixing violates $\Delta B \neq 2$ rule.

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
0.118 ±0.005 OUR AVERAGE					
$0.1192 \pm 0.0068 \pm 0.0051$			[46] ACCIARRI 99D	L3	$e^+e^- \to Z$
$0.131 \pm 0.020 \pm 0.016$			[47] ABE 97I	CDF	$p\overline{p}$ 1.8 TeV
$0.1107 \pm 0.0062 \pm 0.0055$			[48] ALEXANDER 96	OPAL	$e^+e^- \to Z$
$0.121 \pm 0.016 \pm 0.006$			[49] ABREU 94J	DLPH	$e^+e^- \to Z$
$0.114 \pm 0.014 \pm 0.008$			[50] BUSKULIC 94G	ALEP	$e^+e^- \to Z$
0.129 ± 0.022			[51] BUSKULIC 92B	ALEP	$e^+e^- \to Z$
$0.176 \pm 0.031 \pm 0.032$		1112	[52] ABE 91G	CDF	$p\overline{p}$ 1.8 TeV
$0.148 \pm 0.029 \pm 0.017$			[53] ALBAJAR 91D	UA1	$p\overline{p}$ 630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$0.136 \pm 0.037 \pm 0.040$			[54] UENO 96	AMY	e^+e^- at 57.9 GeV
$0.144 \pm 0.014 {}^{+0.017}_{-0.011}$			[55] ABREU 94F	DLPH	Sup. by ABREU 94J
0.131 ± 0.014			[56] ABREU 94J	DLPH	$e^+e^- \to Z$
$0.123 \pm 0.012 \pm 0.008$			ACCIARRI 94D	L3	Repl. by ACCIARRI 99D
$0.157 \pm 0.020 \pm 0.032$			[57] ALBAJAR 94	UA1	$\sqrt{s} = 630$ GeV
$0.121 {}^{+0.044}_{-0.040} \pm 0.017$		1665	[58] ABREU 93C	DLPH	Sup. by ABREU 94J
$0.143 {}^{+0.022}_{-0.021} \pm 0.007$			[59] AKERS 93B	OPAL	Sup. by ALEXANDER 96
$0.145 {}^{+0.041}_{-0.035} \pm 0.018$			[60] ACTON 92C	OPAL	$e^+e^- \to Z$

0.121 ± 0.017 ± 0.006		[61] ADEVA	92C	L3	Sup. by ACCIARRI 94D
0.132 ± 0.22 ${}^{+0.015}_{-0.012}$	823	[62] DECAMP	91	ALEP	$e^+e^- \rightarrow Z$
0.178 ${}^{+0.049}_{-0.040}$ ± 0.020		[63] ADEVA	90P	L3	$e^+e^- \rightarrow Z$
0.17 ${}^{+0.15}_{-0.08}$		[64,65] WEIR	90	MRK2	e^+e^- 29 GeV
0.21 ${}^{+0.29}_{-0.15}$		[64] BAND	88	MAC	$E^{ee}_{\rm cm}$= 29 GeV
>0.02	90	[64] BAND	88	MAC	$E^{ee}_{\rm cm}$= 29 GeV
0.121 ± 0.047		[64,66] ALBAJAR	87C	UA1	Repl. by ALBAJAR 91D
<0.12	90	[64,67] SCHAAD	85	MRK2	$E^{ee}_{\rm cm}$= 29 GeV

[46] ACCIARRI 99D uses maximum-likelihood fits to extract χ_b as well as the A^b_{FB} in $Z \rightarrow b\overline{b}$ events containing prompt leptons.

[47] Uses di-muon events.

[48] ALEXANDER 96 uses a maximum likelihood fit to simultaneously extract χ as well as the forward-backward asymmetries in $e^+e^- \rightarrow Z \rightarrow b\overline{b}$ and $c\overline{c}$.

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

[50] BUSKULIC 94G data analyzed using ee, $e\mu$, and $\mu\mu$ events.

[51] BUSKULIC 92B uses a jet charge technique combined with electrons and muons.

[52] ABE 91G measurement of χ is done with $e\mu$ and ee events.

[53] ALBAJAR 91D measurement of χ is done with dimuons.

[54] UENO 96 extracted χ from the energy dependence of the forward-backward asymmetry.

[55] 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 $\overline{\chi} = f_d\chi_d + 0.9 f_s\chi_s$.

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

[57] ALBAJAR 94 uses dimuon events. Not independent of ALBAJAR 91D.

[58] ABREU 93C data analyzed using ee, $e\mu$, and $\mu\mu$ events.

[59] AKERS 93B analysis performed using dilepton events.

[60] ACTON 92C uses electrons and muons. Superseded by AKERS 93B.

[61] ADEVA 92C uses electrons and muons.

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

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

[64] 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.

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

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

[67] Limit is average probability for hadron containing B quark to produce a positive lepton.

$\Delta m_{B^0_s} = m_{B^0_{sH}} - m_{B^0_{sL}}$

$\Delta m_{B^0_s}$ is a measure of 2π times the B^0_s-$\overline{B}^0_s$ oscillation frequency in time-dependent mixing experiments.

"OUR EVALUATION" is an average of the data listed below performed by the LEP B Oscillation Working Group as described in our "Review of B-$\overline{B}$ Mixing" in the B^0 Section of these Listings. The averaging procedure takes into account correlations between the measurements.

VALUE (10^{12} $\hbar$ s^{-1})	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
>10.6 (CL = 95%) OUR EVALUATION				
$>$ 5.2	95	[68] ABBIENDI 99S	OPAL	$e^+e^- \rightarrow Z$
$>$ 5.8	95	[69] ABE 99J	CDF	$p\overline{p}$ at 1.8 TeV
$>$ 9.6	95	[70] BARATE 99J	ALEP	$e^+e^- \rightarrow Z$
$>$ 6.5	95	[71] ADAM 97	DLPH	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<$96	95	[72] ABE 99D	CDF	$p\overline{p}$ at 1.8 TeV
$>$ 7.9	95	[73] BARATE 98C	ALEP	Repl. by BARATE 99J
$>$ 3.1	95	[74] ACKERSTAFF 97U	OPAL	Repl. by ABBIENDI 99S
$>$ 2.2	95	[75] ACKERSTAFF 97V	OPAL	Repl. by ABBIENDI 99S
$>$ 6.6	95	[76] BUSKULIC 96M	ALEP	Repl. by BARATE 98C
$>$ 2.2	95	[75] AKERS 95J	OPAL	Sup. by ACKERSTAFF 97V
$>$ 5.7	95	[77] BUSKULIC 95J	ALEP	$e^+e^- \rightarrow Z$
$>$ 1.8	95	[75] BUSKULIC 94B	ALEP	$e^+e^- \rightarrow Z$

[68] Uses ℓ-Q_{hem} and ℓ-ℓ.

[69] ABE 99J uses ϕ ℓ-ℓ correlation.

[70] BARATE 99J uses combination of an inclusive lepton and D_s^--based analyses.

[71] ADAM 97 combines results from $D_s \ell$-Q_{hem}, ℓ-Q_{hem}, and ℓ-ℓ.

[72] ABE 99D assumes $\tau_{B_s^0} = 1.55 \pm 0.05$ ps and $\Delta\Gamma/\Delta m = (5.6 \pm 2.6) \times 10^{-3}$.

[73] BARATE 98C combines results from $D_s h$-ℓ/Q_{hem}, $D_s h$-K in the same side, $D_s \ell$-ℓ/Q_{hem} and $D_s \ell$-K in the same side.

[74] Uses ℓ-Q_{hem}.

[75] Uses ℓ-ℓ.

[76] BUSKULIC 96M uses D_s lepton correlations and lepton, kaon, and jet charge tags.

[77] BUSKULIC 95J uses ℓ-Q_{hem}. They find $\Delta m_s > 5.6$ [> 6.1] for f_s=10% [12%]. We interpolate to our central value f_s=10.5%.

$x_s = \Delta m_{B_s^0}/\Gamma_{B_s^0}$

This is derived by the LEP B Oscillation Working Group from the results on $\Delta m_{B_s^0}$ and "OUR EVALUATION" of the B_s^0 mean lifetime.

VALUE	*CL%*	*DOCUMENT ID*
>15.7 (CL = 95%) OUR EVALUATION		

χ_s

This B_s^0-$\overline{B}_s^0$ integrated mixing parameter is derived from x_s above.

VALUE	*CL%*	*DOCUMENT ID*
>0.4980 (CL = 95%) OUR EVALUATION		

B^0_s REFERENCES

ABBIENDI	99S	EPJ C11 587	G. Abbiendi *et al.*	(OPAL Collab.)
ABE	99D	PR D59 032004	F. Abe *et al.*	(CDF Collab.)
ABE	99J	PRL 82 3576	F. Abe *et al.*	(CDF Collab.)
ACCIARRI	99D	PL B448 152	M. Acciarri *et al.*	(L3 Collab.)
BARATE	99J	EPJ C7 553	R Barate *et al.*	(ALEPH Collab.)
Also	00	EPJ C12 181 (erratum)		(ALEPH Collab.)
ABE	98	PR D57 R3811	F. Abe *et al.*	(CDF Collab.)
ABE	98B	PR D57 5382	F. Abe *et al.*	(CDF Collab.)
ABE	98V	PRL 81 5742	F. Abe *et al.*	(CDF Collab.)
ACCIARRI	98S	PL B438 417	M. Acciarri *et al.*	(L3 Collab.)
ACKERSTAFF	98F	EPJ C2 407	K. Ackerstaff *et al.*	(OPAL Collab.)
ACKERSTAFF	98G	PL B426 161	K. Ackerstaff *et al.*	(OPAL Collab.)
BARATE	98C	EPJ C4 367	R. Barate *et al.*	(ALEPH Collab.)
BARATE	98Q	EPJ C4 387	R. Barate *et al.*	(ALEPH Collab.)
PDG	98	EPJ C3 1	C. Caso *et al.*	
ABE	97I	PR D55 2546	F. Abe *et al.*	(CDF Collab.)
ACCIARRI	97B	PL B391 474	M. Acciarri *et al.*	(L3 Collab.)
ACCIARRI	97C	PL B391 481	M. Acciarri *et al.*	(L3 Collab.)
ACKERSTAFF	97U	ZPHY C76 401	K. Ackerstaff *et al.*	(OPAL Collab.)
ACKERSTAFF	97V	ZPHY C76 417	K. Ackerstaff *et al.*	(OPAL Collab.)
ADAM	97	PL B414 382	W. Adam *et al.*	(DELPHI Collab.)
ABE	96B	PR D53 3496	F. Abe *et al.*	(CDF Collab.)
ABE	96L	PRL 76 4675	F. Abe *et al.*	(CDF Collab.)
ABE	96N	PRL 77 1945	F. Abe *et al.*	(CDF Collab.)
ABE	96Q	PR D54 6596	F. Abe *et al.*	(CDF Collab.)
ABREU	96F	ZPHY C71 11	P. Abreu *et al.*	(DELPHI Collab.)
ADAM	96D	ZPHY C72 207	W. Adam *et al.*	(DELPHI Collab.)
ALEXANDER	96	ZPHY C70 357	G. Alexander *et al.*	(OPAL Collab.)
BUSKULIC	96E	ZPHY C69 585	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	96M	PL B377 205	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	96V	PL B384 471	D. Buskulic *et al.*	(ALEPH Collab.)
PDG	96	PR D54 1		
UENO	96	PL B381 365	K. Ueno *et al.*	(AMY Collab.)
ABE	95R	PRL 74 4988	F. Abe *et al.*	(CDF Collab.)
ABE	95Z	PRL 75 3068	F. Abe *et al.*	(CDF Collab.)
ACCIARRI	95H	PL B363 127	M. Acciarri *et al.*	(L3 Collab.)
ACCIARRI	95I	PL B363 137	M. Acciarri *et al.*	(L3 Collab.)
AKERS	95G	PL B350 273	R. Akers *et al.*	(OPAL Collab.)
AKERS	95J	ZPHY C66 555	R. Akers *et al.*	(OPAL Collab.)
BUSKULIC	95J	PL B356 409	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	95O	PL B361 221	D. Buskulic *et al.*	(ALEPH Collab.)
ABREU	94D	PL B324 500	P. Abreu *et al.*	(DELPHI Collab.)
ABREU	94E	ZPHY C61 407	P. Abreu *et al.*	(DELPHI Collab.)
Also	92M	PL B289 199	P. Abreu *et al.*	(DELPHI Collab.)
ABREU	94F	PL B322 459	P. Abreu *et al.*	(DELPHI Collab.)
ABREU	94J	PL B332 488	P. Abreu *et al.*	(DELPHI Collab.)
ACCIARRI	94D	PL B335 542	M. Acciarri *et al.*	(L3 Collab.)
AKERS	94J	PL B337 196	R. Akers *et al.*	(OPAL Collab.)
AKERS	94L	PL B337 393	R. Akers *et al.*	(OPAL Collab.)
ALBAJAR	94	ZPHY C61 41	C. Albajar *et al.*	(UA1 Collab.)
BUSKULIC	94B	PL B322 441	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	94C	PL B322 275	D. Buskulic *et al.*	(ALEPH Collab.)
BUSKULIC	94G	ZPHY C62 179	D. Buskulic *et al.*	(ALEPH Collab.)
PDG	94	PR D50 1173	L. Montanet *et al.*	(CERN, LBL, BOST+)
ABE	93F	PRL 71 1685	F. Abe *et al.*	(CDF Collab.)
ABREU	93C	PL B301 145	P. Abreu *et al.*	(DELPHI Collab.)
ACTON	93H	PL B312 501	P.D. Acton *et al.*	(OPAL Collab.)
AKERS	93B	ZPHY C60 199	R. Akers *et al.*	(OPAL Collab.)
BUSKULIC	93G	PL B311 425	D. Buskulic *et al.*	(ALEPH Collab.)
ABREU	92M	PL B289 199	P. Abreu *et al.*	(DELPHI Collab.)
ACTON	92C	PL B276 379	D.P. Acton *et al.*	(OPAL Collab.)
ACTON	92N	PL B295 357	P.D. Acton *et al.*	(OPAL Collab.)
ADEVA	92C	PL B288 395	B. Adeva *et al.*	(L3 Collab.)
BUSKULIC	92B	PL B284 177	D. Buskulic *et al.*	(ALEPH Collab.)

BUSKULIC 92E PL B294 145 D. Buskulic *et al.* (ALEPH Collab.)
ABE 91G PRL 67 3351 F. Abe *et al.* (CDF Collab.)
ALBAJAR 91D PL B262 171 C. Albajar *et al.* (UA1 Collab.)
DECAMP 91 PL B258 236 D. Decamp *et al.* (ALEPH Collab.)
ADEVA 90P PL B252 703 B. Adeva *et al.* (L3 Collab.)
LEE-FRANZINI 90 PRL 65 2947 J. Lee-Franzini *et al.* (CUSB II Collab.)
WEIR 90 PL B240 289 A.J. Weir *et al.* (Mark II Collab.)
BAND 88 PL B200 221 H.R. Band *et al.* (MAC Collab.)
ALBAJAR 87C PL B186 247 C. Albajar *et al.* (UA1 Collab.)
SCHAAD 85 PL 160B 188 T. Schaad *et al.* (Mark II Collab.)