$B_c^{\pm}$

$I(J^P) = 0(0^-)$
I, J, P need confirmation.

Quantum numbers shown are quark-model predictions.

$B_c^{\pm}$ MASS

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
6.2745±0.0018 OUR AVERAGE				
6.2737±0.0013±0.0016	[1] AAIJ	12AV	LHCB	pp at 7 TeV
6.2756±0.0029±0.0025	[2] AALTONEN	08M	CDF	$p\overline{p}$ at 1.96 TeV
6.300 ±0.014 ±0.005	[2] ABAZOV	08T	D0	$p\overline{p}$ at 1.96 TeV
6.4 ±0.39 ±0.13	[3] ABE	98M	CDF	$p\overline{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6.2857±0.0053±0.0012	[2] ABULENCIA	06C	CDF	Repl. by AALTONEN 08M
6.32 ±0.06	[4] ACKERSTAFF	98O	OPAL	$e^+e^- \to Z$

[1] AAIJ 12AV uses the $B(c)^+ \to J/\psi\pi^+$ mode and also measures the mass difference $M(B(c)^+) - M(B^+) = 994.6 \pm 1.3 \pm 0.6$ MeV/c^2.

[2] Measured using a fully reconstructed decay mode of $B_c \to J/\psi\pi$.

[3] ABE 98M observed $20.4^{+6.2}_{-5.5}$ events in the $B_c^+ \to J/\psi(1s)\ell\nu_\ell$ with a significance of > 4.8 standard deviations. The mass value is estimated from $m(J/\psi(1S)\ell)$.

[4] ACKERSTAFF 98O observed 2 candidate events in the $B_c \to J/\psi(1S)\pi^+$ channel with an estimated background of 0.63 ± 0.20 events.

$B_c^{\pm}$ MEAN LIFE

"OUR EVALUATION" is an average using rescaled values of the data listed below. The average and rescaling were performed by the Heavy Flavor Averaging Group (HFAG) and are described at http://www.slac.stanford.edu/xorg/hfag/. The averaging/rescaling procedure takes into account correlations between the measurements.

VALUE (10^{-12} s)	DOCUMENT ID		TECN	COMMENT
0.452±0.033 OUR EVALUATION				
0.452±0.032 OUR AVERAGE				
0.452±0.048±0.027	[5] AALTONEN	13	CDF	$p\overline{p}$ at 1.96 TeV
$0.448^{+0.038}_{-0.036}\pm0.032$	[6] ABAZOV	09H	D0	$p\overline{p}$ at 1.96 TeV
$0.463^{+0.073}_{-0.065}\pm0.036$	[6] ABULENCIA	06O	CDF	$p\overline{p}$ at 1.96 TeV
$0.46^{+0.18}_{-0.16}\pm0.03$	[6] ABE	98M	CDF	$p\overline{p}$ 1.8 TeV

[5] Uses fully reconstructed $B_c^+ \to J/\psi\pi^+$ decays.

[6] The lifetime is measured from the $J/\psi e$ decay vertices.

B_c^+ DECAY MODES × B($\overline{b} \to B_c$)

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

	Mode	Fraction (Γ_i/Γ)		Confidence level
	The following quantities are not pure branching ratios; rather the fraction $\Gamma_i/\Gamma \times$ B($\overline{b} \to B_c$).			
Γ_1	$J/\psi(1S)\ell^+\nu_\ell$ anything	$(5.2\ ^{+2.4}_{-2.1}) \times 10^{-5}$		
Γ_2	$J/\psi(1S)\pi^+$	seen		
Γ_3	$J/\psi(1S)\pi^+\pi^+\pi^-$	seen		
Γ_4	$J/\psi(1S)a_1(1260)$	< 1.2	$\times 10^{-3}$	90%
Γ_5	$D^*(2010)^+\overline{D}^0$	< 6.2	$\times 10^{-3}$	90%
Γ_6	D^+K^{*0}	< 0.20	$\times 10^{-6}$	90%
Γ_7	$D^+\overline{K}^{*0}$	< 0.16	$\times 10^{-6}$	90%
Γ_8	$D_s^+K^{*0}$	< 0.28	$\times 10^{-6}$	90%
Γ_9	$D_s^+\overline{K}^{*0}$	< 0.4	$\times 10^{-6}$	90%
Γ_{10}	$D_s^+\phi$	< 0.32	$\times 10^{-6}$	90%

B_c^+ BRANCHING RATIOS

$\Gamma(J/\psi(1S)\ell^+\nu_\ell$ anything$)/\Gamma_{total} \times$ B($\overline{b} \to B_c$) **$\Gamma_1/\Gamma \times$ B**

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$(5.2^{+2.4}_{-2.1}) \times 10^{-5}$		[7] ABE	98M	CDF	$p\overline{p}$ 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$< 1.6 \times 10^{-4}$	90	[8] ACKERSTAFF	98O	OPAL	$e^+e^- \to Z$
$< 1.9 \times 10^{-4}$	90	[9] ABREU	97E	DLPH	$e^+e^- \to Z$
$< 1.2 \times 10^{-4}$	90	[10] BARATE	97H	ALEP	$e^+e^- \to Z$

[7] ABE 98M result is derived from the measurement of $[\sigma(B_c)\times B(B_c \to J/\psi(1S)\ell\nu_\ell)]$ / $[\sigma(B^+)\times B(B^+ \to J/\psi(1S)K^+)] = 0.132^{+0.041}_{-0.037}$(stat)$\pm 0.031(sys)^{+0.032}_{-0.020}$(lifetime) by using PDG 98 values of B($b \to B^+$) and B($B^+ \to J/\psi(1S)K^+$).

[8] ACKERSTAFF 98O reports B($Z \to B_c$X)/B($Z \to q q$)×B($B_c \to J/\psi(1S)\ell\nu_\ell$) $<$ 6.95×10^{-5} at 90%CL. We rescale to our PDG 98 values of B($Z \to b\overline{b}$).

[9] ABREU 97E value listed is for an assumed $\tau_{B_c} = 0.4$ ps and improves to 1.6×10^{-4} for $\tau_{B_c} = 1.4$ ps.

[10] BARATE 97H reports B($Z \to B_c$X)/B($Z \to q q$)·B($B_c \to J/\psi(1S)\ell\nu_\ell$) $< 5.2\times 10^{-5}$ at 90%CL. We rescale to our PDG 96 values of B($Z \to b\overline{b}$). A $B_c^+ \to J/\psi(1S)\mu^+\nu_\mu$ candidate event is found, compared to all the known background sources 2×10^{-3}, which gives $m_{B_c} = 5.96^{+0.25}_{-0.19}$ GeV and $\tau_{B_c} = 1.77 \pm 0.17$ ps.

$\Gamma(J/\psi(1S)\pi^+)/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_2/\Gamma \times B$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
seen		AALTONEN	13	CDF	$p\overline{p}$ at 1.96 TeV
seen		[11] AAIJ	12AV	LHCB	pp at 7 TeV
seen		AALTONEN	08M	CDF	$p\overline{p}$ at 1.96 TeV
seen		ABAZOV	08T	D0	$p\overline{p}$ at 1.96 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<2.4 \times 10^{-4}$	90	[12] ACKERSTAFF	98O	OPAL	$e^+e^- \to Z$
$<3.4 \times 10^{-4}$	90	[13] ABREU	97E	DLPH	$e^+e^- \to Z$
$<8.2 \times 10^{-5}$	90	[14] BARATE	97H	ALEP	$e^+e^- \to Z$
$<2.0 \times 10^{-5}$	95	[15] ABE	96R	CDF	$p\overline{p}$ 1.8 TeV

[11] AAIJ 12AV reports a measurement of $B(B_c^+ \to J/\psi\pi^+)/B(B^+ \to J/\psi K^+)\ f_c/f_u = (0.68 \pm 0.10 \pm 0.03 \pm 0.05)\%$ at $p_T(B) > 4$ GeV and $2.5 < \eta(B) < 4.5$.

[12] ACKERSTAFF 98O reports $B(Z \to B_c X)/B(Z \to q q) \times B(B_c \to J/\psi(1S)\pi^+) < 1.06 \times 10^{-4}$ at 90%CL. We rescale to our PDG 98 values of $B(Z \to b\overline{b})$.

[13] ABREU 97E value listed is for an assumed $\tau_{B_c} = 0.4$ ps and improves to 2.7×10^{-4} for $\tau_{B_c} = 1.4$ ps.

[14] BARATE 97H reports $B(Z \to B_c X)/B(Z \to q q) \cdot B(B_c \to J/\psi(1S)\pi) < 3.6 \times 10^{-5}$ at 90%CL. We rescale to our PDG 96 values of $B(Z \to b\overline{b})$.

[15] ABE 96R reports $B(b \to B_c X)/B(b \to B^+ X) \cdot B(B_c^+ \to J/\psi(1S)\pi^+)/B(B^+ \to J/\psi(1S)K^+) < 0.053$ at 95%CL for $\tau_{B_c} = 0.8$ ps. It changes from 0.15 to 0.04 for 0.17 ps$< \tau_{B_c} < 1.6$ ps. We rescale to our PDG 96 values of $B(b \to B^+) = 0.378 \pm 0.022$ and $B(B^+ \to J/\psi(1S)K^+) = 0.00101 \pm 0.00014$.

$\Gamma(J/\psi(1S)\pi^+\pi^+\pi^-)/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_3/\Gamma \times B$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
seen		AAIJ	12Y	LHCB	pp at 7 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<5.7 \times 10^{-4}$	90	[16] ABREU	97E	DLPH	$e^+e^- \to Z$

[16] ABREU 97E value listed is independent of 0.4 ps$< \tau_{B_c} < 1.4$ ps.

$\Gamma(J/\psi(1S)\pi^+\pi^+\pi^-)/\Gamma(J/\psi(1S)\pi^+)$ — Γ_3/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
2.41±0.30±0.33	AAIJ	12Y	LHCB	pp at 7 TeV

$\Gamma(J/\psi(1S)a_1(1260))/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_4/\Gamma \times B$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{<1.2 \times 10^{-3}}$	90	[17] ACKERSTAFF	98O	OPAL	$e^+e^- \to Z$

[17] ACKERSTAFF 98O reports $B(Z \to B_c X)/B(Z \to q q) \times B(B_c \to J/\psi(1S)a_1(1260)) < 5.29 \times 10^{-4}$ at 90%CL. We rescale to our PDG 98 values of $B(Z \to b\overline{b})$.

$\Gamma(D^*(2010)^+\overline{D}^0)/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_5/\Gamma \times B$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{<6.2 \times 10^{-3}}$	90	[18] BARATE	98Q	ALEP	$e^+e^- \to Z$

[18] BARATE 98Q reports $B(Z \to B_c X) \times B(B_c \to D^*(2010)^+\overline{D}^0) < 1.9 \times 10^{-3}$ at 90%CL. We rescale to our PDG 98 values of $B(Z \to b\overline{b})$.

$\Gamma(D^+ K^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_6/\Gamma \times B$

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.20	90	[19] AAIJ	13R	LHCB	pp at 7 TeV

[19] AAIJ 13R reports $[\Gamma(B_c^+ \to D^+ K^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)] / [B(\overline{b} \to B^+)] < 0.5 \times 10^{-6}$ which we multiply by our best value $B(\overline{b} \to B^+) = 40.2 \times 10^{-2}$.

$\Gamma(D^+ \overline{K}^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_7/\Gamma \times B$

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.16	90	[20] AAIJ	13R	LHCB	pp at 7 TeV

[20] AAIJ 13R reports $[\Gamma(B_c^+ \to D^+ \overline{K}^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)] / [B(\overline{b} \to B^+)] < 0.4 \times 10^{-6}$ which we multiply by our best value $B(\overline{b} \to B^+) = 40.2 \times 10^{-2}$.

$\Gamma(D_s^+ K^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_8/\Gamma \times B$

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.28	90	[21] AAIJ	13R	LHCB	pp at 7 TeV

[21] AAIJ 13R reports $[\Gamma(B_c^+ \to D_s^+ K^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)] / [B(\overline{b} \to B^+)] < 0.7 \times 10^{-6}$ which we multiply by our best value $B(\overline{b} \to B^+) = 40.2 \times 10^{-2}$.

$\Gamma(D_s^+ \overline{K}^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_9/\Gamma \times B$

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.4	90	[22] AAIJ	13R	LHCB	pp at 7 TeV

[22] AAIJ 13R reports $[\Gamma(B_c^+ \to D_s^+ \overline{K}^{*0})/\Gamma_{total} \times B(\overline{b} \to B_c)] / [B(\overline{b} \to B^+)] < 1.1 \times 10^{-6}$ which we multiply by our best value $B(\overline{b} \to B^+) = 40.2 \times 10^{-2}$.

$\Gamma(D_s^+ \phi)/\Gamma_{total} \times B(\overline{b} \to B_c)$ — $\Gamma_{10}/\Gamma \times B$

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<0.32	90	[23] AAIJ	13R	LHCB	pp at 7 TeV

[23] AAIJ 13R reports $[\Gamma(B_c^+ \to D_s^+ \phi)/\Gamma_{total} \times B(\overline{b} \to B_c)] / [B(\overline{b} \to B^+)] < 0.8 \times 10^{-6}$ which we multiply by our best value $B(\overline{b} \to B^+) = 40.2 \times 10^{-2}$.

$B_c^{\pm}$ REFERENCES

AAIJ	13R	JHEP 1302 043	R. Aaij et al.	(LHCb Collab.)
AALTONEN	13	PR D87 011101	T. Aaltonen et al.	(CDF Collab.)
AAIJ	12AV	PRL 109 232001	R. Aaij et al.	(LHCb Colalb.)
AAIJ	12Y	PRL 108 251802	R. Aaij et al.	(LHCb Collab.)
ABAZOV	09H	PRL 102 092001	V.M. Abazov et al.	(D0 Collab.)
AALTONEN	08M	PRL 100 182002	T. Aaltonen et al.	(CDF Collab.)
ABAZOV	08T	PRL 101 012001	V.M. Abazov et al.	(D0 Collab.)
ABULENCIA	06C	PRL 96 082002	A. Abulencia et al.	(CDF Collab.)
ABULENCIA	06O	PRL 97 012002	A. Abulencia et al.	(CDF Collab.)
ABE	98M	PRL 81 2432	F. Abe et al.	(CDF Collab.)
Also		PR D58 112004	F. Abe et al.	(CDF Collab.)
ACKERSTAFF	98O	PL B420 157	K. Ackerstaff et al.	(OPAL Collab.)
BARATE	98Q	EPJ C4 387	R. Barate et al.	(ALEPH Collab.)

PDG	98	EPJ C3 1	C. Caso *et al.*	
ABREU	97E	PL B398 207	P. Abreu *et al.*	(DELPHI Collab.)
BARATE	97H	PL B402 213	R. Barate *et al.*	(ALEPH Collab.)
ABE	96R	PRL 77 5176	F. Abe *et al.*	(CDF Collab.)
PDG	96	PR D54 1	R. M. Barnett *et al.*	