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*
5374 ± 5 OUR FIT Error includes scale factor of 1.2.				
5374 ± 4 OUR AVERAGE Error includes scale factor of 1.1.				
5374 ±16 ±2	3	ABREU 94D	DLPH	$e^+ e^- \to Z$
5359 ±19 ±7	1	[1] AKERS 94J	OPAL	$e^+ e^- \to Z$
5383.3± 4.5±5.0	14	ABE 93F	CDF	$p\overline{p}$ at 1.8 TeV
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	$e^+ e^- \to Z$

[1] From the decay $B_s \to J/\psi(1S)\phi$.
[2] From the decay $B_s \to D_s^- \pi^+$.

$m_{B_s^0} - m_B$

Fit value is from B_s mass above and the average of our B masses $(m_{B^\pm}+m_{B^0})/2$.

VALUE (MeV)	*CL%*	*DOCUMENT ID*	*TECN*	*COMMENT*
95±5 OUR FIT Error includes scale factor of 1.1.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
80 to 130	68	LEE-FRANZINI 90	CSB2	$e^+ e^- \to \Upsilon(5S)$

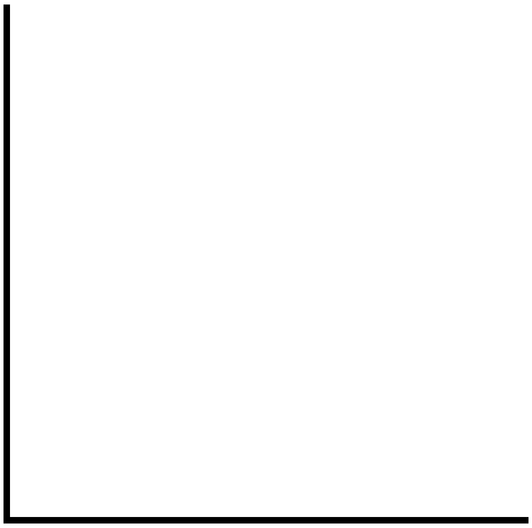
$m_{B_{sH}^0} - m_{B_{sL}^0}$

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

VALUE (10^{-12} s)	*EVTS*	*DOCUMENT ID*	*TECN*	*COMMENT*
$\mathbf{1.34^{+0.32}_{-0.27}}$ **OUR AVERAGE** Error includes scale factor of 1.4. See the ideogram below.				
0.96±0.37	41	[3] ABREU 94E	DLPH	$e^+ e^- \to Z$
$1.92^{+0.45}_{-0.35}\pm0.04$	31	[4] BUSKULIC 94C	ALEP	$e^+ e^- \to Z$
$1.13^{+0.35}_{-0.26}\pm0.09$	22	[4] ACTON 93H	OPAL	$e^+ e^- \to Z$

[3] ABREU 94E uses the flight-distance distribution of D_s vertices, ϕ-lepton vertices, and $D_s\mu$ vertices. This result inclues the result of ABREU 92M.
[4] Measured using $D_s \ell^+$ events.



B_s^0 mean life (10^{-12} s)

B_s^0 DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$D_s^- $ anything	seen	
Γ_2	$D_s^- \ell^+ \nu_\ell$ anything (ℓ means sum of e and μ)	seen	
Γ_3	$D_s^- \pi^+$	seen	
Γ_4	$J/\psi(1S)\phi$	seen	
Γ_5	$\psi(2S)\phi$	seen	
Γ_6	$\pi^+ K^-$	$<2.6 \times 10^{-4}$	90%
Γ_7	$K^+ K^-$	$<1.4 \times 10^{-4}$	90%

B_s^0 BRANCHING RATIOS

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	147	[5] ACTON	92N	OPAL	$e^+ e^- \rightarrow Z$

[5] ACTON 92N assumes that excess of 147 $\pm$ 48 D_s^0 $e^+ e^- \rightarrow Z$ 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 f($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^-$ anything)$\times$B($D_s^- \rightarrow \phi\pi^-$) = $(5.9 \pm 1.9 \pm 1.1) \times 10^{-3}$.

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

ℓ means sum of e and μ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	7	[6] ABREU	92M	DLPH	$e^+ e^- \rightarrow Z$
seen	18	[7] ACTON	92N	OPAL	$e^+ e^- \rightarrow Z$
seen	27	[8] BUSKULIC	92E	ALEP	$e^+ e^- \rightarrow Z$

[6] ABREU 92M measured muons only and obtained product branching ratio B($Z \rightarrow b$ or $\overline{b}$) $\times$ B($\overline{b} \rightarrow B_s$) $\times$ B($B_s \rightarrow D_s \mu^+ \nu_\mu$X) $\times$ B($D_s \rightarrow \phi\pi$) = $(18 \pm 8) \times 10^{-5}$.

[7] 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 f($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$ anything) $\times$B($D_s^- \rightarrow \phi\pi^-$) = $(3.9 \pm 1.1 \pm 0.8) \times 10^{-4}$.

[8] BUSKULIC 92E is measured using $D_s \rightarrow \phi\pi^+$ and $K^*(892)^0 K^+$ events. They use 2.7 $\pm$ 0.7% for the $\phi\pi^+$ branching fraction. The average product branching fraction is measured to be f($\overline{b} \rightarrow B_s^0$)B($B_s^0 \rightarrow D_s^- \ell^+ \nu_\ell$ anything) $=0.040 \pm 0.011^{+0.010}_{-0.012}$.

*CITATION: L. Montanet et al., Physical Review D50, 1173 (1994) and 1995 off-year partial update for the 1996 edition (URL: http://pdg.lbl.gov/)

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	6	[9] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
seen	1	BUSKULIC	93G	ALEP	$e^+e^- \rightarrow Z$

[9] AKERS 94J sees $\leq$ 6 events and measures the limit on the product branching fraction $f(\overline{b} \rightarrow B_s^0) \cdot B(B_s^0 \rightarrow D_s^- \pi^+) <$ 1.3% at CL = 90%.

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

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	1	[10] AKERS	94J	OPAL	$e^+e^- \rightarrow Z$
seen	14	[11] ABE	93F	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
seen	1	[12] ACTON	92N	OPAL	Sup. by AKERS 94J

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

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

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

$\Gamma(\psi(2S)\phi)/\Gamma_{\text{total}}$ Γ_5/Γ

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

$\Gamma(\pi^+ K^-)/\Gamma_{\text{total}}$ Γ_6/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<2.6 \times 10^{-4}$	90	[13] AKERS	94L	OPAL	$e^+e^- \rightarrow Z$

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

$\Gamma(K^+ K^-)/\Gamma_{\text{total}}$ Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.4 \times 10^{-4}$	90	[14] AKERS	94L	OPAL	$e^+e^- \rightarrow Z$

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

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 and *CP* Violation in *B* Decay" in the B^0 Full Listings above.

χ_s

This B_s^0-$\overline{B}_s^0$ mixing parameter measures the probability (integrated over time) that a produced B_s^0 ($\overline{B}_s^0$) decays as a $\overline{B}_s^0$ (B_s^0). The χ_s values are derived from combining χ_B values measured at high energy (see the following data block) with χ_d values from the $\Upsilon(4S)$. Mixing violates $\Delta B \neq 2$ rule.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
0.56 ± 0.11		PDG	95	RVUE	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.74 ± 0.27	95	[15] ABREU	94F	RVUE	$e^+e^- \rightarrow Z$
$0.43^{+0.26}_{-0.17}$		[16] ACCIARRI	94D	RVUE	
0.46 ± 0.21		[17] ADEVA	92C	RVUE	Sup. by ACCIARRI 94D
0.53 ± 0.15		[18] ALBAJAR	91D	RVUE	

[15] From a combination of DELPHI (ABREU 94F), CLEO (ARTUSO 89), and ARGUS (ALBRECHT 92L). Estimated from ABREU 94F figure 7.

[16] Uses BARTELT 93 to remove B_d mixing contribution and assuming $f_d = 0.375 \pm 0.05$ and $f_s = 0.15 \pm 0.05$.

[17] From combination of L3 (ADEVA 92C), CLEO (ARTUSO 89), and ARGUS (ALBRECHT 92L). Corresponding limit is $>$ 0.16 at 90%CL.

[18] From combination of UA1 (ALBAJAR 91D), CLEO (BEAN 87B), ARGUS (ALBRECHT 87I), ALEPH (DECAMP 91), and L3 (ADEVA 90P). Corresponding limits are $>$ 0.23 at 95% CL and $>$ 0.27 at 90% CL.

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 production fractions of B^0_d and B^0_s mesons relative to all b-flavored hadrons. Only the measurements at the Z and higher energy $p\overline{p}$ are averaged.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.126±0.008 OUR AVERAGE						
$0.121 \pm 0.016 \pm 0.006$			[19] ABREU	94J	DLPH	$e^+e^- \rightarrow Z$
$0.123 \pm 0.012 \pm 0.008$			ACCIARRI	94D	L3	$e^+e^- \rightarrow Z$
$0.114 \pm 0.014 \pm 0.008$			[20] BUSKULIC	94G	ALEP	$e^+e^- \rightarrow Z$
$0.143^{+0.022}_{-0.021} \pm 0.007$			[21] AKERS	93B	OPAL	$e^+e^- \rightarrow Z$
0.129 ± 0.022			[22] BUSKULIC	92B	ALEP	$e^+e^- \rightarrow Z$
$0.176 \pm 0.031 \pm 0.032$		1112	[23] ABE	91G	CDF	$p\overline{p}$ 1.8 TeV
$0.148 \pm 0.029 \pm 0.017$			[24] ALBAJAR	91D	UA1	$p\overline{p}$ 630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
$0.144 \pm 0.014^{+0.017}_{-0.011}$			[25] ABREU	94F	DLPH	Sup. by ABREU 94J
0.131 ± 0.014			[26] ABREU	94J	DLPH	$e^+e^- \rightarrow Z$
$0.157 \pm 0.020 \pm 0.032$			[27] ALBAJAR	94	UA1	$\sqrt{s} = 630$ GeV
$0.121^{+0.044}_{-0.040} \pm 0.017$		1665	[28] ABREU	93C	DLPH	Sup. by ABREU 94J
$0.145^{+0.041}_{-0.035} \pm 0.018$			[29] ACTON	92C	OPAL	$e^+e^- \rightarrow Z$
$0.121 \pm 0.017 \pm 0.006$			[30] ADEVA	92C	L3	Sup. by ACCIARRI 94D
$0.132 \pm 0.22\ ^{+0.015}_{-0.012}$		823	[31] DECAMP	91	ALEP	$e^+e^- \rightarrow Z$
$0.178^{+0.049}_{-0.040} \pm 0.020$			[32] ADEVA	90P	L3	$e^+e^- \rightarrow Z$
$0.17\ ^{+0.15}_{-0.08}$			[33,34] WEIR	90	MRK2	e^+e^- 29 GeV
$0.21\ ^{+0.29}_{-0.15}$			[33] BAND	88	MAC	$E^{ee}_{\rm cm} = 29$ GeV
>0.02	90		[33] BAND	88	MAC	$E^{ee}_{\rm cm} = 29$ GeV
0.121 ± 0.047			[33,35] ALBAJAR	87C	UA1	Repl. by ALBAJAR 91D
<0.12	90		[33,36] SCHAAD	85	MRK2	$E^{ee}_{\rm cm} = 29$ GeV

[19] This ABREU 94J result is from 5182 $\ell\ell$ and 279 $\Lambda\ell$ events. The systematic error includes 0.004 for model dependence.
[20] BUSKULIC 94G data analyzed using ee, $e\mu$, and $\mu\mu$ events.
[21] AKERS 93B analysis performed using dilepton events.
[22] BUSKULIC 92B uses a jet charge technique combined with electrons and muons.
[23] ABE 91G measurement of χ is done with $e\mu$ and ee events.
[24] ALBAJAR 91D measurement of χ is done with dimuons.
[25] 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 $\overline{\chi} = f_d \chi_d + 0.9 f_s \chi_s$.
[26] This ABREU 94J result combines $\ell\ell$, $\Lambda\ell$, and jet-charge ℓ (ABREU 94F) analyses. It is for $\overline{\chi} = f_d \chi_d + 0.96 f_s \chi_s$.
[27] ALBAJAR 94 uses dimuon events. Not independent of ALBAJAR 91D.
[28] ABREU 93C data analyzed using ee, $e\mu$, and $\mu\mu$ events.
[29] ACTON 92C uses electrons and muons. Superseded by AKERS 93B.
[30] ADEVA 92C uses electrons and muons.
[31] DECAMP 91 done with opposite and like-sign dileptons. Superseded by BUSKULIC 92B.
[32] ADEVA 90P measurement uses ee, $\mu\mu$, and $e\mu$ events from 118k events at the Z. Superseded by ADEVA 92C.
[33] 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.
[34] The WEIR 90 measurement supersedes the limit obtained in SCHAAD 85. The 90% CL are 0.06 and 0.38.
[35] 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.
[36] 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 the B^0_s-$\overline{B}^0_s$ oscillation frequency in time-dependent mixing experiments.

VALUE (10^{12} $\hbar$ s^{-1})	CL%	DOCUMENT ID		TECN	COMMENT
>1.8	95	[37] BUSKULIC	94B	ALEP	$e^+e^- \rightarrow Z$

[37] BUSKULIC 94B determines $\Delta m_{B^0_s}$ from the time dependence of B mixing using dileptons.

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

This section combines the results from the previous two sections.

Time integrated mixing measurement of χ determine this quantity directly via

$$\frac{\Delta m_{B_s^0}}{\Gamma_{B_s^0}} = \left(\frac{\chi}{0.5-\chi}\right)^{1/2}$$

while time-dependent mixing measurements determine $\Delta m_{B_s^0} = m_{B_{sH}^0} - m_{B_{sL}^0}$ which are combined with $\tau_{B_s^0}$ to give

$$\frac{\Delta m_{B_s^0}}{\Gamma_{B_s^0}} = \frac{(m_{B_{sH}^0} - m_{B_{sL}^0})\ \tau_{B_s^0}}{\hbar} \ .$$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
>2.0	95	[38] BUSKULIC	94B	ALEP	$e^+e^- \rightarrow Z$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>1.5		[39] PDG	94	RVUE	

[38] BUSKULIC 94B is their $\Delta m_{B_s^0}$ measurement combined with $\tau_{B_s^0} = (1.26^{+0.22}_{-0.17})$ ps.

[39] From PDG 94 χ_s value.

B_s^0 REFERENCES

PDG	95	Unofficial 1995 WWW edition		
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, DeBonis, 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.)
BARTELT	93	PRL 71 1680	+Csorna, Egyed, Jain, Sheldon+	(CLEO 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.)
ALBRECHT	92L	ZPHY C55 357	+Ehrlichmann, Hamacher, Krueger, Nau+	(ARGUS 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.)
ARTUSO	89	PRL 62 2233	+Bebek, Berkelman, Blucher+	(CLEO Collab.)
BAND	88	PL B200 221	+Camporesi, Chadwick+	(MAC Collab.)
ALBAJAR	87C	PL B186 247	+Albrow, Allkofer, Arnison+	(UA1 Collab.)
ALBRECHT	87I	PL B192 245	+Andam, Binder, Boeckmann+	(ARGUS Collab.)
BEAN	87B	PRL 58 183	+Bobbink, Brock, Engler+	(CLEO Collab.)
SCHAAD	85	PL 160B 188	+Nelson, Abrams, Amidei+	(Mark II Collab.)

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