B_s^0

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

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

B_s^0 MASS

The fit uses m_{B^+}, $(m_{B^0} - m_{B^+})$, $m_{B_s^0}$, and $(m_{B_s^0} - (m_{B^+} + m_{B^0})/2)$ to determine m_{B^+}, m_{B^0}, $m_{B_s^0}$, and the mass differences.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
5369.3± 2.0 OUR 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	$e^+e^- \to Z$
5359 ±19 ±7	1	[1] AKERS	94J	OPAL	$e^+e^- \to Z$
5368.6± 5.6±1.5	2	BUSKULIC	93G	ALEP	$e^+e^- \to Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5370 ±40	6	[2] AKERS	94J	OPAL	$e^+e^- \to Z$
5383.3± 4.5±5.0	14	ABE	93F	CDF	Repl by ABE 96B

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

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

$m_{B_s^0} - m_B$

m_B is the average of our B masses $(m_{B^\pm}+m_{B^0})/2$. The fits uses m_{B^+}, $(m_{B^0} - m_{B^+})$, $m_{B_s^0}$, and $m_{B_s^0} - m_B$ to determine m_{B^+}, m_{B^0}, $m_{B_s^0}$, and the mass differences.

VALUE (MeV)	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
90.2±2.2 OUR 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	$e^+e^- \to \Upsilon(5S)$

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

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
1.54±0.07 OUR EVALUATION					
$1.34^{+0.23}_{-0.19}\pm0.05$		[3] ABE	98B	CDF	$p\overline{p}$ at 1.8 TeV
$1.72^{+0.20}_{-0.19}{}^{+0.18}_{-0.17}$		[4] ACKERSTAFF	98F	OPAL	$e^+e^- \to Z$
$1.50^{+0.16}_{-0.15}\pm0.04$		[5] ACKERSTAFF	98G	OPAL	$e^+e^- \to Z$
$1.47\pm0.14\pm0.08$		[6] BARATE	98C	ALEP	$e^+e^- \to Z$
$1.56^{+0.29}_{-0.26}{}^{+0.08}_{-0.07}$		[5] ABREU	96F	DLPH	$e^+e^- \to Z$
$1.65^{+0.34}_{-0.31}\pm0.12$		[6] ABREU	96F	DLPH	$e^+e^- \to Z$
$1.76\pm0.20^{+0.15}_{-0.10}$		[7] ABREU	96F	DLPH	$e^+e^- \to Z$
$1.60\pm0.26^{+0.13}_{-0.15}$		[8] ABREU	96F	DLPH	$e^+e^- \to Z$
$1.54^{+0.14}_{-0.13}\pm0.04$		[5] BUSKULIC	96M	ALEP	$e^+e^- \to Z$
$1.42^{+0.27}_{-0.23}\pm0.11$	76	[5] ABE	95R	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1.51 ± 0.11		[9] BARATE	98C	ALEP	$e^+e^- \to Z$
$1.34^{+0.23}_{-0.19}\pm0.05$		[10] ABE	96N	CDF	Repl. by ABE 98B
1.67 ± 0.14		[11] ABREU	96F	DLPH	$e^+e^- \to Z$
$1.61^{+0.30}_{-0.29}{}^{+0.18}_{-0.16}$	90	[6] BUSKULIC	96E	ALEP	Repl. by BARATE 98C
$1.74^{+1.08}_{-0.69}\pm0.07$	8	[12] ABE	95R	CDF	Sup. by ABE 96N
$1.54^{+0.25}_{-0.21}\pm0.06$	79	[5] AKERS	95G	OPAL	Repl. by ACKERSTAFF 98G
$1.59^{+0.17}_{-0.15}\pm0.03$	134	[5] BUSKULIC	95O	ALEP	Sup. by BUSKULIC 96M
0.96 ± 0.37	41	[13] ABREU	94E	DLPH	Sup. by ABREU 96F
$1.92^{+0.45}_{-0.35}\pm0.04$	31	[5] BUSKULIC	94C	ALEP	Sup. by BUSKULIC 95O
$1.13^{+0.35}_{-0.26}\pm0.09$	22	[5] ACTON	93H	OPAL	Sup. by AKERS 95G

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

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

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

[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 $B_s \to J/\psi(1S)\phi$ 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.

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($\overline{b} \rightarrow B_s^0$) = $(10.5^{+1.8}_{-1.7})$% 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 ±33) %	
Γ_2	$D_s^- \ell^+ \nu_\ell$ anything		[a] (8.1 ± 2.5) %	
Γ_3	$D_s^- \pi^+$		< 13 %	
Γ_4	$J/\psi(1S)\phi$		(9.3 ± 3.3) × 10^{-4}	
Γ_5	$J/\psi(1S)\pi^0$		< 1.2 × 10^{-3}	90%
Γ_6	$J/\psi(1S)\eta$		< 3.8 × 10^{-3}	90%
Γ_7	$\psi(2S)\phi$		seen	
Γ_8	$\pi^+\pi^-$		< 1.7 × 10^{-4}	90%
Γ_9	$\pi^0\pi^0$		< 2.1 × 10^{-4}	90%
Γ_{10}	$\eta\pi^0$		< 1.0 × 10^{-3}	90%
Γ_{11}	$\eta\eta$		< 1.5 × 10^{-3}	90%
Γ_{12}	$\pi^+ K^-$		< 2.1 × 10^{-4}	90%
Γ_{13}	$K^+ K^-$		< 5.9 × 10^{-5}	90%
Γ_{14}	$p\overline{p}$		< 5.9 × 10^{-5}	90%
Γ_{15}	$\gamma\gamma$		< 1.48 × 10^{-4}	90%
Γ_{16}	$\phi\gamma$		< 7 × 10^{-4}	90%
	Lepton Family number (*LF*) violating modes or $\Delta B = 1$ weak neutral current (*B1*) modes			
Γ_{17}	$\mu^+\mu^-$	*B1*	< 2.0 × 10^{-6}	90%
Γ_{18}	$e^+ e^-$	*B1*	< 5.4 × 10^{-5}	90%
Γ_{19}	$e^\pm \mu^\mp$	*LF*	[b] < 4.1 × 10^{-5}	90%
Γ_{20}	$\phi\nu\overline{\nu}$	*B1*	< 5.4 × 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 of 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±0.33 OUR AVERAGE					
0.81±0.24±0.24	90	[14] BUSKULIC	96E	ALEP	$e^+e^- \rightarrow Z$
1.56±0.58±0.47	147	[15] ACTON	92N	OPAL	$e^+e^- \rightarrow Z$

[14] 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($\overline{b} \rightarrow B_s^0$) × B($B_s^0 \rightarrow D_s^-$ anything) = 0.088 ± 0.020 ± 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($\overline{b} \rightarrow B_s^0$) = $0.105^{+0.018}_{-0.017}$ 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($D_s \rightarrow \phi\pi$).

[15] 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($\overline{b} \rightarrow B_s^0$) = $0.105^{+0.018}_{-0.017}$ 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±0.025 OUR AVERAGE					
0.076±0.012±0.022	134	[16] BUSKULIC	95O	ALEP	$e^+e^- \rightarrow Z$
0.107±0.043±0.032		[17] ABREU	92M	DLPH	$e^+e^- \rightarrow Z$
0.103±0.036±0.031	18	[18] 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	[19] BUSKULIC	92E	ALEP	$e^+e^- \rightarrow Z$

[16] 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($\overline{b} \rightarrow B_s^0$) = $0.105^{+0.018}_{-0.017}$ 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($D_s \rightarrow \phi\pi$).

[17] 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($\overline{b} \rightarrow B_s^0$) = $0.105^{+0.018}_{-0.017}$ 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($\overline{b} \rightarrow B^0_s$) 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).

[18] 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($\overline{b} \rightarrow B^0_s$)B($B^0_s \rightarrow D^-_s \ell^+ \nu_\ell$ anything) ×B($D^-_s \rightarrow \phi\pi^-$) = (3.9 ± 1.1 ± 0.8) × 10^{-4}. We evaluate using our current values B($\overline{b} \rightarrow B^0_s$) = $0.105^{+0.018}_{-0.017}$ 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($\overline{b} \rightarrow B^0_s$) and B($D_s \rightarrow \phi\pi$).

[19] 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($\overline{b} \rightarrow B^0_s$)B($B^0_s \rightarrow D^-_s \ell^+ \nu_\ell$ anything) =0.020 ± $0.0055^{+0.005}_{-0.006}$. We evaluate using our current values B($\overline{b} \rightarrow B^0_s$) = $0.105^{+0.018}_{-0.017}$ 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($\overline{b} \rightarrow B^0_s$) and B($D_s \rightarrow \phi\pi$). Superseded by BUSKULIC 95O.

$\Gamma(D^-_s \pi^+)/\Gamma_{total}$ — Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
<0.13	6	[20] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	1	BUSKULIC	93G	ALEP	$e^+e^- \rightarrow Z$

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

$\Gamma(J/\psi(1S)\phi)/\Gamma_{total}$ — Γ_4/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
0.93±0.28±0.17		[21] ABE	96Q	CDF	$p\overline{p}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<6	1	[22] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
seen	14	[23] ABE	93F	CDF	$p\overline{p}$ at 1.8 TeV
seen	1	[24] ACTON	92N	OPAL	Sup. by AKERS 94J

[21] ABE 96Q assumes $f_u = f_d$ and f_s/f_u = 0.40 ± 0.06. Uses $B \rightarrow J/\psi(1S)K$ and $B \rightarrow J/\psi(1S)K^*$ 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.

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

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

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

$\Gamma(J/\psi(1S)\pi^0)/\Gamma_{total}$ — Γ_5/Γ

VALUE	CL%	DOCUMENT ID		TECN
<1.2 × 10^{-3}	90	[25] ACCIARRI	97C	L3

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

$\Gamma(J/\psi(1S)\eta)/\Gamma_{total}$ — Γ_6/Γ

VALUE	CL%	DOCUMENT ID	TECN
$<3.8 \times 10^{-3}$	90	[26] ACCIARRI 97C	L3

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

$\Gamma(\psi(2S)\phi)/\Gamma_{total}$ — Γ_7/Γ

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

$\Gamma(\pi^+\pi^-)/\Gamma_{total}$ — Γ_8/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.7 \times 10^{-4}$	90	[27] BUSKULIC 96V	ALEP	$e^+e^- \rightarrow Z$

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

$\Gamma(\pi^0\pi^0)/\Gamma_{total}$ — Γ_9/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<2.1 \times 10^{-4}$	90	[28] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

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

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.0 \times 10^{-3}$	90	[29] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

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

$\Gamma(\eta\eta)/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<1.5 \times 10^{-3}$	90	[30] ACCIARRI 95H	L3	$e^+e^- \rightarrow Z$

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

$\Gamma(\pi^+K^-)/\Gamma_{total}$ — Γ_{12}/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<2.1 \times 10^{-4}$	90	[31] 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	[32] AKERS 94L	OPAL	$e^+e^- \rightarrow Z$

[31] BUSKULIC 96V assumes PDG 96 production fractions for B^0, B^+, B_s, b baryons.
[32] Assumes B($Z \rightarrow b\overline{b}$) = 0.217 and B^0_d (B^0_s) fraction 39.5% (12%).

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

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$<5.9 \times 10^{-5}$	90	[33] 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	[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%).

$\Gamma(p\overline{p})/\Gamma_{total}$ — Γ_{14}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5.9 \times 10^{-5}$	90	[35] BUSKULIC	96V	ALEP	$e^+e^- \rightarrow Z$

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

$\Gamma(\gamma\gamma)/\Gamma_{total}$ — Γ_{15}/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<14.8 \times 10^{-5}$	90	[36] ACCIARRI	95I	L3	$e^+e^- \rightarrow Z$

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

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<7 \times 10^{-4}$	90	[37] ADAM	96D	DLPH	$e^+e^- \rightarrow Z$

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

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_{17}/Γ

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<2.0 \times 10^{-6}$	90	[38] 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	[39] ACCIARRI	97B	L3	$e^+e^- \rightarrow Z$
$<8.4 \times 10^{-6}$	90	[40] ABE	96L	CDF	Repl. by ABE 98

[38] 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.

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

[40] 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.

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

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5.4 \times 10^{-5}$	90	[41] ACCIARRI	97B	L3	$e^+e^- \rightarrow Z$

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

$\Gamma(e^\pm\mu^\mp)/\Gamma_{total}$ — Γ_{19}/Γ

test of lepton family number conservation.

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<4.1 \times 10^{-5}$	90	[42] ACCIARRI	97B	L3	$e^+e^- \rightarrow Z$

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

$\Gamma(\phi\nu\overline{\nu})/\Gamma_{total}$ — Γ_{20}/Γ

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5.4 \times 10^{-3}$	90	[43] ADAM	96D	DLPH	$e^+e^- \rightarrow Z$

[43] 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 $B_s^0 \to J/\psi(1S)\phi$

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

For a discussion of B_s^0-$\overline{B}_s^0$ 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_s^0-$\overline{B}_s^0$ mixing probability that produced $B_s^0(\overline{B}_s^0)$ decays as a $\overline{B}_s^0(B_s^0)$. Mixing violates $\Delta B \neq 2$ rule.

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

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

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

χ_B at high energy

This is a B-$\overline{B}$ mixing measurement for an admixture of B^0 and B_s^0 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_d^0 and B_s^0 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 ±0.006 OUR AVERAGE						
0.131 ±0.020 ±0.016			[44] ABE	97I	CDF	$p\overline{p}$ 1.8 TeV
0.1107±0.0062±0.0055			[45] ALEXANDER	96	OPAL	$e^+e^- \to Z$
0.121 ±0.016 ±0.006			[46] ABREU	94J	DLPH	$e^+e^- \to Z$
0.123 ±0.012 ±0.008			ACCIARRI	94D	L3	$e^+e^- \to Z$
0.114 ±0.014 ±0.008			[47] BUSKULIC	94G	ALEP	$e^+e^- \to Z$
0.129 ±0.022			[48] BUSKULIC	92B	ALEP	$e^+e^- \to Z$
0.176 ±0.031 ±0.032		1112	[49] ABE	91G	CDF	$p\overline{p}$ 1.8 TeV
0.148 ±0.029 ±0.017			[50] ALBAJAR	91D	UA1	$p\overline{p}$ 630 GeV

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

0.136	±0.037	±0.040			[51] UENO	96	AMY	e^+e^- at 57.9 GeV
0.144	±0.014	$^{+0.017}_{-0.011}$			[52] ABREU	94F	DLPH	Sup. by ABREU 94J
0.131	±0.014				[53] ABREU	94J	DLPH	$e^+e^- \to Z$
0.157	±0.020	±0.032			[54] ALBAJAR	94	UA1	$\sqrt{s}$ = 630 GeV
0.121	$^{+0.044}_{-0.040}$	±0.017		1665	[55] ABREU	93C	DLPH	Sup. by ABREU 94J
0.143	$^{+0.022}_{-0.021}$	±0.007			[56] AKERS	93B	OPAL	Sup. by ALEXANDER 96
0.145	$^{+0.041}_{-0.035}$	±0.018			[57] ACTON	92C	OPAL	$e^+e^- \to Z$
0.121	±0.017	±0.006			[58] ADEVA	92C	L3	Sup. by ACCIARRI 94D
0.132	±0.22	$^{+0.015}_{-0.012}$		823	[59] DECAMP	91	ALEP	$e^+e^- \to Z$
0.178	$^{+0.049}_{-0.040}$	±0.020			[60] ADEVA	90P	L3	$e^+e^- \to Z$
0.17	$^{+0.15}_{-0.08}$				[61,62] WEIR	90	MRK2	e^+e^- 29 GeV
0.21	$^{+0.29}_{-0.15}$				[61] BAND	88	MAC	$E^{ee}_{\rm cm}$= 29 GeV
>0.02			90		[61] BAND	88	MAC	$E^{ee}_{\rm cm}$= 29 GeV
0.121	±0.047				[61,63] ALBAJAR	87C	UA1	Repl. by ALBAJAR 91D
<0.12			90		[61,64] SCHAAD	85	MRK2	$E^{ee}_{\rm cm}$= 29 GeV

[44] Uses di-muon events.
[45] ALEXANDER 96 uses a maximum likelihood fit to simultaneously extract χ as well as the forward-backward asymmetries in $e^+e^- \to Z \to b\overline{b}$ and $c\overline{c}$.
[46] This ABREU 94J result is from 5182 $\ell\ell$ and 279 $\Lambda\ell$ events. The systematic error includes 0.004 for model dependence.
[47] BUSKULIC 94G data analyzed using ee, $e\mu$, and $\mu\mu$ events.
[48] BUSKULIC 92B uses a jet charge technique combined with electrons and muons.
[49] ABE 91G measurement of χ is done with $e\mu$ and ee events.
[50] ALBAJAR 91D measurement of χ is done with dimuons.
[51] UENO 96 extracted χ from the energy dependence of the forward-backward asymmetry.
[52] 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 $\overline{\chi} = f_d\chi_d + 0.9 f_s\chi_s$.
[53] This ABREU 94J result combines $\ell\ell$, $\Lambda\ell$, and jet-charge ℓ (ABREU 94F) analyses. It is for $\overline{\chi} = f_d\chi_d + 0.96 f_s\chi_s$.
[54] ALBAJAR 94 uses dimuon events. Not independent of ALBAJAR 91D.
[55] ABREU 93C data analyzed using ee, $e\mu$, and $\mu\mu$ events.
[56] AKERS 93B analysis performed using dilepton events.
[57] ACTON 92C uses electrons and muons. Superseded by AKERS 93B.
[58] ADEVA 92C uses electrons and muons.
[59] DECAMP 91 done with opposite and like-sign dileptons. Superseded by BUSKULIC 92B.
[60] ADEVA 90P measurement uses ee, $\mu\mu$, and $e\mu$ events from 118k events at the Z. Superseded by ADEVA 92C.
[61] 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.
[62] The WEIR 90 measurement supersedes the limit obtained in SCHAAD 85. The 90% CL are 0.06 and 0.38.
[63] ALBAJAR 87C measured $\chi = (\overline{B}^0 \to B^0 \to \mu^+ X)$ divided by the average production weighted semileptonic branching fraction for B hadrons at 546 and 630 GeV.
[64] 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 "Production and Decays of *B*-flavored Hadrons" in the $B^{\pm}$ 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
>9.1 (CL = 95%) OUR EVALUATION					
>7.9	95	[65] BARATE	98C	ALEP	$e^+e^- \to Z$
>3.1	95	[66] ACKERSTAFF	97U	OPAL	$e^+e^- \to Z$
>6.5	95	[67] ADAM	97	DLPH	$e^+e^- \to Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>2.2	95	[68] ACKERSTAFF	97V	OPAL	$e^+e^- \to Z$
>6.6	95	[69] BUSKULIC	96M	ALEP	Repl. by BARATE 98C
>2.2	95	[68] AKERS	95J	OPAL	Sup. by ACKERSTAFF 97V
>5.7	95	[70] BUSKULIC	95J	ALEP	$e^+e^- \to Z$
>1.8	95	[68] BUSKULIC	94B	ALEP	$e^+e^- \to Z$

[65] 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.

[66] Uses ℓ-Q_{hem}.

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

[68] Uses ℓ-ℓ.

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

[70] 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%.

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

This is derived from "OUR EVALUATION" of $\Delta m_{B^0_s}$ measurements and $\tau_{B^0_s} =$ 1.54 ps, our central value.

VALUE	CL%	DOCUMENT ID
>14.0 (CL = 95%) OUR EVALUATION		

χ_s

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

VALUE	CL%	DOCUMENT ID
>0.4975 (CL = 95%) OUR EVALUATION		

B_s^0 REFERENCES

ABE	98	PR D57 R3811	F. Abe+	(CDF Collab.)
ABE	98B	PR D57 5382	F. Abe+	(CDF Collab.)
ACKERSTAFF	98F	EPJ C2 407	K. Ackerstaff+	(OPAL Collab.)
ACKERSTAFF	98G	PL B426 161	K. Ackerstaff+	(OPAL Collab.)
BARATE	98C	EPJ C (to be publ.)	R. Barate+	(ALEPH Collab.)
CERN-PPE/97-157				
ABE	97I	PR D55 2546	F. Abe+	(CDF Collab.)
ACCIARRI	97B	PL B391 474	M. Acciarri+	(L3 Collab.)
ACCIARRI	97C	PL B391 481	M. Acciarri+	(L3 Collab.)
ACKERSTAFF	97U	ZPHY C76 401	K. Ackerstaff+	(OPAL Collab.)
ACKERSTAFF	97V	ZPHY C76 417	K. Ackerstaff+	(OPAL Collab.)
ADAM	97	PL B414 382	W. Adam+	(DELPHI Collab.)
ABE	96B	PR D53 3496	+Albrow, Amendolia, Amidei+	(CDF Collab.)
ABE	96L	PRL 76 4675	+Akimoto, Akopian, Albrow+	(CDF Collab.)
ABE	96N	PRL 77 1945	+Akimoto, Akopian, Albrow+	(CDF Collab.)
ABE	96Q	PR D54 6596	+Akimoto, Akopian, Albrow+	(CDF Collab.)
ABREU	96F	ZPHY C71 11	+Adam, Adye, Agasi+	(DELPHI Collab.)
ADAM	96D	ZPHY C72 207	W. Adam+	(DELPHI Collab.)
ALEXANDER	96	ZPHY C70 357	+Allison, Altekamp+	(OPAL Collab.)
BUSKULIC	96E	ZPHY C69 585	+Casper, De Bonis, Decamp+	(ALEPH Collab.)
BUSKULIC	96M	PL B377 205	+De Bonis, Decamp, Ghez+	(ALEPH Collab.)
BUSKULIC	96V	PL B384 471	+De Bonis, Decamp, Ghez+	(ALEPH Collab.)
PDG	96	PR D54 1		
UENO	96	PL B381 365	+Kanda, Olsen, Kirk+	(AMY Collab.)
ABE	95R	PRL 74 4988	+Albrow, Amendolia, Amidei+	(CDF Collab.)
ABE	95Z	PRL 75 3068	+Albrow, Amendolia, Amidei+	(CDF Collab.)
ACCIARRI	95H	PL B363 127	+Adam, Adriani, Aguilar-Benitez+	(L3 Collab.)
ACCIARRI	95I	PL B363 137	+Adam, Adriani, Aguilar-Benitez+	(L3 Collab.)
AKERS	95G	PL B350 273	+Alexander, Allison, Ametewee+	(OPAL Collab.)
AKERS	95J	ZPHY C66 555	+Alexander, Allison, Ametewee+	(OPAL Collab.)
BUSKULIC	95J	PL B356 409	+Casper, De Bonis, Decamp+	(ALEPH Collab.)
BUSKULIC	95O	PL B361 221	+Casper, De Bonis, Decamp+	(ALEPH Collab.)
ABREU	94D	PL B324 500	+Adam, Adye, Agasi, Aleksan+	(DELPHI Collab.)
ABREU	94E	ZPHY C61 407	+Adam, Adye, Agasi, Aleksan+	(DELPHI Collab.)
Also	92M	PL B289 199	Abreu, Adam, Adye, Agasi, Alekseev+	(DELPHI Collab.)
ABREU	94F	PL B322 459	+Adam, Adye, Agasi, Ajinenko+	(DELPHI Collab.)
ABREU	94J	PL B332 488	+Adam, Adye, Agasi, Ajinenko+	(DELPHI Collab.)
ACCIARRI	94D	PL B335 542	+Adam, Adriani, Aguilar-Benitez, Ahlen+	(L3 Collab.)
AKERS	94J	PL B337 196	+Alexander, Allison, Anderson, Arcelli+	(OPAL Collab.)
AKERS	94L	PL B337 393	+Alexander, Allison, Anderson, Arcelli+	(OPAL Collab.)
ALBAJAR	94	ZPHY C61 41	+Ankoviak, Bartha, Bezaguet, Boehrer+	(UA1 Collab.)
BUSKULIC	94B	PL B322 441	+De Bonis, Decamp, Ghez, Goy, Lees+	(ALEPH Collab.)
BUSKULIC	94C	PL B322 275	+De Bonis, Decamp, Ghez, Goy, Lees+	(ALEPH Collab.)
BUSKULIC	94G	ZPHY C62 179	+Casper, De Bonis, Decamp, Ghez+	(ALEPH Collab.)
PDG	94	PR D50 1173	Montanet+	(CERN, LBL, BOST, IFIC+)
ABE	93F	PRL 71 1685	+Albrow, Amidei, Anway-Wiese+	(CDF Collab.)
ABREU	93C	PL B301 145	+Adam, Adye, Agasi, Aleksan+	(DELPHI Collab.)
ACTON	93H	PL B312 501	+Akers, Alexander, Allison, Anderson+	(OPAL Collab.)
AKERS	93B	ZPHY C60 199	+Alexander, Allison, Anderson, Arcelli+	(OPAL Collab.)
BUSKULIC	93G	PL B311 425	+De Bonis, Decamp, Ghez, Goy, Lees+	(ALEPH Collab.)
ABREU	92M	PL B289 199	+Adam, Adye, Agasi, Alekseev+	(DELPHI Collab.)
ACTON	92C	PL B276 379	+Alexander, Allison, Allport, Anderson+	(OPAL Collab.)
ACTON	92N	PL B295 357	+Alexander, Allison, Allport, Anderson+	(OPAL Collab.)
ADEVA	92C	PL B288 395	+Adriani, Aguilar-Benitez, Ahlen+	(L3 Collab.)
BUSKULIC	92B	PL B284 177	+Decamp, Goy, Lees, Minard+	(ALEPH Collab.)
BUSKULIC	92E	PL B294 145	+Decamp, Goy, Lees, Minard+	(ALEPH Collab.)
ABE	91G	PRL 67 3351	+Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
ALBAJAR	91D	PL B262 171	+Albrow, Allkofer, Ankoviak, Apsimon+	(UA1 Collab.)
DECAMP	91	PL B258 236	+Deschizeaux, Goy, Lees, Minard+	(ALEPH Collab.)
ADEVA	90P	PL B252 703	+Adriani, Aguilar-Benitez, Akbari, Alcaraz+	(L3 Collab.)
LEE-FRANZINI	90	PRL 65 2947	+Heintz, Lovelock, Narain, Schamberger+	(CUSB II Collab.)
WEIR	90	PL B240 289	+Abrams, Adolphsen, Alexander, Alvarez+	(Mark II Collab.)
BAND	88	PL B200 221	+Camporesi, Chadwick+	(MAC Collab.)
ALBAJAR	87C	PL B186 247	+Albrow, Allkofer, Arnison+	(UA1 Collab.)
SCHAAD	85	PL 160B 188	+Nelson, Abrams, Amidei+	(Mark II Collab.)