b

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

Charge $= -\frac{1}{3}\ e$ Bottom $= -1$

b-QUARK MASS

The first value is the "running mass" $\overline{m}_b(\mu = \overline{m}_b)$ in the $\overline{\text{MS}}$ scheme, and the second value is the *1S* mass, which is half the mass of the $\Upsilon(1S)$ in perturbation theory. For a review of different quark mass definitions and their properties, see EL-KHADRA 02. The *1S* mass is better suited for use in analyzing B decays than the $\overline{\text{MS}}$ mass because it gives a stable perturbative expansion. We have converted masses in other schemes to the $\overline{\text{MS}}$ mass and *1S* mass using two-loop QCD perturbation theory with $\alpha_s(\mu = \overline{m}_b) = 0.223 \pm 0.008$. The values 4.18 ± 0.03 GeV for the $\overline{\text{MS}}$ mass and 4.66 ± 0.03 GeV for the *1S* mass correspond to 4.78 ± 0.06 GeV for the pole mass, using the two-loop conversion formula. A discussion of masses in different schemes can be found in the "Note on Quark Masses."

$\overline{\text{MS}}$ *MASS* (GeV)	*1S MASS* (GeV)	*DOCUMENT ID*		*TECN*
4.18 ±0.03 OUR EVALUATION of $\overline{\text{MS}}$ Mass. See the ideogram below.				
4.66 ±0.03 OUR EVALUATION of $1S$ Mass. See the ideogram below.				
4.236 ± 0.069	4.715 ± 0.077	[1] NARISON	13	THEO
4.171 ± 0.009	4.642 ± 0.010	[2] BODENSTEIN	12	THEO
4.29 ± 0.14	4.77 ± 0.16	[3] DIMOPOUL...	12	LATT
$4.235 \pm 0.003 \pm 0.055$	$4.755 \pm 0.003 \pm 0.058$	[4] HOANG	12	THEO
4.177 ± 0.011	4.649 ± 0.012	[5] NARISON	12	THEO
$4.18\ ^{+0.05}_{-0.04}$	$4.65\ ^{+0.06}_{-0.04}$	[6] LASCHKA	11	THEO
$4.186 \pm 0.044 \pm 0.015$	$4.659 \pm 0.050 \pm 0.017$	[7] AUBERT	10A	BABR
4.164 ± 0.023	4.635 ± 0.026	[8] MCNEILE	10	LATT
4.163 ± 0.016	4.633 ± 0.018	[9] CHETYRKIN	09	THEO
5.26 ± 1.2	5.85 ± 1.3	[10] ABDALLAH	08D	DLPH
4.243 ± 0.049	4.723 ± 0.055	[11] SCHWANDA	08	BELL
4.19 ± 0.40	4.66 ± 0.45	[12] ABDALLAH	06D	DLPH
4.205 ± 0.058	4.68 ± 0.06	[13] BOUGHEZAL	06	THEO
4.20 ± 0.04	4.67 ± 0.04	[14] BUCHMULLER	06	THEO
4.19 ± 0.06	4.66 ± 0.07	[15] PINEDA	06	THEO
4.17 ± 0.03	4.68 ± 0.03	[16] BAUER	04	THEO
4.22 ± 0.11	4.72 ± 0.12	[17,18] HOANG	04	THEO
4.19 ± 0.05	4.66 ± 0.05	[19] BORDES	03	THEO
4.20 ± 0.09	4.67 ± 0.10	[20] CORCELLA	03	THEO
4.24 ± 0.10	4.72 ± 0.11	[21] EIDEMULLER	03	THEO
4.207 ± 0.031	4.682 ± 0.035	[22] ERLER	03	THEO
$4.33 \pm 0.06 \pm 0.10$	$4.82 \pm 0.07 \pm 0.11$	[23] MAHMOOD	03	CLEO
4.190 ± 0.032	4.663 ± 0.036	[24] BRAMBILLA	02	THEO
4.346 ± 0.070	4.837 ± 0.078	[25] PENIN	02	THEO

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

4.212 ± 0.032	4.688 ± 0.036	[26] NARISON	12	THEO
4.171 ± 0.014	4.642 ± 0.016	[27] NARISON	12A	THEO
4.173 ± 0.010	4.645 ± 0.011	[28] NARISON	10	THEO
$4.42 \pm 0.06 \pm 0.08$	$4.92 \pm 0.07 \pm 0.09$	[29] GUAZZINI	08	LATT
$4.347 \pm 0.048 \pm 0.08$	$4.838 \pm 0.053 \pm 0.09$	[30] DELLA-MOR...	07	LATT
4.164 ± 0.025	4.635 ± 0.028	[31] KUHN	07	THEO
4.4 ± 0.3	4.9 ± 0.3	[17,32] GRAY	05	LATT
4.22 ± 0.06	4.72 ± 0.07	[33] AUBERT	04X	THEO
4.25 ± 0.11	4.76 ± 0.12	[17,34] MCNEILE	04	LATT
4.22 ± 0.09	4.74 ± 0.10	[35] BAUER	03	THEO
4.33 ± 0.10	4.84 ± 0.11	[17,36] DEDIVITIIS	03	LATT

[1] NARISON 13 determines m_b using QCD spectral sum rules to NNLO and including condensates up to dimension 6. We have converted the $\overline{\rm MS}$ value to the 1S scheme.

[2] BODENSTEIN 12 determine m_b using sum rules for the vector current correlator and the $e^+ e^- \rightarrow Q\overline{Q}$ total cross-section. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[3] DIMOPOULOS 12 determine quark masses from a lattice computation using $N_f = 2$ dynamical flavors of twisted mass fermions. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[4] HOANG 12 determine m_b using non-relativistic sum rules for the Υ system at NNLO with renormalization group improvement.

[5] Determines m_b to order α_s^3, including the effect of gluon condensates up to dimension eight combining the methods of NARISON 12 and NARISON 12A. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[6] LASCHKA 11 determine the b mass from the charmonium spectrum. The theoretical computation uses the heavy $Q\overline{Q}$ potential to order $1/m_Q$ obtained by matching the short-distance perturbative result onto lattice QCD result at larger scales. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[7] AUBERT 10A determine the b- and c-quark masses from a fit to the inclusive decay spectra in semileptonic B decays in the kinetic scheme (and convert it to the $\overline{\rm MS}$ scheme). We have converted this to the 1S scheme.

[8] MCNEILE 10 determines m_b by comparing four-loop perturbative results for the pseudoscalar current to lattice simulations with $N_f = 2+1$ sea-quarks by the HPQCD collaboration. We have converted $\overline{m}_b$ $(\overline{m}_b)$ to the 1S scheme.

[9] CHETYRKIN 09 determine m_c and m_b from the $e^+ e^- \rightarrow Q\overline{Q}$ cross-section and sum rules, using a four-loop computation of the heavy quark vacuum polarization. We have converted their m_b to the 1S scheme.

[10] ABDALLAH 08D determine $\overline{m}_b(M_Z) = 3.76 \pm 1.0$ GeV from a leading order study of four-jet rates at LEP. We have converted this to $\overline{m}_b(\overline{m}_b)$ and m_b^{1S}.

[11] SCHWANDA 08 measure moments of the inclusive photon spectrum in $B \rightarrow X_s \gamma$ decay to determine m_b^{1S}. We have converted this to $\overline{\rm MS}$ scheme.

[12] ABDALLAH 06D determine $m_b(M_Z) = 2.85 \pm 0.32$ GeV from Z-decay three-jet events containing a b-quark. We have converted this to $\overline{m}_b(\overline{m}_b)$ and m_b^{1S}.

[13] BOUGHEZAL 06 $\overline{\rm MS}$ scheme result comes from the first moment of the hadronic production cross-section to order α_s^3. We have converted it to the 1S scheme.

[14] BUCHMULLER 06 determine m_b and m_c by a global fit to inclusive B decay spectra. We have converted this to the 1S scheme.

[15] PINEDA 06 $\overline{\rm MS}$ scheme result comes from a partial NNLL evaluation (complete at NNLO) of sum rules of the bottom production cross-section in $e^+ e^-$ annihilation. We have converted it to the 1S scheme.

[16] BAUER 04 determine m_b, m_c and $m_b - m_c$ by a global fit to inclusive B decay spectra.

[17] We have converted m_b to the 1S scheme.

[18] HOANG 04 determines $\overline{m}_b(\overline{m}_b)$ from moments at order α_s^2 of the bottom production cross-section in $e^+ e^-$ annihilation.

[19] BORDES 03 determines m_b using QCD finite energy sum rules to order α_s^2.

[20] CORCELLA 03 determines $\overline{m}_b$ using sum rules computed to order α_s^2. Includes charm quark mass effects.

[21] EIDEMULLER 03 determines $\overline{m}_b$ and $\overline{m}_c$ using QCD sum rules.

[22] ERLER 03 determines $\overline{m}_b$ and $\overline{m}_c$ using QCD sum rules. Includes recent BES data.

[23] MAHMOOD 03 determines m_b^{1S} by a fit to the lepton energy moments in $B \to X_c \ell \nu_\ell$ decay. The theoretical expressions used are of order $1/\mathrm{m}^3$ and $\alpha_s^2 \beta_0$. We have converted their result to the $\overline{\mathrm{MS}}$ scheme.

[24] BRAMBILLA 02 determine $\overline{m}_b(\overline{m}_b)$ from a computation of the $\Upsilon(1S)$ mass to order α_s^4, including finite m_c corrections. We have converted this to the 1S scheme.

[25] PENIN 02 determines $\overline{m}_b$ from the spectrum of the Υ system.

[26] NARISON 12 determines m_b using exponential sum rules for the vector current correlator to order α_s^3, including the effect of gluon condensates up to dimension eight. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[27] NARISON 12A determines m_b using sum rules for the vector current correlator to order α_s^3, including the effect of gluon condensates up to dimension eight. We have converted $\overline{m}_b(\overline{m}_b)$ to the 1S scheme.

[28] NARISON 10 determines m_b from ratios of moments of vector current correlators computed to order α_s^3 and including the dimension-six gluon condensate. These values are taken from the erratum to that reference.

[29] GUAZZINI 08 determine $\overline{m}_b(\overline{m}_b)$ from a quenched lattice simulation of heavy meson masses. The ± 0.08 is an estimate of the quenching error. We have converted these values to the $1S$ scheme.

[30] DELLA-MORTE 07 determine $\overline{m}_b(\overline{m}_b)$ from a computation of the spin-averaged B meson mass using quenched lattice HQET at order $1/m$. The ± 0.08 is an estimate of the quenching error.

[31] KUHN 07 determine $\overline{m}_b(\mu = 10\text{ GeV}) = 3.609 \pm 0.025$ GeV and $\overline{m}_b(\overline{m}_b)$ from a four-loop sum-rule computation of the cross-section for $e^+ e^- \to$ hadrons in the bottom threshold region. We have converted this to the 1S scheme.

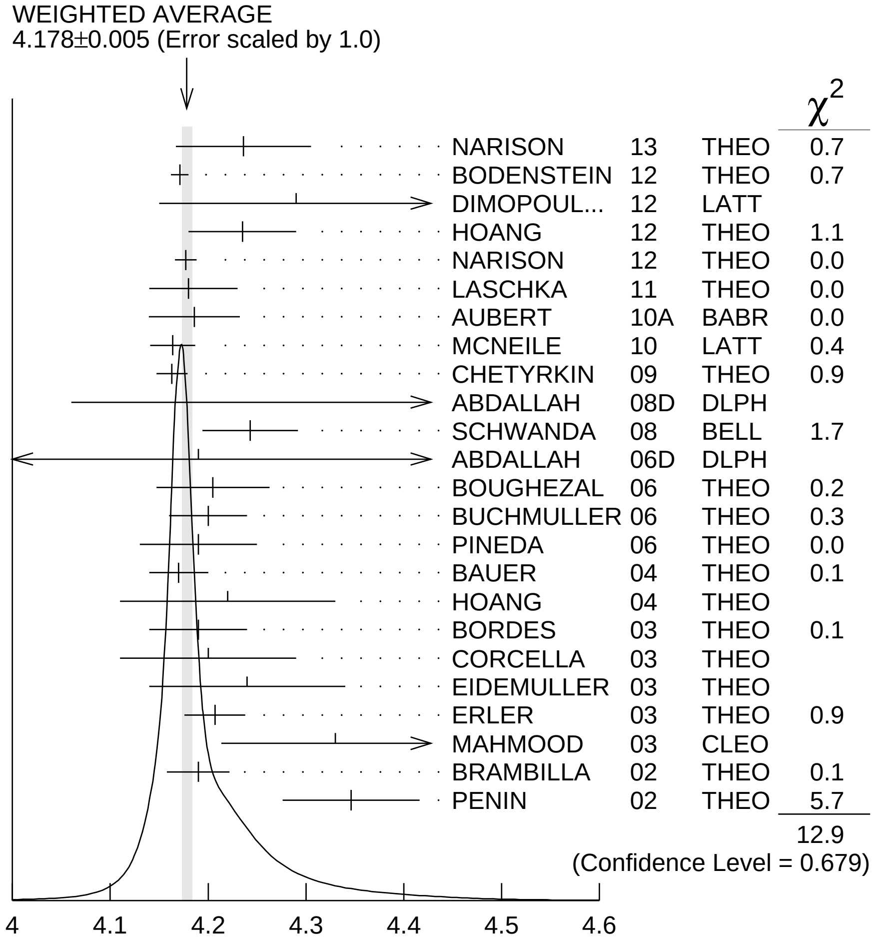
[32] GRAY 05 determines $\overline{m}_b(\overline{m}_b)$ from a lattice computation of the Υ spectrum. The simulations have 2+1 dynamical light flavors. The b quark is implemented using NRQCD.

[33] AUBERT 04X obtain m_b from a fit to the hadron mass and lepton energy distributions in semileptonic B decay. The paper quotes values in the kinetic scheme. The $\overline{\mathrm{MS}}$ value has been provided by the BABAR collaboration, and we have converted this to the 1S scheme.

[34] MCNEILE 04 use lattice QCD with dynamical light quarks and a static heavy quark to compute the masses of heavy-light mesons.

[35] BAUER 03 determine the b quark mass by a global fit to B decay observables. The experimental data includes lepton energy and hadron invariant mass moments in semileptonic $B \to X_c \ell \nu_\ell$ decay, and the inclusive photon spectrum in $B \to X_s \gamma$ decay. The theoretical expressions used are of order $1/\mathrm{m}^3$, and $\alpha_s^2 \beta_0$.

[36] DEDIVITIIS 03 use a quenched lattice computation of heavy-heavy and heavy-light meson masses.



b-QUARK $\overline{\text{MS}}$ MASS (GeV)

b-QUARK REFERENCES

NARISON	13	PL B718 1321	S. Narison	(MONP)
BODENSTEIN	12	PR D85 034003	S. Bodenstein *et al.*	
DIMOPOUL...	12	JHEP 1201 046	P. Dimopoulos *et al.*	(ETM Collab.)
HOANG	12	JHEP 1210 188	A.H. Hoang, P. Ruiz-Femenia, M. Stahlhofen	(WIEN+)
NARISON	12	PL B707 259	S. Narison	(MONP)
NARISON	12A	PL B706 412	S. Narison	(MONP)
LASCHKA	11	PR D83 094002	A. Laschka, N. Kaiser, W. Weise	
AUBERT	10A	PR D81 032003	B. Aubert *et al.*	(BABAR Collab.)
MCNEILE	10	PR D82 034512	C. McNeile *et al.*	(HPQCD Collab.)
NARISON	10	PL B693 559	S. Narison	(MONP)
Also		PL B705 544 (errat.)	S. Narison	(MONP)
CHETYRKIN	09	PR D80 074010	K.G. Chetyrkin *et al.*	(KARL, BNL)
ABDALLAH	08D	EPJ C55 525	J. Abdallah *et al.*	(DELPHI Collab.)
GUAZZINI	08	JHEP 0801 076	D. Guazzini, R. Sommer, N. Tantalo	
SCHWANDA	08	PR D78 032016	C. Schwanda *et al.*	(BELLE Collab.)
DELLA-MOR...	07	JHEP 0701 007	M. Della Morte *et al.*	
KUHN	07	NP B778 192	J.H. Kuhn, M. Steinhauser, C. Sturm	
ABDALLAH	06D	EPJ C46 569	J. Abdallah *et al.*	(DELPHI Collab.)
BOUGHEZAL	06	PR D74 074006	R. Boughezal, M. Czakon, T. Schutzmeier	
BUCHMULLER	06	PR D73 073008	O.L. Buchmuller, H.U. Flacher	(RHBL)
PINEDA	06	PR D73 111501	A. Pineda, A. Signer	
GRAY	05	PR D72 094507	A. Gray *et al.*	(HPQCD, UKQCD Collab.)
AUBERT	04X	PRL 93 011803	B. Aubert *et al.*	(BABAR Collab.)

BAUER	04	PR D70 094017	C. Bauer *et al.*	
HOANG	04	PL B594 127	A.H. Hoang, M. Jamin	
MCNEILE	04	PL B600 77	C. McNeile, C. Michael, G. Thompson	(UKQCD Collab.)
BAUER	03	PR D67 054012	C.W. Bauer *et al.*	
BORDES	03	PL B562 81	J. Bordes, J. Penarrocha, K. Schilcher	
CORCELLA	03	PL B554 133	G. Corcella, A.H. Hoang	
DEDIVITIIS	03	NP B675 309	G.M. de Divitiis *et al.*	
EIDEMULLER	03	PR D67 113002	M. Eidemuller	
ERLER	03	PL B558 125	J. Erler, M. Luo	
MAHMOOD	03	PR D67 072001	A.H. Mahmood *et al.*	(CLEO Collab.)
BRAMBILLA	02	PR D65 034001	N. Brambilla, Y. Sumino, A. Vairo	
EL-KHADRA	02	ARNPS 52 201	A.X. El-Khadra, M. Luke	
PENIN	02	PL B538 335	A. Penin, M. Steinhauser	