BOTTOM MESONS
($B = \pm 1$)

$B^+ = u\overline{b}$, $B^0 = d\overline{b}$, $\overline{B}^0 = \overline{d}\,b$, $B^- = \overline{u}\,b$, similarly for B^*'s

B-particle organization

Many measurements of B decays involve admixtures of B hadrons. Previously we arbitrarily included such admixtures in the $B^\pm$ section, but because of their importance we have created two new sections: "$B^\pm/B^0$ Admixture" for $\Upsilon(4S)$ results and "$B^\pm/B^0/B^0_s$/b-baryon Admixture" for results at higher energies. Most inclusive decay branching fractions are found in the Admixture sections. B^0-$\overline{B}^0$ mixing data are found in the B^0 section, while B^0_s-$\overline{B}^0_s$ mixing data and B-$\overline{B}$ mixing data for a B^0/B^0_s admixture are found in the B^0_s section. CP-violation data are found in the B^0 section. b-baryons are found near the end of the Baryon section.

The organization of the B sections is now as follows, where bullets indicate particle sections and brackets indicate reviews.

[Production and Decay of b-flavored Hadrons]

- $B^{\pm}$
  - mass, mean life
  - branching fractions
- B^0
  - mass, mean life
  - branching fractions
  - polarization in B^0 decay
  - B^0-$\overline{B}^0$ mixing
  - [CP Violation in B Decay]
  - CP violation
- $B^{\pm}$ B^0 Admixtures
  - branching fractions
- $B^{\pm}/B^0/B^0_s/b$-baryon Admixtures
  - mean life
  - production fractions
  - branching fractions
- B^*
  - mass
- B^0_s
  - mass, mean life
  - branching fractions
  - polarization in B^0_s decay
  - B^0_s-$\overline{B}^0_s$ mixing
  - B-$\overline{B}$ mixing (admixture of B^0, B^0_s)

At end of Baryon Listings:

- Λ_b
  - mass, mean life
  - branching fractions
- b-baryon Admixture
  - mean life
  - branching fractions

$B^{\pm}$

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

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

Mass $m_{B^{\pm}} = 5278.9 \pm 1.8$ MeV
Mean life $\tau_{B^{\pm}} = (1.65 \pm 0.04) \times 10^{-12}$ s
$c\tau = 495$ μm

B^- modes are charge conjugates of the modes below. 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.

B^+ DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
Semileptonic and leptonic modes				
$\ell^+\nu_\ell$ anything	[pp]	(10.3 ± 0.9) %		–
$\overline{D}^0\ell^+\nu_\ell$	[pp]	(1.86 ± 0.33) %		–
$\overline{D}^*(2007)^0\ell^+\nu_\ell$	[pp]	(5.3 ± 0.8) %		–
$\pi^0 e^+\nu_e$		$< 2.2 \times 10^{-3}$	CL=90%	2638
$\omega\ell^+\nu_\ell$	[pp]	$< 2.1 \times 10^{-4}$	CL=90%	–
$\rho^0\ell^+\nu_\ell$	[pp]	$< 2.1 \times 10^{-4}$	CL=90%	–
$e^+\nu_e$		$< 1.5 \times 10^{-5}$	CL=90%	2639
$\mu^+\nu_\mu$		$< 2.1 \times 10^{-5}$	CL=90%	2638
$\tau^+\nu_\tau$		$< 5.7 \times 10^{-4}$	CL=90%	2340
$e^+\nu_e\gamma$		$< 2.0 \times 10^{-4}$	CL=90%	–
$\mu^+\nu_\mu\gamma$		$< 5.2 \times 10^{-5}$	CL=90%	–

D, D^*, or D_s modes

$\overline{D}^0 \pi^+$	$(5.3 \pm 0.5) \times 10^{-3}$		2308
$\overline{D}^0 \rho^+$	(1.34 ± 0.18) %		2238
$\overline{D}^0 \pi^+ \pi^+ \pi^-$	(1.1 ± 0.4) %		2289
$\overline{D}^0 \pi^+ \pi^+ \pi^-$ nonresonant	$(5 \pm 4) \times 10^{-3}$		2289
$\overline{D}^0 \pi^+ \rho^0$	$(4.2 \pm 3.0) \times 10^{-3}$		2209
$\overline{D}^0 a_1(1260)^+$	$(5 \pm 4) \times 10^{-3}$		2123
$D^*(2010)^- \pi^+ \pi^+$	$(2.1 \pm 0.6) \times 10^{-3}$		2247
$D^- \pi^+ \pi^+$	$< 1.4 \times 10^{-3}$	CL=90%	2299
$\overline{D}^*(2007)^0 \pi^+$	$(4.6 \pm 0.4) \times 10^{-3}$		2256
$D^*(2010)^+ \pi^0$	$< 1.7 \times 10^{-4}$	CL=90%	2254
$\overline{D}^*(2007)^0 \rho^+$	(1.55 ± 0.31) %		2183
$\overline{D}^*(2007)^0 \pi^+ \pi^+ \pi^-$	$(9.4 \pm 2.6) \times 10^{-3}$		2236
$\overline{D}^*(2007)^0 a_1(1260)^+$	(1.9 ± 0.5) %		2062
$D^*(2010)^- \pi^+ \pi^+ \pi^0$	(1.5 ± 0.7) %		2235
$D^*(2010)^- \pi^+ \pi^+ \pi^+ \pi^-$	< 1 %	CL=90%	2217
$\overline{D}_1^*(2420)^0 \pi^+$	$(1.5 \pm 0.6) \times 10^{-3}$	S=1.3	2081
$\overline{D}_1^*(2420)^0 \rho^+$	$< 1.4 \times 10^{-3}$	CL=90%	1997
$\overline{D}_2^*(2460)^0 \pi^+$	$< 1.3 \times 10^{-3}$	CL=90%	2064
$\overline{D}_2^*(2460)^0 \rho^+$	$< 4.7 \times 10^{-3}$	CL=90%	1979
$\overline{D}^0 D_s^+$	(1.3 ± 0.4) %		1815
$\overline{D}^0 D_s^{*+}$	$(9 \pm 4) \times 10^{-3}$		1734
$\overline{D}^*(2007)^0 D_s^+$	(1.2 ± 0.5) %		1737
$\overline{D}^*(2007)^0 D_s^{*+}$	(2.7 ± 1.0) %		1650
$D_s^+ \pi^0$	$< 2.0 \times 10^{-4}$	CL=90%	2270
$D_s^{*+} \pi^0$	$< 3.3 \times 10^{-4}$	CL=90%	2214
$D_s^+ \eta$	$< 5 \times 10^{-4}$	CL=90%	2235
$D_s^{*+} \eta$	$< 8 \times 10^{-4}$	CL=90%	2177
$D_s^+ \rho^0$	$< 4 \times 10^{-4}$	CL=90%	2198
$D_s^{*+} \rho^0$	$< 5 \times 10^{-4}$	CL=90%	2139
$D_s^+ \omega$	$< 5 \times 10^{-4}$	CL=90%	2195
$D_s^{*+} \omega$	$< 7 \times 10^{-4}$	CL=90%	2136
$D_s^+ a_1(1260)^0$	$< 2.2 \times 10^{-3}$	CL=90%	2079
$D_s^{*+} a_1(1260)^0$	$< 1.6 \times 10^{-3}$	CL=90%	2014
$D_s^+ \phi$	$< 3.2 \times 10^{-4}$	CL=90%	2141
$D_s^{*+} \phi$	$< 4 \times 10^{-4}$	CL=90%	2079
$D_s^+ \overline{K}^0$	$< 1.1 \times 10^{-3}$	CL=90%	2241
$D_s^{*+} \overline{K}^0$	$< 1.1 \times 10^{-3}$	CL=90%	2184
$D_s^+ \overline{K}^*(892)^0$	$< 5 \times 10^{-4}$	CL=90%	2171

$D_s^{*+}\overline{K}^*(892)^0$	$<$ 4	$\times 10^{-4}$	CL=90%	2110
$D_s^-\pi^+K^+$	$<$ 8	$\times 10^{-4}$	CL=90%	2222
$D_s^{*-}\pi^+K^+$	$<$ 1.2	$\times 10^{-3}$	CL=90%	2164
$D_s^-\pi^+K^*(892)^+$	$<$ 6	$\times 10^{-3}$	CL=90%	2137
$D_s^{*-}\pi^+K^*(892)^+$	$<$ 8	$\times 10^{-3}$	CL=90%	2075

Charmonium modes

$J/\psi(1S)K^+$	(9.9 $\pm$1.0)	$\times 10^{-4}$		1683
$J/\psi(1S)K^+\pi^+\pi^-$	(1.4 $\pm$0.6)	$\times 10^{-3}$		1612
$J/\psi(1S)K^*(892)^+$	(1.47$\pm$0.27)	$\times 10^{-3}$		1571
$J/\psi(1S)\pi^+$	(5.0 $\pm$1.5)	$\times 10^{-5}$		1727
$J/\psi(1S)\rho^+$	$<$ 7.7	$\times 10^{-4}$	CL=90%	1613
$J/\psi(1S)a_1(1260)^+$	$<$ 1.2	$\times 10^{-3}$	CL=90%	1414
$\psi(2S)K^+$	(6.9 $\pm$3.1)	$\times 10^{-4}$	S=1.3	1284
$\psi(2S)K^*(892)^+$	$<$ 3.0	$\times 10^{-3}$	CL=90%	1115
$\psi(2S)K^+\pi^+\pi^-$	(1.9 $\pm$1.2)	$\times 10^{-3}$		909
$\chi_{c1}(1P)K^+$	(1.0 $\pm$0.4)	$\times 10^{-3}$		1411
$\chi_{c1}(1P)K^*(892)^+$	$<$ 2.1	$\times 10^{-3}$	CL=90%	1265

***K* or *K** modes**

$K^0\pi^+$	(2.3 $\pm$1.1)	$\times 10^{-5}$		2614
$K^+\pi^0$	$<$ 1.6	$\times 10^{-5}$	CL=90%	2615
$\eta' K^+$	(6.5 $\pm$1.7)	$\times 10^{-5}$		2528
$\eta' K^*(892)^+$	$<$ 1.3	$\times 10^{-4}$	CL=90%	2472
ηK^+	$<$ 1.4	$\times 10^{-5}$	CL=90%	2587
$\eta K^*(892)^+$	$<$ 3.0	$\times 10^{-5}$	CL=90%	2534
$K^*(892)^0\pi^+$	$<$ 4.1	$\times 10^{-5}$	CL=90%	2561
$K^*(892)^+\pi^0$	$<$ 9.9	$\times 10^{-5}$	CL=90%	2562
$K^+\pi^-\pi^+$ nonresonant	$<$ 2.8	$\times 10^{-5}$	CL=90%	2609
$K^-\pi^+\pi^+$ nonresonant	$<$ 5.6	$\times 10^{-5}$	CL=90%	–
$K_1(1400)^0\pi^+$	$<$ 2.6	$\times 10^{-3}$	CL=90%	2451
$K_2^*(1430)^0\pi^+$	$<$ 6.8	$\times 10^{-4}$	CL=90%	2443
$K^+\rho^0$	$<$ 1.9	$\times 10^{-5}$	CL=90%	2559
$K^0\rho^+$	$<$ 4.8	$\times 10^{-5}$	CL=90%	2559
$K^*(892)^+\pi^+\pi^-$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2556
$K^*(892)^+\rho^0$	$<$ 9.0	$\times 10^{-4}$	CL=90%	2505
$K_1(1400)^+\rho^0$	$<$ 7.8	$\times 10^{-4}$	CL=90%	2389
$K_2^*(1430)^+\rho^0$	$<$ 1.5	$\times 10^{-3}$	CL=90%	2382

$K^+ \overline{K}^0$	$<$ 2.1	$\times 10^{-5}$	CL=90%	2592
$K^+ K^- \pi^+$ nonresonant	$<$ 7.5	$\times 10^{-5}$	CL=90%	–
$K^+ K^- K^+$	$<$ 2.0	$\times 10^{-4}$	CL=90%	2522
$K^+ \phi$	$<$ 1.2	$\times 10^{-5}$	CL=90%	2516
$K^+ K^- K^+$ nonresonant	$<$ 3.8	$\times 10^{-5}$	CL=90%	2516
$K^*(892)^+ K^+ K^-$	$<$ 1.6	$\times 10^{-3}$	CL=90%	2466
$K^*(892)^+ \phi$	$<$ 7.0	$\times 10^{-5}$	CL=90%	2460
$K_1(1400)^+ \phi$	$<$ 1.1	$\times 10^{-3}$	CL=90%	2339
$K_2^*(1430)^+ \phi$	$<$ 3.4	$\times 10^{-3}$	CL=90%	2332
$K^+ f_0(980)$	$<$ 8	$\times 10^{-5}$	CL=90%	2524
$K^*(892)^+ \gamma$	(5.7 $\pm$3.3)	$\times 10^{-5}$		2564
$K_1(1270)^+ \gamma$	$<$ 7.3	$\times 10^{-3}$	CL=90%	2486
$K_1(1400)^+ \gamma$	$<$ 2.2	$\times 10^{-3}$	CL=90%	2453
$K_2^*(1430)^+ \gamma$	$<$ 1.4	$\times 10^{-3}$	CL=90%	2447
$K^*(1680)^+ \gamma$	$<$ 1.9	$\times 10^{-3}$	CL=90%	2361
$K_3^*(1780)^+ \gamma$	$<$ 5.5	$\times 10^{-3}$	CL=90%	2343
$K_4^*(2045)^+ \gamma$	$<$ 9.9	$\times 10^{-3}$	CL=90%	2243

Light unflavored meson modes

$\pi^+ \pi^0$	$<$ 2.0	$\times 10^{-5}$	CL=90%	2636
$\pi^+ \pi^+ \pi^-$	$<$ 1.3	$\times 10^{-4}$	CL=90%	2630
$\rho^0 \pi^+$	$<$ 4.3	$\times 10^{-5}$	CL=90%	2582
$\pi^+ f_0(980)$	$<$ 1.4	$\times 10^{-4}$	CL=90%	2547
$\pi^+ f_2(1270)$	$<$ 2.4	$\times 10^{-4}$	CL=90%	2483
$\pi^+ \pi^- \pi^+$ nonresonant	$<$ 4.1	$\times 10^{-5}$	CL=90%	–
$\pi^+ \pi^0 \pi^0$	$<$ 8.9	$\times 10^{-4}$	CL=90%	2631
$\rho^+ \pi^0$	$<$ 7.7	$\times 10^{-5}$	CL=90%	2582
$\pi^+ \pi^- \pi^+ \pi^0$	$<$ 4.0	$\times 10^{-3}$	CL=90%	2621
$\rho^+ \rho^0$	$<$ 1.0	$\times 10^{-3}$	CL=90%	2525
$a_1(1260)^+ \pi^0$	$<$ 1.7	$\times 10^{-3}$	CL=90%	2494
$a_1(1260)^0 \pi^+$	$<$ 9.0	$\times 10^{-4}$	CL=90%	2494
$\omega \pi^+$	$<$ 4.0	$\times 10^{-4}$	CL=90%	2580
$\eta \pi^+$	$<$ 1.5	$\times 10^{-5}$	CL=90%	2609
$\eta' \pi^+$	$<$ 3.1	$\times 10^{-5}$	CL=90%	2550
$\eta' \rho^+$	$<$ 4.7	$\times 10^{-5}$	CL=90%	2493
$\eta \rho^+$	$<$ 3.2	$\times 10^{-5}$	CL=90%	2554
$\pi^+ \pi^+ \pi^+ \pi^- \pi^-$	$<$ 8.6	$\times 10^{-4}$	CL=90%	2608
$\rho^0 a_1(1260)^+$	$<$ 6.2	$\times 10^{-4}$	CL=90%	2434
$\rho^0 a_2(1320)^+$	$<$ 7.2	$\times 10^{-4}$	CL=90%	2411
$\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^0$	$<$ 6.3	$\times 10^{-3}$	CL=90%	2592
$a_1(1260)^+ a_1(1260)^0$	$<$ 1.3	%	CL=90%	2335

Baryon modes

$p\overline{p}\pi^+$		< 1.6	$\times 10^{-4}$	CL=90%	2439
$p\overline{p}\pi^+$ nonresonant		< 5.3	$\times 10^{-5}$	CL=90%	–
$p\overline{p}\pi^+\pi^+\pi^-$		< 5.2	$\times 10^{-4}$	CL=90%	2369
$p\overline{p}K^+$ nonresonant		< 8.9	$\times 10^{-5}$	CL=90%	–
$p\overline{\Lambda}$		< 6	$\times 10^{-5}$	CL=90%	2430
$p\overline{\Lambda}\pi^+\pi^-$		< 2.0	$\times 10^{-4}$	CL=90%	2367
$\overline{\Delta}^0 p$		< 3.8	$\times 10^{-4}$	CL=90%	2402
$\Delta^{++}\overline{p}$		< 1.5	$\times 10^{-4}$	CL=90%	2402
$\Lambda_c^- p\pi^+$		(6.2 ±2.7)	$\times 10^{-4}$		–
$\Lambda_c^- p\pi^+\pi^0$		< 3.12	$\times 10^{-3}$	CL=90%	–
$\Lambda_c^- p\pi^+\pi^+\pi^-$		< 1.46	$\times 10^{-3}$	CL=90%	–
$\Lambda_c^- p\pi^+\pi^+\pi^-\pi^0$		< 1.34	%	CL=90%	–

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

$\pi^+ e^+ e^-$	*B1*	< 3.9	$\times 10^{-3}$	CL=90%	2638
$\pi^+ \mu^+ \mu^-$	*B1*	< 9.1	$\times 10^{-3}$	CL=90%	2633
$K^+ e^+ e^-$	*B1*	< 6	$\times 10^{-5}$	CL=90%	2616
$K^+ \mu^+ \mu^-$	*B1*	< 1.0	$\times 10^{-5}$	CL=90%	2612
$K^*(892)^+ e^+ e^-$	*B1*	< 6.9	$\times 10^{-4}$	CL=90%	2564
$K^*(892)^+ \mu^+ \mu^-$	*B1*	< 1.2	$\times 10^{-3}$	CL=90%	2560
$\pi^+ e^+ \mu^-$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2637
$\pi^+ e^- \mu^+$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2637
$K^+ e^+ \mu^-$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2615
$K^+ e^- \mu^+$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2615
$\pi^- e^+ e^+$	*L*	< 3.9	$\times 10^{-3}$	CL=90%	2638
$\pi^- \mu^+ \mu^+$	*L*	< 9.1	$\times 10^{-3}$	CL=90%	2633
$\pi^- e^+ \mu^+$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2637
$K^- e^+ e^+$	*L*	< 3.9	$\times 10^{-3}$	CL=90%	2616
$K^- \mu^+ \mu^+$	*L*	< 9.1	$\times 10^{-3}$	CL=90%	2612
$K^- e^+ \mu^+$	*LF*	< 6.4	$\times 10^{-3}$	CL=90%	2615

B^0

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

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

Mass $m_{B^0} = 5279.2 \pm 1.8$ MeV
$m_{B^0} - m_{B^\pm} = 0.35 \pm 0.29$ MeV (S = 1.1)
Mean life $\tau_{B^0} = (1.56 \pm 0.04) \times 10^{-12}$ s
$c\tau = 468$ μm
$\tau_{B^+}/\tau_{B^0} = 1.02 \pm 0.04$ (average of direct and inferred)
$\tau_{B^+}/\tau_{B^0} = 1.04 \pm 0.04$ (direct measurements)
$\tau_{B^+}/\tau_{B^0} = 0.95^{+0.15}_{-0.12}$ (inferred from branching fractions)

B^0-$\overline{B}^0$ mixing parameters

$\chi_d = 0.172 \pm 0.010$
$\Delta m_{B^0} = m_{B^0_H} - m_{B^0_L} = (0.464 \pm 0.018) \times 10^{12}$ $\hbar$ s^{-1}
$x_d = \Delta m_{B^0}/\Gamma_{B^0} = 0.723 \pm 0.032$

CP violation parameters

$\left|\text{Re}(\epsilon_{B^0})\right| = 0.002 \pm 0.008$

$\overline{B}^0$ 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.

B^0 DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\ell^+\nu_\ell$ anything	[pp]	(10.5 ± 0.8) %		–
$D^-\ell^+\nu_\ell$	[pp]	(2.00 ± 0.25) %		–
$D^*(2010)^-\ell^+\nu_\ell$	[pp]	(4.60 ± 0.27) %		–
$\rho^-\ell^+\nu_\ell$	[pp]	$(2.5\ ^{+\ 0.8}_{-\ 1.0}) \times 10^{-4}$		–
$\pi^-\ell^+\nu_\ell$		$(1.8 \pm 0.6) \times 10^{-4}$		–
Inclusive modes				
K^+ anything		(78 ± 80) %		–

D, D^*, or D_s modes

$D^- \pi^+$	$(3.0 \pm 0.4) \times 10^{-3}$		2306
$D^- \rho^+$	$(7.9 \pm 1.4) \times 10^{-3}$		2236
$\overline{D}^0 \pi^+ \pi^-$	$< 1.6 \times 10^{-3}$	CL=90%	2301
$D^*(2010)^- \pi^+$	$(2.76 \pm 0.21) \times 10^{-3}$		2254
$D^- \pi^+ \pi^+ \pi^-$	$(8.0 \pm 2.5) \times 10^{-3}$		2287
$(D^- \pi^+ \pi^+ \pi^-)$ nonresonant	$(3.9 \pm 1.9) \times 10^{-3}$		2287
$D^- \pi^+ \rho^0$	$(1.1 \pm 1.0) \times 10^{-3}$		2207
$D^- a_1(1260)^+$	$(6.0 \pm 3.3) \times 10^{-3}$		2121
$D^*(2010)^- \pi^+ \pi^0$	(1.5 ± 0.5) %		2247
$D^*(2010)^- \rho^+$	$(6.7 \pm 3.3) \times 10^{-3}$		2181
$D^*(2010)^- \pi^+ \pi^+ \pi^-$	$(7.6 \pm 1.7) \times 10^{-3}$	S=1.3	2235
$(D^*(2010)^- \pi^+ \pi^+ \pi^-)$ non-resonant	$(0.0 \pm 2.5) \times 10^{-3}$		2235
$D^*(2010)^- \pi^+ \rho^0$	$(5.7 \pm 3.1) \times 10^{-3}$		2151
$D^*(2010)^- a_1(1260)^+$	(1.30 ± 0.27) %		2061
$D^*(2010)^- \pi^+ \pi^+ \pi^- \pi^0$	(3.4 ± 1.8) %		2218
$\overline{D}_2^*(2460)^- \pi^+$	$< 2.2 \times 10^{-3}$	CL=90%	2064
$\overline{D}_2^*(2460)^- \rho^+$	$< 4.9 \times 10^{-3}$	CL=90%	1979
$D^- D_s^+$	$(8.0 \pm 3.0) \times 10^{-3}$		1812
$D^*(2010)^- D_s^+$	$(9.6 \pm 3.4) \times 10^{-3}$		1735
$D^- D_s^{*+}$	(1.0 ± 0.5) %		1731
$D^*(2010)^- D_s^{*+}$	(2.0 ± 0.7) %		1649
$D_s^+ \pi^-$	$< 2.8 \times 10^{-4}$	CL=90%	2270
$D_s^{*+} \pi^-$	$< 5 \times 10^{-4}$	CL=90%	2214
$D_s^+ \rho^-$	$< 7 \times 10^{-4}$	CL=90%	2198
$D_s^{*+} \rho^-$	$< 8 \times 10^{-4}$	CL=90%	2139
$D_s^+ a_1(1260)^-$	$< 2.6 \times 10^{-3}$	CL=90%	2079
$D_s^{*+} a_1(1260)^-$	$< 2.2 \times 10^{-3}$	CL=90%	2014
$D_s^- K^+$	$< 2.4 \times 10^{-4}$	CL=90%	2242
$D_s^{*-} K^+$	$< 1.7 \times 10^{-4}$	CL=90%	2185
$D_s^- K^*(892)^+$	$< 9.9 \times 10^{-4}$	CL=90%	2172
$D_s^{*-} K^*(892)^+$	$< 1.1 \times 10^{-3}$	CL=90%	2112
$D_s^- \pi^+ K^0$	$< 5 \times 10^{-3}$	CL=90%	2221
$D_s^{*-} \pi^+ K^0$	$< 3.1 \times 10^{-3}$	CL=90%	2164
$D_s^- \pi^+ K^*(892)^0$	$< 4 \times 10^{-3}$	CL=90%	2136
$D_s^{*-} \pi^+ K^*(892)^0$	$< 2.0 \times 10^{-3}$	CL=90%	2074
$\overline{D}^0 \pi^0$	$< 1.2 \times 10^{-4}$	CL=90%	2308
$\overline{D}^0 \rho^0$	$< 3.9 \times 10^{-4}$	CL=90%	2238
$\overline{D}^0 \eta$	$< 1.3 \times 10^{-4}$	CL=90%	2274

$\overline{D}^0\,\eta'$	$<\ 9.4$	$\times 10^{-4}$	CL=90%	2198
$\overline{D}^0\,\omega$	$<\ 5.1$	$\times 10^{-4}$	CL=90%	2235
$\overline{D}^*(2007)^0\,\pi^0$	$<\ 4.4$	$\times 10^{-4}$	CL=90%	2256
$\overline{D}^*(2007)^0\,\rho^0$	$<\ 5.6$	$\times 10^{-4}$	CL=90%	2183
$\overline{D}^*(2007)^0\,\eta$	$<\ 2.6$	$\times 10^{-4}$	CL=90%	2220
$\overline{D}^*(2007)^0\,\eta'$	$<\ 1.4$	$\times 10^{-3}$	CL=90%	2141
$\overline{D}^*(2007)^0\,\omega$	$<\ 7.4$	$\times 10^{-4}$	CL=90%	2180
$D^*(2010)^+\,D^*(2010)^-$	$<\ 2.2$	$\times 10^{-3}$	CL=90%	1711
$D^*(2010)^+\,D^-$	$<\ 1.8$	$\times 10^{-3}$	CL=90%	1790
$D^+\,D^*(2010)^-$	$<\ 1.2$	$\times 10^{-3}$	CL=90%	1790

Charmonium modes

$J/\psi(1S)\,K^0$	$(\ 8.9\ \pm\ 1.2\ )$	$\times 10^{-4}$		1683
$J/\psi(1S)\,K^+\pi^-$	$(\ 1.1\ \pm\ 0.6\ )$	$\times 10^{-3}$		1652
$J/\psi(1S)\,K^*(892)^0$	$(\ 1.35\pm\ 0.18)$	$\times 10^{-3}$		1570
$J/\psi(1S)\,\pi^0$	$<\ 5.8$	$\times 10^{-5}$	CL=90%	1728
$J/\psi(1S)\,\eta$	$<\ 1.2$	$\times 10^{-3}$	CL=90%	1672
$J/\psi(1S)\,\rho^0$	$<\ 2.5$	$\times 10^{-4}$	CL=90%	1614
$J/\psi(1S)\,\omega$	$<\ 2.7$	$\times 10^{-4}$	CL=90%	1609
$\psi(2S)\,K^0$	$<\ 8$	$\times 10^{-4}$	CL=90%	1283
$\psi(2S)\,K^+\pi^-$	$<\ 1$	$\times 10^{-3}$	CL=90%	1238
$\psi(2S)\,K^*(892)^0$	$(\ 1.4\ \pm\ 0.9\ )$	$\times 10^{-3}$		1113
$\chi_{c1}(1P)\,K^0$	$<\ 2.7$	$\times 10^{-3}$	CL=90%	1411
$\chi_{c1}(1P)\,K^*(892)^0$	$<\ 2.1$	$\times 10^{-3}$	CL=90%	1263

K or K^* modes

$K^+\pi^-$	$(\ 1.5\ ^{+0.5}_{-0.4}\ )$	$\times 10^{-5}$		2615
$K^0\pi^0$	$<\ 4.1$	$\times 10^{-5}$	CL=90%	2614
$\eta'\,K^0$	$(\ 4.7\ ^{+2.8}_{-2.2}\ )$	$\times 10^{-5}$		2528
$\eta'\,K^*(892)^0$	$<\ 3.9$	$\times 10^{-5}$	CL=90%	2472
$\eta\,K^*(892)^0$	$<\ 3.0$	$\times 10^{-5}$	CL=90%	2534
$\eta\,K^0$	$<\ 3.3$	$\times 10^{-5}$	CL=90%	2593
K^+K^-	$<\ 4.3$	$\times 10^{-6}$	CL=90%	2593
$K^0\overline{K}^0$	$<\ 1.7$	$\times 10^{-5}$	CL=90%	2592
$K^+\rho^-$	$<\ 3.5$	$\times 10^{-5}$	CL=90%	2559
$K^0\rho^0$	$<\ 3.9$	$\times 10^{-5}$	CL=90%	2559
$K^0 f_0(980)$	$<\ 3.6$	$\times 10^{-4}$	CL=90%	2523
$K^*(892)^+\pi^-$	$<\ 7.2$	$\times 10^{-5}$	CL=90%	2562
$K^*(892)^0\pi^0$	$<\ 2.8$	$\times 10^{-5}$	CL=90%	2562
$K_2^*(1430)^+\pi^-$	$<\ 2.6$	$\times 10^{-3}$	CL=90%	2445

$K^0 K^+ K^-$		<	1.3	$\times 10^{-3}$	CL=90%	2522
$K^0 \phi$		<	8.8	$\times 10^{-5}$	CL=90%	2516
$K^- \pi^+ \pi^+ \pi^-$	[*bbb*]	<	2.3	$\times 10^{-4}$	CL=90%	2600
$K^*(892)^0 \pi^+ \pi^-$		<	1.4	$\times 10^{-3}$	CL=90%	2556
$K^*(892)^0 \rho^0$		<	4.6	$\times 10^{-4}$	CL=90%	2504
$K^*(892)^0 f_0(980)$		<	1.7	$\times 10^{-4}$	CL=90%	2467
$K_1(1400)^+ \pi^-$		<	1.1	$\times 10^{-3}$	CL=90%	2451
$K^- a_1(1260)^+$	[*bbb*]	<	2.3	$\times 10^{-4}$	CL=90%	2471
$K^*(892)^0 K^+ K^-$		<	6.1	$\times 10^{-4}$	CL=90%	2466
$K^*(892)^0 \phi$		<	4.3	$\times 10^{-5}$	CL=90%	2459
$K_1(1400)^0 \rho^0$		<	3.0	$\times 10^{-3}$	CL=90%	2389
$K_1(1400)^0 \phi$		<	5.0	$\times 10^{-3}$	CL=90%	2339
$K_2^*(1430)^0 \rho^0$		<	1.1	$\times 10^{-3}$	CL=90%	2380
$K_2^*(1430)^0 \phi$		<	1.4	$\times 10^{-3}$	CL=90%	2330
$K^*(892)^0 \gamma$			(4.0 ± 1.9)	$\times 10^{-5}$		2564
$K_1(1270)^0 \gamma$		<	7.0	$\times 10^{-3}$	CL=90%	2486
$K_1(1400)^0 \gamma$		<	4.3	$\times 10^{-3}$	CL=90%	2453
$K_2^*(1430)^0 \gamma$		<	4.0	$\times 10^{-4}$	CL=90%	2445
$K^*(1680)^0 \gamma$		<	2.0	$\times 10^{-3}$	CL=90%	2361
$K_3^*(1780)^0 \gamma$		<	1.0	%	CL=90%	2343
$K_4^*(2045)^0 \gamma$		<	4.3	$\times 10^{-3}$	CL=90%	2244
$\phi \phi$		<	3.9	$\times 10^{-5}$	CL=90%	2435

Light unflavored meson modes

$\pi^+ \pi^-$		<	1.5	$\times 10^{-5}$	CL=90%	2636
$\pi^0 \pi^0$		<	9.3	$\times 10^{-6}$	CL=90%	2636
$\eta \pi^0$		<	8	$\times 10^{-6}$	CL=90%	2609
$\eta \eta$		<	1.8	$\times 10^{-5}$	CL=90%	2582
$\eta' \pi^0$		<	1.1	$\times 10^{-5}$	CL=90%	2551
$\eta' \eta'$		<	4.7	$\times 10^{-5}$	CL=90%	2460
$\eta' \eta$		<	2.7	$\times 10^{-5}$	CL=90%	2522
$\eta' \rho^0$		<	2.3	$\times 10^{-5}$	CL=90%	2493
$\eta \rho^0$		<	1.3	$\times 10^{-5}$	CL=90%	2554
$\pi^+ \pi^- \pi^0$		<	7.2	$\times 10^{-4}$	CL=90%	2631
$\rho^0 \pi^0$		<	2.4	$\times 10^{-5}$	CL=90%	2582
$\rho^\mp \pi^\pm$	[*gg*]	<	8.8	$\times 10^{-5}$	CL=90%	2582
$\pi^+ \pi^- \pi^+ \pi^-$		<	2.3	$\times 10^{-4}$	CL=90%	2621
$\rho^0 \rho^0$		<	2.8	$\times 10^{-4}$	CL=90%	2525
$a_1(1260)^\mp \pi^\pm$	[*gg*]	<	4.9	$\times 10^{-4}$	CL=90%	2494
$a_2(1320)^\mp \pi^\pm$	[*gg*]	<	3.0	$\times 10^{-4}$	CL=90%	2473

$\pi^+\pi^-\pi^0\pi^0$			< 3.1	$\times 10^{-3}$	CL=90%	2622
$\rho^+\rho^-$			< 2.2	$\times 10^{-3}$	CL=90%	2525
$a_1(1260)^0\pi^0$			< 1.1	$\times 10^{-3}$	CL=90%	2494
$\omega\pi^0$			< 4.6	$\times 10^{-4}$	CL=90%	2580
$\pi^+\pi^+\pi^-\pi^-\pi^0$			< 9.0	$\times 10^{-3}$	CL=90%	2609
$a_1(1260)^+\rho^-$			< 3.4	$\times 10^{-3}$	CL=90%	2434
$a_1(1260)^0\rho^0$			< 2.4	$\times 10^{-3}$	CL=90%	2434
$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$			< 3.0	$\times 10^{-3}$	CL=90%	2592
$a_1(1260)^+a_1(1260)^-$			< 2.8	$\times 10^{-3}$	CL=90%	2336
$\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$			< 1.1	%	CL=90%	2572

Baryon modes

$p\overline{p}$			< 1.8	$\times 10^{-5}$	CL=90%	2467
$p\overline{p}\pi^+\pi^-$			< 2.5	$\times 10^{-4}$	CL=90%	2406
$p\overline{\Lambda}\pi^-$			< 1.8	$\times 10^{-4}$	CL=90%	2401
$\Delta^0\overline{\Delta}^0$			< 1.5	$\times 10^{-3}$	CL=90%	2334
$\Delta^{++}\Delta^{--}$			< 1.1	$\times 10^{-4}$	CL=90%	2334
$\overline{\Sigma}_c^{--}\Delta^{++}$			< 1.0	$\times 10^{-3}$	CL=90%	1839
$\Lambda_c^- p\pi^+\pi^-$			(1.3 ± 0.6)	$\times 10^{-3}$		–
$\Lambda_c^- p$			< 2.1	$\times 10^{-4}$	CL=90%	2021
$\Lambda_c^- p\pi^0$			< 5.9	$\times 10^{-4}$	CL=90%	–
$\Lambda_c^- p\pi^+\pi^-\pi^0$			< 5.07	$\times 10^{-3}$	CL=90%	–
$\Lambda_c^- p\pi^+\pi^-\pi^+\pi^-$			< 2.74	$\times 10^{-3}$	CL=90%	–

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

$\gamma\gamma$	*B1*		< 3.9	$\times 10^{-5}$	CL=90%	2640
e^+e^-	*B1*		< 5.9	$\times 10^{-6}$	CL=90%	2640
$\mu^+\mu^-$	*B1*		< 6.8	$\times 10^{-7}$	CL=90%	2637
$K^0e^+e^-$	*B1*		< 3.0	$\times 10^{-4}$	CL=90%	2616
$K^0\mu^+\mu^-$	*B1*		< 3.6	$\times 10^{-4}$	CL=90%	2612
$K^*(892)^0e^+e^-$	*B1*		< 2.9	$\times 10^{-4}$	CL=90%	2564
$K^*(892)^0\mu^+\mu^-$	*B1*		< 2.3	$\times 10^{-5}$	CL=90%	2559
$K^*(892)^0\nu\overline{\nu}$	*B1*		< 1.0	$\times 10^{-3}$	CL=90%	2244
$e^\pm\mu^\mp$	*LF*	[gg]	< 5.9	$\times 10^{-6}$	CL=90%	2639
$e^\pm\tau^\mp$	*LF*	[gg]	< 5.3	$\times 10^{-4}$	CL=90%	2341
$\mu^\pm\tau^\mp$	*LF*	[gg]	< 8.3	$\times 10^{-4}$	CL=90%	2339

$B^{\pm}/B^0$ ADMIXTURE

The branching fraction measurements are for an admixture of B mesons at the $\Upsilon(4S)$. The values quoted assume that $B(\Upsilon(4S) \rightarrow B\overline{B}) = 100\%$.

For inclusive branching fractions, *e.g.*, $B \rightarrow D^{\pm}$ anything, the treatment of multiple D's in the final state must be defined. One possiblity would be to count the number of events with one-or-more D's and divide by the total number of B's. Another possibility would be to count the total number of D's and divide by the total number of B's, which is the definition of average multiplicity. The two definitions are identical when only one of the specified particles is allowed in the final state. Even though the "one-or-more" definition seems sensible, for practical reasons inclusive branching fractions are almost always measured using the multiplicity definition. For heavy final state particles, authors call their results inclusive branching fractions while for light particles some authors call their results multiplicities. In the B sections, we list all results as inclusive branching fractions, adopting a multiplicity definition. This means that inclusive branching fractions can exceed 100% and that inclusive partial widths can exceed total widths, just as inclusive cross sections can exceed total cross sections.

$\overline{B}$ modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing.

B DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
Semileptonic and leptonic modes				
$B \rightarrow e^+ \nu_e$ anything	[*ccc*]	(10.41 ± 0.29) %	S=1.2	–
$B \rightarrow \overline{p} e^+ \nu_e$ anything		< 1.6 × 10^{-3}	CL=90%	–
$B \rightarrow \mu^+ \nu_\mu$ anything	[*ccc*]	(10.3 ± 0.5) %		–
$B \rightarrow \ell^+ \nu_\ell$ anything	[*pp,ccc*]	(10.45 ± 0.21) %		–
$B \rightarrow D^- \ell^+ \nu_\ell$ anything	[*pp*]	(2.7 ± 0.8) %		–
$B \rightarrow \overline{D}^0 \ell^+ \nu_\ell$ anything	[*pp*]	(7.0 ± 1.4) %		–
$B \rightarrow \overline{D}^{**} \ell^+ \nu_\ell$	[*pp,ddd*]	(2.7 ± 0.7) %		–
$B \rightarrow \overline{D}_1(2420) \ell^+ \nu_\ell$ anything		(7.4 ± 1.6) × 10^{-3}		–
$B \rightarrow D \pi \ell^+ \nu_\ell$ anything + $D^* \pi \ell^+ \nu_\ell$ anything		(2.3 ± 0.4) %		–
$B \rightarrow \overline{D}_2^*(2460) \ell^+ \nu_\ell$ anything		< 6.5 × 10^{-3}	CL=95%	–
$B \rightarrow D^{*-} \pi^+ \ell^+ \nu_\ell$ anything		(1.00 ± 0.34) %		–

$B \to D_s^- \ell^+ \nu_\ell$ anything	[pp]	< 9	$\times 10^{-3}$	CL=90%	–
$B \to D_s^- \ell^+ \nu_\ell K^+$ anything	[pp]	< 6	$\times 10^{-3}$	CL=90%	–
$B \to D_s^- \ell^+ \nu_\ell K^0$ anything	[pp]	< 9	$\times 10^{-3}$	CL=90%	–
$B \to K^+ \ell^+ \nu_\ell$ anything	[pp]	(6.0 ±0.5) %			–
$B \to K^- \ell^+ \nu_\ell$ anything	[pp]	(10 ±4)	$\times 10^{-3}$		–
$B \to K^0 / \overline{K}^0 \ell^+ \nu_\ell$ anything	[pp]	(4.4 ±0.5) %			–

D, *D**, or *D_s* modes

$B \to D^\pm$ anything		(24.1 ±1.9) %			–
$B \to D^0 / \overline{D}^0$ anything		(63.1 ±2.9) %		S=1.1	–
$B \to D^*(2010)^\pm$ anything		(22.7 ±1.6) %			–
$B \to D^*(2007)^0$ anything		(26.0 ±2.7) %			–
$B \to D_s^\pm$ anything	[gg]	(10.0 ±2.5) %			–
$b \to c \overline{c} s$		(22 ±4) %			–
$B \to D_s D$, $D_s^* D$, $D_s D^*$, or $D_s^* D^*$	[gg]	(4.9 ±1.3) %			–
$B \to D^*(2010) \gamma$		< 1.1	$\times 10^{-3}$	CL=90%	–
$B \to D_s^+ \pi^-$, $D_s^{*+} \pi^-$, $D_s^+ \rho^-$, $D_s^{*+} \rho^-$, $D_s^+ \pi^0$, $D_s^{*+} \pi^0$, $D_s^+ \eta$, $D_s^{*+} \eta$, $D_s^+ \rho^0$, $D_s^{*+} \rho^0$, $D_s^+ \omega$, $D_s^{*+} \omega$	[gg]	< 5	$\times 10^{-4}$	CL=90%	–
$B \to D_{s1}(2536)^+$ anything		< 9.5	$\times 10^{-3}$	CL=90%	–

Charmonium modes

$B \to J/\psi(1S)$ anything		(1.13±0.06) %			–
$B \to J/\psi(1S)$(direct) anything		(8.0 ±0.8)	$\times 10^{-3}$		–
$B \to \psi(2S)$ anything		(3.5 ±0.5)	$\times 10^{-3}$		–
$B \to \chi_{c1}(1P)$ anything		(4.2 ±0.7)	$\times 10^{-3}$		–
$B \to \chi_{c1}(1P)$(direct) anything		(3.7 ±0.7)	$\times 10^{-3}$		–
$B \to \chi_{c2}(1P)$ anything		< 3.8	$\times 10^{-3}$	CL=90%	–
$B \to \eta_c(1S)$ anything		< 9	$\times 10^{-3}$	CL=90%	–

K or *K** modes

$B \to K^\pm$ anything	[gg]	(78.9 ±2.5) %			–
$B \to K^+$ anything		(66 ±5) %			–
$B \to K^-$ anything		(13 ±4) %			–
$B \to K^0 / \overline{K}^0$ anything	[gg]	(64 ±4) %			–
$B \to K^*(892)^\pm$ anything		(18 ±6) %			–
$B \to K^*(892)^0 / \overline{K}^*(892)^0$ anything	[gg]	(14.6 ±2.6) %			–

$B \rightarrow K_1(1400)\gamma$		$<$	4.1	$\times 10^{-4}$	CL=90%	–
$B \rightarrow K_2^*(1430)\gamma$		$<$	8.3	$\times 10^{-4}$	CL=90%	–
$B \rightarrow K_2(1770)\gamma$		$<$	1.2	$\times 10^{-3}$	CL=90%	–
$B \rightarrow K_3^*(1780)\gamma$		$<$	3.0	$\times 10^{-3}$	CL=90%	–
$B \rightarrow K_4^*(2045)\gamma$		$<$	1.0	$\times 10^{-3}$	CL=90%	–
$B \rightarrow \overline{b} \rightarrow \overline{s}\gamma$			(2.3 ± 0.7)	$\times 10^{-4}$		–
$B \rightarrow \overline{b} \rightarrow \overline{s}$gluon		$<$	6.8	%	CL=90%	–

Light unflavored meson modes

$B \rightarrow \pi^{\pm}$ anything	[*gg,eee*]		(359 ± 7)	%		–
$B \rightarrow \eta$ anything			(17.6 ± 1.6)	%		–
$B \rightarrow \rho^0$ anything			(21 ± 5)	%		–
$B \rightarrow \omega$ anything		$<$	81	%	CL=90%	–
$B \rightarrow \phi$ anything			(3.5 ± 0.7)	%	S=1.8	–

Baryon modes

$B \rightarrow \Lambda_c^{\pm}$ anything			(6.4 ± 1.1)	%		–
$B \rightarrow \Lambda_c^- e^+$ anything		$<$	3.2	$\times 10^{-3}$	CL=90%	–
$B \rightarrow \Lambda_c^- p$ anything			(3.6 ± 0.7)	%		–
$B \rightarrow \Lambda_c^- p e^+ \nu_e$		$<$	1.5	$\times 10^{-3}$	CL=90%	–
$B \rightarrow \overline{\Sigma}_c^{--}$ anything			(4.2 ± 2.4)	$\times 10^{-3}$		–
$B \rightarrow \overline{\Sigma}_c^{-}$ anything		$<$	9.6	$\times 10^{-3}$	CL=90%	–
$B \rightarrow \overline{\Sigma}_c^{0}$ anything			(4.6 ± 2.4)	$\times 10^{-3}$		–
$B \rightarrow \overline{\Sigma}_c^{0} N (N = p$ or $n)$		$<$	1.5	$\times 10^{-3}$	CL=90%	–
$B \rightarrow \Xi_c^0$ anything $\times$ B$(\Xi_c^0 \rightarrow \Xi^- \pi^+)$			(1.4 ± 0.5)	$\times 10^{-4}$		–
$B \rightarrow \Xi_c^+$ anything $\times$ B$(\Xi_c^+ \rightarrow \Xi^- \pi^+ \pi^+)$			$(4.5 ^{+1.3}_{-1.2})$	$\times 10^{-4}$		–
$B \rightarrow p/\overline{p}$anything	[*gg*]		(8.0 ± 0.4)	%		–
$B \rightarrow p/\overline{p}$(direct) anything	[*gg*]		(5.5 ± 0.5)	%		–
$B \rightarrow \Lambda/\overline{\Lambda}$anything	[*gg*]		(4.0 ± 0.5)	%		–
$B \rightarrow \Xi^-/\overline{\Xi}^+$ anything	[*gg*]		(2.7 ± 0.6)	$\times 10^{-3}$		–
$B \rightarrow$ baryons anything			(6.8 ± 0.6)	%		–
$B \rightarrow p\overline{p}$anything			(2.47 ± 0.23)	%		–
$B \rightarrow \Lambda\overline{p}/\overline{\Lambda}p$anything	[*gg*]		(2.5 ± 0.4)	%		–
$B \rightarrow \Lambda\overline{\Lambda}$anything		$<$	5	$\times 10^{-3}$	CL=90%	–

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

$B \rightarrow e^+ e^- s$	*B1*	$<$	5.7	$\times 10^{-5}$	CL=90%	–
$B \rightarrow \mu^+ \mu^- s$	*B1*	$<$	5.8	$\times 10^{-5}$	CL=90%	–
$B \rightarrow e^{\pm} \mu^{\mp} s$	*LF*	$<$	2.2	$\times 10^{-5}$	CL=90%	–

$B^{\pm}/B^0/B^0_s/b$-baryon ADMIXTURE

These measurements are for an admixture of bottom particles at high energy (LEP, Tevatron, $Sp\overline{p}S$).

Mean life $\tau = (1.564 \pm 0.014) \times 10^{-12}$ s

Mean life $\tau = (1.72 \pm 0.10) \times 10^{-12}$ s Charged b-hadron admixture

Mean life $\tau = (1.58 \pm 0.14) \times 10^{-12}$ s Neutral b-hadron admixture

$\tau_{\text{charged } b-\text{hadron}}/\tau_{\text{neutral } b-\text{hadron}} = 1.09 \pm 0.13$

The branching fraction measurements are for an admixture of B mesons and baryons at energies above the $\Upsilon(4S)$. Only the highest energy results (LEP, Tevatron, $Sp\overline{p}S$) are used in the branching fraction averages. The production fractions give our best current estimate of the admixture at LEP.

For inclusive branching fractions, *e.g.*, $B \rightarrow D^{\pm}$ anything, the treatment of multiple D's in the final state must be defined. One possiblity would be to count the number of events with one-or-more D's and divide by the total number of B's. Another possibility would be to count the total number of D's and divide by the total number of B's, which is the definition of average multiplicity. The two definitions are identical when only one of the specified particles is allowed in the final state. Even though the "one-or-more" definition seems sensible, for practical reasons inclusive branching fractions are almost always measured using the multiplicity definition. For heavy final state particles, authors call their results inclusive branching fractions while for light particles some authors call their results multiplicities. In the B sections, we list all results as inclusive branching fractions, adopting a multiplicity definition. This means that inclusive branching fractions can exceed 100% and that inclusive partial widths can exceed total widths, just as inclusive cross sections can exceed total cross sections.

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

$\overline{b}$ DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)

PRODUCTION FRACTIONS

The production fractions for weakly decaying b-hadrons at the Z have been calculated from the best values of mean lives, mixing parameters, and branching fractions in this edition by the LEP B Oscillation Working Group as described in the note "Production and Decay of b-Flavored Hadrons" in the $B^{\pm}$ Particle Listings. Values assume

$$\mathrm{B}(\overline{b} \to B^+) = \mathrm{B}(\overline{b} \to B^0)$$
$$\mathrm{B}(\overline{b} \to B^+) + \mathrm{B}(\overline{b} \to B^0) + \mathrm{B}(\overline{b} \to B^0_s) + \mathrm{B}(b \to \Lambda_b) = 100\ \%.$$

The notation for production fractions varies in the literature (f_{B^0}, $f(b \to \overline{B}^0)$, $\mathrm{Br}(b \to \overline{B}^0)$). We use our own branching fraction notation here, $\mathrm{B}(\overline{b} \to B^0)$.

B^+	$(39.7^{+1.8}_{-2.2})$ %		–
B^0	$(39.7^{+1.8}_{-2.2})$ %		–
B^0_s	$(10.5^{+1.8}_{-1.7})$ %		–
Λ_b	$(10.1^{+3.9}_{-3.1})$ %		–

DECAY MODES

Semileptonic and leptonic modes

ν anything		(23.1 ± 1.5) %		–
$\ell^+ \nu_\ell$ anything	[pp,ccc]	(10.99 ± 0.23) %		–
$e^+ \nu_e$ anything	[ccc]	(10.9 ± 0.5) %		–
$\mu^+ \nu_\mu$ anything	[ccc]	(10.8 ± 0.5) %		–
$D^- \ell^+ \nu_\ell$ anything	[pp]	(2.02 ± 0.29) %		–
$\overline{D}^0 \ell^+ \nu_\ell$ anything	[pp]	(6.5 ± 0.6) %		–
$D^{*-} \ell^+ \nu_\ell$ anything	[pp]	(2.76 ± 0.29) %		–
$\overline{D}^0_j \ell^+ \nu_\ell$ anything	[pp,fff]	seen		–
$D^-_j \ell^+ \nu_\ell$ anything	[pp,fff]	seen		–
$\overline{D}^*_2(2460)^0 \ell^+ \nu_\ell$ anything		seen		–
$D^*_2(2460)^- \ell^+ \nu_\ell$ anything		seen		–
$\tau^+ \nu_\tau$ anything		(2.6 ± 0.4) %		–
$\overline{c} \to \ell^- \overline{\nu}_\ell$ anything	[pp]	(7.8 ± 0.6) %		–

Charmed meson and baryon modes				
$\overline{D}^0$ anything		(60.1 ± 3.2) %		–
D^- anything		(23.7 ± 2.3) %		–
$\overline{D}_s$ anything		(18 ± 5) %		–
Λ_c anything		(9.7 ± 2.9) %		–
$\overline{c}\,/\,c$ anything	[eee]	(117 ± 4) %		–
Charmonium modes				
$J/\psi(1S)$ anything		(1.16± 0.10) %		–
$\psi(2S)$ anything		(4.8 ± 2.4) $\times 10^{-3}$		–
$\chi_{c1}(1P)$ anything		(1.8 ± 0.5) %		–
K or K^* modes				
$\overline{s}\gamma$		< 5.4 $\times 10^{-4}$	90%	–
$K^{\pm}$ anything		(88 ±19) %		–
K^0_S anything		(29.0 ± 2.9) %		–
Pion modes				
π^0 anything	[eee]	(278 ±60) %		–
Baryon modes				
$p\,/\,\overline{p}$ anything		(14 ± 6) %		–
Other modes				
charged anything	[eee]	(497 ± 7) %		–
hadron$^+$ hadron$^-$		($1.7 \,^{+1.0}_{-0.7}$) $\times 10^{-5}$		–
charmless		(7 ±21) $\times 10^{-3}$		–
Baryon modes				
$\Lambda\,/\,\overline{\Lambda}$ anything		(5.9 ± 0.6) %		–
$\Delta B = 1$ weak neutral current ($B1$) modes				
$\mu^+\mu^-$ anything	*B1*	< 3.2 $\times 10^{-4}$	90%	–

B^*

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

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

Mass $m_{B^*} = 5324.9 \pm 1.8$ MeV

$m_{B^*} - m_B = 45.78 \pm 0.35$ MeV

B^* DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$B\gamma$	dominant	46