B^0 – THIS IS PART 1 OF 4

To reduce the size of this section's PostScript file, we have divided it into four PostScript files. We present the following index:

PART 1

PART 2

PART 3

PART 4

B^0

$I(J^P) = \frac{1}{2}(0^-)$

Quantum numbers not measured. Values shown are quark-model predictions.

See also the $B^{\pm}/B^0$ ADMIXTURE and $B^{\pm}/B^0/B^0_s/b$-baryon ADMIXTURE sections.

See the Notes "Experimental Highlights of B Meson Production and Decay" and "Semileptonic Decays of B Mesons" at the beginning of the $B^{\pm}$ Particle Listings and the Note on "B^0-$\overline{B}^0$ Mixing and CP Violation in B Decay" near the end of the B^0 Particle Listings.

B^0 MASS

The fit uses m_{B^+}, $(m_{B^0} - m_{B^+})$, $m_{B^0_s}$, and $(m_{B^0_s} - (m_{B^+} + m_{B^0})/2)$ to determine m_{B^+}, m_{B^0}, $m_{B^0_s}$, and the mass differences. m_{B^0} data are excluded from the fit because they are not independent.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
5279.2±1.8 OUR FIT					
5279.8±1.6 OUR AVERAGE					
5281.3±2.2 ±1.4	51	[1] ABE	96B	CDF	$p\overline{p}$ at 1.8 TeV
5279.2±0.54±2.0	340	[2] ALAM	94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
5278.0±0.4 ±2.0		[2] BORTOLETTO	92	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
5279.6±0.7 ±2.0	40	[2,3] ALBRECHT	90J	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
5280.6±0.8 ±2.0		[2] BEBEK	87	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
5278.2±1.0 ±3.0	40	ALBRECHT	87C	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
5279.5±1.6 ±3.0	7	[4] ALBRECHT	87D	ARG	$e^+e^- \rightarrow \Upsilon(4S)$

[1] Excluded from fit because it is not independent of ABE 96B B^0_s mass and B^0_s-B mass difference.
[2] These experiments all report a common systematic error 2.0 MeV. We have artificially increased the systematic error to allow the experiments to be treated as independent measurements in our average. See "Treatment of Errors" section of the Introductory Text. These experiments actually measure the difference between half of E_{cm} and the B mass.
[3] ALBRECHT 90J assumes 10580 for $\Upsilon(4S)$ mass. Supersedes ALBRECHT 87C and ALBRECHT 87D.
[4] Found using fully reconstructed decays with J/ψ. ALBRECHT 87D assume $m_{\Upsilon(4S)}$ = 10577 MeV.

$m_{B^0} - m_{B^+}$

The mass difference measurements are not independent of the $B^{\pm}$ and B^0 mass measurement by the same experimenters. The fit uses m_{B^+}, $(m_{B^0} - m_{B^+})$, $m_{B^0_s}$, and $(m_{B^0_s} - (m_{B^+} + m_{B^0})/2)$ to determine m_{B^+}, m_{B^0}, $m_{B^0_s}$, and the mass differences.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
0.35±0.29 OUR FIT Error includes scale factor of 1.1.				
0.34±0.32 OUR AVERAGE Error includes scale factor of 1.2.				
0.41±0.25±0.19	ALAM	94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
−0.4 ±0.6 ±0.5	BORTOLETTO	92	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
−0.9 ±1.2 ±0.5	ALBRECHT	90J	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
2.0 ±1.1 ±0.3	[5] BEBEK	87	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

[5] BEBEK 87 actually measure the difference between half of E_{cm} and the $B^{\pm}$ or B^0 mass, so the $m_{B^0} - m_{B^{\pm}}$ is more accurate. Assume $m_{\Upsilon(4S)}$ = 10580 MeV.

$m_{B^0_H} - m_{B^0_L}$

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

B^0 MEAN LIFE

See $B^{\pm}/B^0/B^0_s/b$-baryon ADMIXTURE section for data on B-hadron mean life averaged over species of bottom particles.

"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*
1.56±0.06 OUR EVALUATION					
$1.54\pm0.08\pm0.06$		[6] ABE	96C	CDF	$p\overline{p}$ at 1.8 TeV
$1.61\pm0.07\pm0.04$		[6] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
$1.25^{+0.15}_{-0.13}\pm0.05$	121	[7] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
$1.49^{+0.17}_{-0.15}{}^{+0.08}_{-0.06}$		[8] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
$1.61^{+0.14}_{-0.13}\pm0.08$		[6,9] ABREU	95Q	DLPH	$e^+e^- \rightarrow Z$
$1.63\pm0.14\pm0.13$		[10] ADAM	95	DLPH	$e^+e^- \rightarrow Z$
$1.53\pm0.12\pm0.08$		[6,11] AKERS	95T	OPAL	$e^+e^- \rightarrow Z$
$1.57\pm0.18\pm0.08$	121	[7] ABE	94D	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.55\pm0.06\pm0.03$		[12] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
1.62 ± 0.12		[13] ADAM	95	DLPH	$e^+e^- \rightarrow Z$
$1.17^{+0.29}_{-0.23}\pm0.16$	96	[6] ABREU	93D	DLPH	Sup. by ABREU 95Q
$1.55\pm0.25\pm0.18$	76	[10] ABREU	93G	DLPH	Sup. by ADAM 95
$1.51^{+0.24}_{-0.23}{}^{+0.12}_{-0.14}$	78	[6] ACTON	93C	OPAL	Sup. by AKERS 95T
$1.52^{+0.20}_{-0.18}{}^{+0.07}_{-0.13}$	77	[6] BUSKULIC	93D	ALEP	Sup. by BUSKULIC 96G
$1.20^{+0.52}_{-0.36}{}^{+0.16}_{-0.14}$	15	[14] WAGNER	90	MRK2	E^{ee}_{cm}= 29 GeV
$0.82^{+0.57}_{-0.37}\pm0.27$		[15] AVERILL	89	HRS	E^{ee}_{cm}= 29 GeV

[6] Data analyzed using $D\,/\,D^*\,\ell$X event vertices.
[7] Measured mean life using fully reconstructed decays.
[8] Measured mean life using partially reconstructed $D^{*-}\,\pi^+$ X vertices.
[9] ABREU 95Q assumes B($B^0 \rightarrow D^{**-}\ell^+\nu_\ell$) = 3.2 ± 1.7%.
[10] Data analyzed using vertex-charge technique to tag B charge.
[11] AKERS 95T assumes B($B^0 \rightarrow D_s{}^{(*)}D^{0\,(*)}$) = 5.0 ± 0.9% to find B^+/B^0 yield.
[12] Combined result of $D/D^*\ell$x analysis, fully reconstructed B analysis, and partially reconstructed $D^{*-}\,\pi^+$ X analysis.
[13] Combined ABREU 95Q and ADAM 95 result.
[14] WAGNER 90 tagged B^0 mesons by their decays into $D^{*-}e^+\nu$ and $D^{*-}\mu^+\nu$ where the D^{*-} is tagged by its decay into $\pi^-\overline{D}^0$.
[15] AVERILL 89 is an estimate of the B^0 mean lifetime assuming that $B^0 \rightarrow D^{*+}$ + X always.

MEAN LIFE RATIO τ_{B^+}/τ_{B^0}

τ_{B^+}/τ_{B^0} (average of direct and inferred)

VALUE	*DOCUMENT ID*
1.02±0.05 OUR AVERAGE	Includes data from the 2 datablocks that follow this one.

τ_{B^+}/τ_{B^0} (direct measurements)

"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	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
The data in this block is included in the average printed for a previous datablock.					
1.03±0.06 OUR EVALUATION					
$1.01\pm0.11\pm0.02$		[16] ABE	96C	CDF	$p\overline{p}$ at 1.8 TeV
$0.98\pm0.08\pm0.03$		[16] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
$1.27^{+0.23}_{-0.19}{}^{+0.03}_{-0.02}$		[17] BUSKULIC	96G	ALEP	$e^+e^- \rightarrow Z$
$1.00^{+0.17}_{-0.15}\pm0.10$		[16,18] ABREU	95Q	DLPH	$e^+e^- \rightarrow Z$
$1.06^{+0.13}_{-0.10}\pm0.10$		[19] ADAM	95	DLPH	$e^+e^- \rightarrow Z$
$0.99\pm0.14^{+0.05}_{-0.04}$		[16,20] AKERS	95T	OPAL	$e^+e^- \rightarrow Z$
$1.02\pm0.16\pm0.05$	269	[17] ABE	94D	CDF	$p\overline{p}$ at 1.8 TeV

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

$1.03 \pm 0.08 \pm 0.02$		[21] BUSKULIC	96G	ALEP	$e^+ e^- \to Z$
$1.11^{+0.51}_{-0.39} \pm 0.11$	188	[16] ABREU	93D	DLPH	Sup. by ABREU 95Q
$1.01^{+0.29}_{-0.22} \pm 0.12$	253	[19] ABREU	93G	DLPH	Sup. by ADAM 95
$1.0\ ^{+0.33}_{-0.25} \pm 0.08$	130	ACTON	93C	OPAL	Sup. by AKERS 95T
$0.96^{+0.19}_{-0.15}{}^{+0.18}_{-0.12}$	154	[16] BUSKULIC	93D	ALEP	Sup. by BUSKULIC 96G

[16] Data analyzed using $D\,/\,D^{*}\,\ell$X vertices.
[17] Measurement using fully reconstructed decays.
[18] ABREU 95Q assumes B($B^0 \to D^{**-}\,\ell^+\,\nu_\ell$) = 3.2 ± 1.7%.
[19] Data analyzed using vertex-charge technique to tag B charge.
[20] AKERS 95T assumes B($B^0 \to D_s{}^{(*)}\,D^{0\,(*)}$) = 5.0 ± 0.9% to find B^+/B^0 yield.
[21] Combined result of $D/D^{*}\,\ell$X analysis and fully reconstructed B analysis.

τ_{B^+}/τ_{B^0} (inferred from branching fractions)

These measurements are inferred from the branching fractions for semileptonic decay or other spectator-dominated decays by assuming that the rates for such decays are equal for B^0 and B^+. We do not use measurements which assume equal production of B^0 and B^+ because of the large uncertainty in the production ratio.

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*

The data in this block is included in the average printed for a previous datablock.

0.93±0.18±0.12			[22] ATHANAS	94	CLE2	$e^+ e^- \to \Upsilon(4S)$

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

$0.91 \pm 0.27 \pm 0.21$			[23] ALBRECHT	92C	ARG	$e^+ e^- \to \Upsilon(4S)$
$1.0\ \pm 0.4$		29	[23,24] ALBRECHT	92G	ARG	$e^+ e^- \to \Upsilon(4S)$
$0.89 \pm 0.19 \pm 0.13$			[23] FULTON	91	CLEO	$e^+ e^- \to \Upsilon(4S)$
$1.00 \pm 0.23 \pm 0.14$			[23] ALBRECHT	89L	ARG	$e^+ e^- \to \Upsilon(4S)$
0.49 to 2.3	90		[25] BEAN	87B	CLEO	$e^+ e^- \to \Upsilon(4S)$

[22] ATHANAS 94 uses events tagged by fully reconstructed B^- decays and partially or fully reconstructed B^0 decays.
[23] Assumes equal production of B^0 and B^+.
[24] ALBRECHT 92G data analyzed using $B \to D_s\overline{D}$, $D_s\overline{D}^*$, $D_s^*\overline{D}$, $D_s^*\overline{D}^*$ events.
[25] BEAN 87B assume the fraction of $B^0\overline{B}^0$ events at the $\Upsilon(4S)$ is 0.41.

B^0 DECAY MODES

$\overline{B}^0$ modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing. Modes which do not identify the charge state of the B are listed in the $B^\pm/B^0$ ADMIXTURE section.

The branching fractions listed below assume 50% $B^0\overline{B}^0$ and 50% B^+B^- production at the $\Upsilon(4S)$. We have attempted to bring older measurements up to date by rescaling their assumed $\Upsilon(4S)$ production ratio to 50:50 and their assumed D, D_s, D^*, and ψ branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Semileptonic and leptonic modes			
Γ_1	$\ell^+\,\nu_\ell$ anything	[a]	(10.3 ±1.0) %	
Γ_2	$D^-\,\ell^+\,\nu_\ell$	[a]	(1.9 ±0.5) %	
Γ_3	$D^*(2010)^-\,\ell^+\,\nu_\ell$	[a]	(4.56±0.27) %	
Γ_4	$\rho^-\,\ell^+\,\nu_\ell$	[a]	< 4.1 $\times 10^{-4}$	CL=90%
Γ_5	$\pi^-\,\mu^+\,\nu_\mu$			

D, D^*, or D_s modes

Γ_6	$D^- \pi^+$		$(3.0 \pm 0.4) \times 10^{-3}$	
Γ_7	$D^- \rho^+$		$(7.8 \pm 1.4) \times 10^{-3}$	
Γ_8	$\overline{D}^0 \pi^+ \pi^-$	$<$	1.6×10^{-3}	CL=90%
Γ_9	$D^*(2010)^- \pi^+$		$(2.6 \pm 0.4) \times 10^{-3}$	
Γ_{10}	$D^- \pi^+ \pi^+ \pi^-$		$(8.0 \pm 2.5) \times 10^{-3}$	
Γ_{11}	$(D^- \pi^+ \pi^+ \pi^-)$ nonresonant		$(3.9 \pm 1.9) \times 10^{-3}$	
Γ_{12}	$D^- \pi^+ \rho^0$		$(1.1 \pm 1.0) \times 10^{-3}$	
Γ_{13}	$D^- a_1(1260)^+$		$(6.0 \pm 3.3) \times 10^{-3}$	
Γ_{14}	$D^*(2010)^- \pi^+ \pi^0$		(1.5 ± 0.5) %	
Γ_{15}	$D^*(2010)^- \rho^+$		$(7.3 \pm 1.5) \times 10^{-3}$	
Γ_{16}	$D^*(2010)^- \pi^+ \pi^+ \pi^-$		$(7.6 \pm 1.7) \times 10^{-3}$	S=1.3
Γ_{17}	$(D^*(2010)^- \pi^+ \pi^+ \pi^-)$ non-resonant		$(0.0 \pm 2.5) \times 10^{-3}$	
Γ_{18}	$D^*(2010)^- \pi^+ \rho^0$		$(5.7 \pm 3.1) \times 10^{-3}$	
Γ_{19}	$D^*(2010)^- a_1(1260)^+$		(1.30 ± 0.27) %	
Γ_{20}	$D^*(2010)^- \pi^+ \pi^+ \pi^- \pi^0$		(3.4 ± 1.8) %	
Γ_{21}	$\overline{D}_2^*(2460)^- \pi^+$	$<$	2.2×10^{-3}	CL=90%
Γ_{22}	$\overline{D}_2^*(2460)^- \rho^+$	$<$	4.9×10^{-3}	CL=90%
Γ_{23}	$D^- D_s^+$		$(7 \pm 4) \times 10^{-3}$	
Γ_{24}	$D^*(2010)^- D_s^+$		(1.2 ± 0.6) %	
Γ_{25}	$D^- D_s^{*+}$		(2.0 ± 1.5) %	
Γ_{26}	$D^*(2010)^- D_s^{*+}$		(1.9 ± 1.2) %	
Γ_{27}	$D_s^+ \pi^-$	$<$	2.8×10^{-4}	CL=90%
Γ_{28}	$D_s^{*+} \pi^-$	$<$	5×10^{-4}	CL=90%
Γ_{29}	$D_s^+ \rho^-$	$<$	7×10^{-4}	CL=90%
Γ_{30}	$D_s^{*+} \rho^-$	$<$	8×10^{-4}	CL=90%
Γ_{31}	$D_s^+ a_1(1260)^-$	$<$	2.6×10^{-3}	CL=90%
Γ_{32}	$D_s^{*+} a_1(1260)^-$	$<$	2.2×10^{-3}	CL=90%
Γ_{33}	$D_s^- K^+$	$<$	2.4×10^{-4}	CL=90%
Γ_{34}	$D_s^{*-} K^+$	$<$	1.7×10^{-4}	CL=90%
Γ_{35}	$D_s^- K^*(892)^+$	$<$	9.9×10^{-4}	CL=90%
Γ_{36}	$D_s^{*-} K^*(892)^+$	$<$	1.1×10^{-3}	CL=90%
Γ_{37}	$D_s^- \pi^+ K^0$	$<$	5×10^{-3}	CL=90%
Γ_{38}	$D_s^{*-} \pi^+ K^0$	$<$	3.1×10^{-3}	CL=90%
Γ_{39}	$D_s^- \pi^+ K^*(892)^0$	$<$	4×10^{-3}	CL=90%
Γ_{40}	$D_s^{*-} \pi^+ K^*(892)^0$	$<$	2.0×10^{-3}	CL=90%
Γ_{41}	$\overline{D}^0 \pi^0$	$<$	4.8×10^{-4}	CL=90%
Γ_{42}	$\overline{D}^0 \rho^0$	$<$	5.5×10^{-4}	CL=90%
Γ_{43}	$\overline{D}^0 \eta$	$<$	6.8×10^{-4}	CL=90%
Γ_{44}	$\overline{D}^0 \eta'$	$<$	8.6×10^{-4}	CL=90%
Γ_{45}	$\overline{D}^0 \omega$	$<$	6.3×10^{-4}	CL=90%
Γ_{46}	$\overline{D}^*(2007)^0 \pi^0$	$<$	9.7×10^{-4}	CL=90%
Γ_{47}	$\overline{D}^*(2007)^0 \rho^0$	$<$	1.17×10^{-3}	CL=90%
Γ_{48}	$\overline{D}^*(2007)^0 \eta$	$<$	6.9×10^{-4}	CL=90%
Γ_{49}	$\overline{D}^*(2007)^0 \eta'$	$<$	2.7×10^{-3}	CL=90%
Γ_{50}	$\overline{D}^*(2007)^0 \omega$	$<$	2.1×10^{-3}	CL=90%

Charmonium modes

Γ_{51}	$J/\psi(1S) K^0$		$(7.5 \pm 2.1) \times 10^{-4}$	
Γ_{52}	$J/\psi(1S) K^+ \pi^-$		$(1.1 \pm 0.6) \times 10^{-3}$	
Γ_{53}	$J/\psi(1S) K^*(892)^0$		$(1.58 \pm 0.27) \times 10^{-3}$	
Γ_{54}	$J/\psi(1S) \pi^0$	$<$	6.9×10^{-3}	CL=90%
Γ_{55}	$\psi(2S) K^0$	$<$	8×10^{-4}	CL=90%
Γ_{56}	$\psi(2S) K^+ \pi^-$	$<$	1×10^{-3}	CL=90%
Γ_{57}	$\psi(2S) K^*(892)^0$		$(1.4 \pm 0.9) \times 10^{-3}$	
Γ_{58}	$\chi_{c1}(1P) K^0$	$<$	2.7×10^{-3}	CL=90%
Γ_{59}	$\chi_{c1}(1P) K^*(892)^0$	$<$	2.1×10^{-3}	CL=90%

K or *K** modes

Γ_{60}	$K^+\pi^-$		$<$ 1.7	$\times 10^{-5}$	CL=90%
Γ_{61}	$K^0\pi^0$		$<$ 4.0	$\times 10^{-5}$	CL=90%
Γ_{62}	K^+K^-		$<$ 4	$\times 10^{-6}$	CL=90%
Γ_{63}	$K^+\rho^-$		$<$ 3.5	$\times 10^{-5}$	CL=90%
Γ_{64}	$K^0\pi^+\pi^-$				
Γ_{65}	$K^0\rho^0$		$<$ 3.9	$\times 10^{-5}$	CL=90%
Γ_{66}	$K^0 f_0(980)$		$<$ 3.6	$\times 10^{-4}$	CL=90%
Γ_{67}	$K^*(892)^+\pi^-$		$<$ 7.2	$\times 10^{-5}$	CL=90%
Γ_{68}	$K^*(892)^0\pi^0$		$<$ 2.8	$\times 10^{-5}$	CL=90%
Γ_{69}	$K_2^*(1430)^+\pi^-$		$<$ 2.6	$\times 10^{-3}$	CL=90%
Γ_{70}	$K^0K^+K^-$		$<$ 1.3	$\times 10^{-3}$	CL=90%
Γ_{71}	$K^0\phi$		$<$ 8.8	$\times 10^{-5}$	CL=90%
Γ_{72}	$K^-\pi^+\pi^+\pi^-$	[b]	$<$ 2.1	$\times 10^{-4}$	CL=90%
Γ_{73}	$K^*(892)^0\pi^+\pi^-$		$<$ 1.4	$\times 10^{-3}$	CL=90%
Γ_{74}	$K^*(892)^0\rho^0$		$<$ 4.6	$\times 10^{-4}$	CL=90%
Γ_{75}	$K^*(892)^0 f_0(980)$		$<$ 1.7	$\times 10^{-4}$	CL=90%
Γ_{76}	$K_1(1400)^+\pi^-$		$<$ 1.1	$\times 10^{-3}$	CL=90%
Γ_{77}	$K^-a_1(1260)^+$	[b]	$<$ 3.9	$\times 10^{-4}$	CL=90%
Γ_{78}	$K^*(892)^0K^+K^-$		$<$ 6.1	$\times 10^{-4}$	CL=90%
Γ_{79}	$K^*(892)^0\phi$		$<$ 4.3	$\times 10^{-5}$	CL=90%
Γ_{80}	$K_1(1400)^0\rho^0$		$<$ 3.0	$\times 10^{-3}$	CL=90%
Γ_{81}	$K_1(1400)^0\phi$		$<$ 5.0	$\times 10^{-3}$	CL=90%
Γ_{82}	$K_2^*(1430)^0\rho^0$		$<$ 1.1	$\times 10^{-3}$	CL=90%
Γ_{83}	$K_2^*(1430)^0\phi$		$<$ 1.4	$\times 10^{-3}$	CL=90%
Γ_{84}	$K^*(892)^0\gamma$		(4.0 $\pm$1.9)	$\times 10^{-5}$	
Γ_{85}	$K_1(1270)^0\gamma$		$<$ 7.0	$\times 10^{-3}$	CL=90%
Γ_{86}	$K_1(1400)^0\gamma$		$<$ 4.3	$\times 10^{-3}$	CL=90%
Γ_{87}	$K_2^*(1430)^0\gamma$		$<$ 4.0	$\times 10^{-4}$	CL=90%
Γ_{88}	$K^*(1680)^0\gamma$		$<$ 2.0	$\times 10^{-3}$	CL=90%
Γ_{89}	$K_3^*(1780)^0\gamma$		$<$ 1.0	%	CL=90%
Γ_{90}	$K_4^*(2045)^0\gamma$		$<$ 4.3	$\times 10^{-3}$	CL=90%
Γ_{91}	$\phi\phi$		$<$ 3.9	$\times 10^{-5}$	CL=90%

Light unflavored meson modes

Γ_{92}	$\pi^+\pi^-$		$<$ 2.0	$\times 10^{-5}$	CL=90%
Γ_{93}	$\pi^0\pi^0$		$<$ 9.1	$\times 10^{-6}$	CL=90%
Γ_{94}	$\eta\pi^0$		$<$ 2.5	$\times 10^{-4}$	CL=90%
Γ_{95}	$\eta\eta$		$<$ 4.1	$\times 10^{-4}$	CL=90%
Γ_{96}	$\pi^+\pi^-\pi^0$		$<$ 7.2	$\times 10^{-4}$	CL=90%
Γ_{97}	$\rho^0\pi^0$		$<$ 2.4	$\times 10^{-5}$	CL=90%
Γ_{98}	$\rho^\mp\pi^\pm$	[c]	$<$ 8.8	$\times 10^{-5}$	CL=90%
Γ_{99}	$\pi^+\pi^-\pi^+\pi^-$		$<$ 2.8	$\times 10^{-4}$	CL=90%
Γ_{100}	$\rho^0\rho^0$		$<$ 2.8	$\times 10^{-4}$	CL=90%
Γ_{101}	$a_1(1260)^\mp\pi^\pm$	[c]	$<$ 4.9	$\times 10^{-4}$	CL=90%
Γ_{102}	$a_2(1320)^\mp\pi^\pm$	[c]	$<$ 3.0	$\times 10^{-4}$	CL=90%
Γ_{103}	$\pi^+\pi^-\pi^0\pi^0$		$<$ 3.1	$\times 10^{-3}$	CL=90%
Γ_{104}	$\rho^+\rho^-$		$<$ 2.2	$\times 10^{-3}$	CL=90%
Γ_{105}	$a_1(1260)^0\pi^0$		$<$ 1.1	$\times 10^{-3}$	CL=90%
Γ_{106}	$\omega\pi^0$		$<$ 4.6	$\times 10^{-4}$	CL=90%
Γ_{107}	$\pi^+\pi^+\pi^-\pi^-\pi^0$		$<$ 9.0	$\times 10^{-3}$	CL=90%
Γ_{108}	$a_1(1260)^+\rho^-$		$<$ 3.4	$\times 10^{-3}$	CL=90%
Γ_{109}	$a_1(1260)^0\rho^0$		$<$ 2.4	$\times 10^{-3}$	CL=90%
Γ_{110}	$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$		$<$ 3.0	$\times 10^{-3}$	CL=90%
Γ_{111}	$a_1(1260)^+a_1(1260)^-$		$<$ 2.8	$\times 10^{-3}$	CL=90%
Γ_{112}	$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$		$<$ 1.1	%	CL=90%

Baryon modes

Γ_{113}	$p\overline{p}$			$<$ 3.4	$\times 10^{-5}$	CL=90%
Γ_{114}	$p\overline{p}\pi^+\pi^-$			$<$ 2.5	$\times 10^{-4}$	CL=90%
Γ_{115}	$p\overline{\Lambda}\pi^-$			$<$ 1.8	$\times 10^{-4}$	CL=90%
Γ_{116}	$\Delta^0\overline{\Delta}^0$			$<$ 1.5	$\times 10^{-3}$	CL=90%
Γ_{117}	$\Delta^{++}\Delta^{--}$			$<$ 1.1	$\times 10^{-4}$	CL=90%
Γ_{118}	$\overline{\Sigma}_c^{--}\Delta^{++}$			$<$ 1.2	$\times 10^{-3}$	CL=90%

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

Γ_{119}	$\gamma\gamma$	*B1*		$<$ 3.9	$\times 10^{-5}$	CL=90%
Γ_{120}	e^+e^-	*B1*		$<$ 5.9	$\times 10^{-6}$	CL=90%
Γ_{121}	$\mu^+\mu^-$	*B1*		$<$ 5.9	$\times 10^{-6}$	CL=90%
Γ_{122}	$K^0e^+e^-$	*B1*		$<$ 3.0	$\times 10^{-4}$	CL=90%
Γ_{123}	$K^0\mu^+\mu^-$	*B1*		$<$ 3.6	$\times 10^{-4}$	CL=90%
Γ_{124}	$K^*(892)^0e^+e^-$	*B1*		$<$ 2.9	$\times 10^{-4}$	CL=90%
Γ_{125}	$K^*(892)^0\mu^+\mu^-$	*B1*		$<$ 2.3	$\times 10^{-5}$	CL=90%
Γ_{126}	$e^\pm\mu^\mp$	*LF*	[c]	$<$ 5.9	$\times 10^{-6}$	CL=90%
Γ_{127}	$e^\pm\tau^\mp$	*LF*	[c]	$<$ 5.3	$\times 10^{-4}$	CL=90%
Γ_{128}	$\mu^\pm\tau^\mp$	*LF*	[c]	$<$ 8.3	$\times 10^{-4}$	CL=90%

[a] ℓ indicates e or μ mode, not sum over modes.

[b] B^0 and B_s^0 contributions not separated. Limit is on weighted average of the two decay rates.

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

B^0 BRANCHING RATIOS

For branching ratios in which the charge of the decaying B is not determined, see the $B^\pm$ section.

$\Gamma(\ell^+\nu_\ell\,\text{anything})/\Gamma_{\text{total}}$ Γ_1/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.103±0.010 OUR AVERAGE				
0.093±0.011±0.015	ALBRECHT	94	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
0.109±0.007±0.011	ATHANAS	94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
0.099±0.030±0.009	HENDERSON	92	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

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

ℓ denotes e or μ, not the sum.

VALUE	DOCUMENT ID		TECN	COMMENT
0.019±0.005 OUR AVERAGE				
0.018±0.006±0.003	[26] FULTON	91	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
0.020±0.007±0.006	[27] ALBRECHT	89J	ARG	$e^+e^- \rightarrow \Upsilon(4S)$

[26] FULTON 91 assumes assuming equal production of B^0 and B^+ at the $\Upsilon(4S)$ and uses Mark III D and D^* branching ratios.

[27] ALBRECHT 89J reports 0.018 ± 0.006 ± 0.005. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \rightarrow K^-\pi^+$).

$\Gamma(D^*(2010)^-\ell^+\nu_\ell)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0456±0.0027 OUR AVERAGE					
0.0449±0.0032±0.0039	376	[28] BARISH	95	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
0.0518±0.0030±0.0062	410	[29] BUSKULIC	95N	ALEP	$e^+e^- \rightarrow Z$
0.045 ±0.003 ±0.004		[30] ALBRECHT	94	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
0.047 ±0.005 ±0.005	235	[31] ALBRECHT	93	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
0.040 ±0.004 ±0.006		[32] BORTOLETTO	89B	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

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

seen	398	[33] SANGHERA	93	CLE2	$e^+e^- \to \Upsilon(4S)$
$0.070 \pm 0.018 \pm 0.014$		[34] ANTREASYAN	90B	CBAL	$e^+e^- \to \Upsilon(4S)$
		[35] ALBRECHT	89C	ARG	$e^+e^- \to \Upsilon(4S)$
$0.060 \pm 0.010 \pm 0.014$		[36] ALBRECHT	89J	ARG	$e^+e^- \to \Upsilon(4S)$
$0.070 \pm 0.012 \pm 0.019$	47	[37] ALBRECHT	87J	ARG	$e^+e^- \to \Upsilon(4S)$

[28] BARISH 95 use B($D^0 \to K^-\pi^+$) = $(3.91 \pm 0.08 \pm 0.17)$% and B($D^{*+} \to D^0\pi^+$) = $(68.1 \pm 1.0 \pm 1.3)$%.

[29] BUSKULIC 95N assumes fraction (B^+) = fraction (B^0) = $38.2 \pm 1.3 \pm 2.2$% and $\tau_{B^0} = 1.58 \pm 0.06$ ps. $\Gamma(D^{*-}\ell^+\nu_\ell)$/total = $[5.18 - 0.13(\text{fraction}(B^0) - 38.2) - 1.5(\tau_{B^0} - 1.58)]$%.

[30] ALBRECHT 94 assumes B($D^{*+} \to D^0\pi^+$) = $68.1 \pm 1.0 \pm 1.3$%. Uses partial reconstruction of D^{*+} and is independent of D^0 branching ratios.

[31] ALBRECHT 93 reports $0.052 \pm 0.005 \pm 0.006$. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \to K^-\pi^+$). We have taken their average e and μ value. They also obtain $\alpha = 2*\Gamma^0/(\Gamma^- + \Gamma^+) - 1 = 1.1 \pm 0.4 \pm 0.2$, $A_{AF} = 3/4*(\Gamma^- - \Gamma^+)/\Gamma = 0.2 \pm 0.08 \pm 0.06$ and a value of $|V_{cb}|$ = 0.036–0.045 depending on model assumptions.

[32] We have taken average of the the BORTOLETTO 89B values for electrons and muons, $0.046 \pm 0.005 \pm 0.007$. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \to K^-\pi^+$). The measurement suggests a D^* polarization parameter value $\alpha = 0.65 \pm 0.66 \pm 0.25$.

[33] Combining $\overline{D}^{*0}\ell^+\nu_\ell$ and $\overline{D}^{*-}\ell^+\nu_\ell$ SANGHERA 93 test $V-A$ structure and fit the decay angular distributions to obtain $A_{FB} = 3/4*(\Gamma^- - \Gamma^+)/\Gamma = 0.14 \pm 0.06 \pm 0.03$. Assuming a value of V_{cb}, they measure V, A_1, and A_2, the three form factors for the $D^*\ell\nu_\ell$ decay, where results are slightly dependent on model assumptions.

[34] ANTREASYAN 90B is average over B and $\overline{D}^*(2010)$ charge states.

[35] The measurement of ALBRECHT 89C suggests a D^* polarization γ_L/γ_T of 0.85 ± 0.45. or $\alpha = 0.7 \pm 0.9$.

[36] ALBRECHT 89J is ALBRECHT 87J value rescaled using B($D^*(2010)^- \to D^0\pi^-$) = $0.57 \pm 0.04 \pm 0.04$. Superseded by ALBRECHT 93.

[37] ALBRECHT 87J assume μ-e universality, the B($\Upsilon(4S) \to B^0\overline{B}^0$) = 0.45, the B($D^0 \to K^-\pi^+$) = $(0.042 \pm 0.004 \pm 0.004)$, and the B($D^*(2010)^- \to D^0\pi^-$) = 0.49 ± 0.08. Superseded by ALBRECHT 89J.

$\Gamma(\rho^-\ell^+\nu_\ell)/\Gamma_{\text{total}}$ — Γ_4/Γ

$\ell = e$ or μ, not sum over e and μ modes.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<4.1 \times 10^{-4}$	90	[38] BEAN	93B	CLE2	$e^+e^- \to \Upsilon(4S)$

[38] BEAN 93B limit set using ISGW Model. Using isospin and the quark model to combine $\Gamma(\rho^0\ell^+\nu_\ell)$ and $\Gamma(\omega\ell^+\nu_\ell)$ with this result, they obtain a limit $<(1.6\text{–}2.7) \times 10^{-4}$ at 90% CL for $B^+ \to (\omega \text{ or } \rho^0)\ell^+\nu_\ell$. The range corresponds to the ISGW, WSB, and KS models. An upper limit on $|V_{ub}/V_{cb}| <$ 0.8–0.13 at 90% CL is derived as well.

$\Gamma(\pi^-\mu^+\nu_\mu)/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •			
seen	[39] ALBRECHT	91C	ARG

[39] In ALBRECHT 91C, one event is fully reconstructed providing evidence for the $b \to u$ transition.