



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

$$\text{Charge} = \frac{2}{3} e \quad \text{Charm} = +1$$

c-QUARK MASS

The c -quark mass corresponds to the “running” mass $m_c(\mu = m_c)$ in the $\overline{\text{MS}}$ scheme. We have converted masses in other schemes to the $\overline{\text{MS}}$ scheme using two-loop QCD perturbation theory with $\alpha_s(\mu=m_c) = 0.38 \pm 0.03$. The value 1.275 ± 0.025 GeV for the $\overline{\text{MS}}$ mass corresponds to 1.67 ± 0.07 GeV for the pole mass (see the “Note on Quark Masses”).

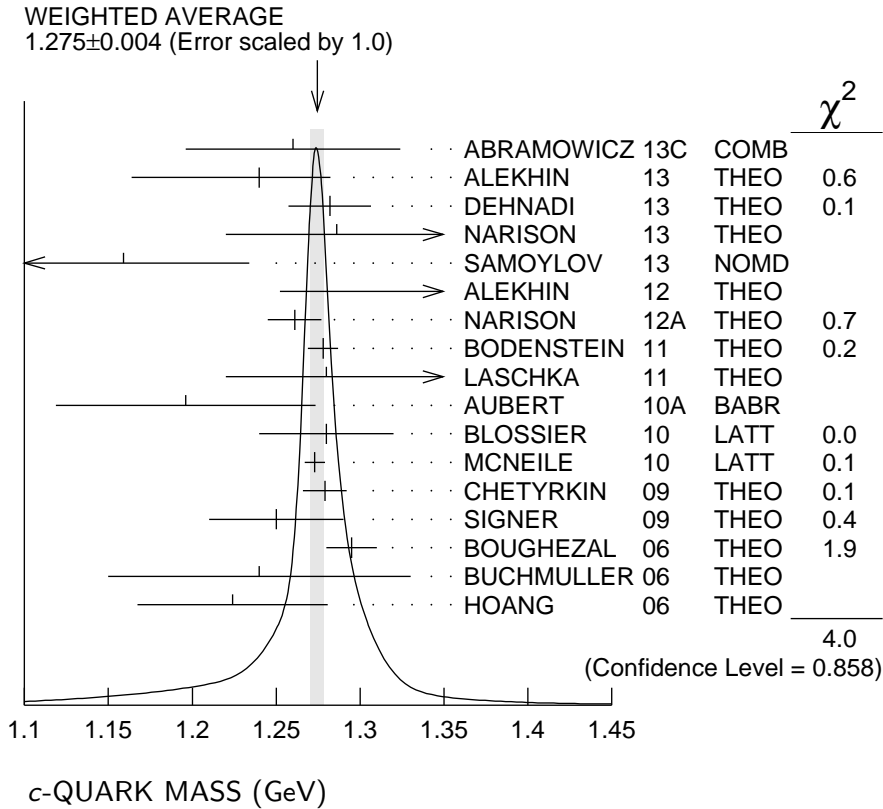
VALUE (GeV)	DOCUMENT ID	TECN	COMMENT
1.275 ± 0.025 OUR EVALUATION	See the ideogram below.		
1.26 ± 0.05 ± 0.04	¹ ABRAMOWICZ13C	COMB	$\overline{\text{MS}}$ scheme
1.24 ± 0.03 ^{+0.03} _{-0.07}	² ALEKHIN 13	THEO	$\overline{\text{MS}}$ scheme
1.282 ± 0.011 ± 0.022	³ DEHNADI 13	THEO	$\overline{\text{MS}}$ scheme
1.286 ± 0.066	⁴ NARISON 13	THEO	$\overline{\text{MS}}$ scheme
1.159 ± 0.075	⁵ SAMOYLOV 13	NOMD	$\overline{\text{MS}}$ scheme
1.36 ± 0.04 ± 0.10	⁶ ALEKHIN 12	THEO	$\overline{\text{MS}}$ scheme
1.261 ± 0.016	⁷ NARISON 12A	THEO	$\overline{\text{MS}}$ scheme
1.278 ± 0.009	⁸ BODENSTEIN 11	THEO	$\overline{\text{MS}}$ scheme
1.28 ^{+0.07} _{-0.06}	⁹ LASCHKA 11	THEO	$\overline{\text{MS}}$ scheme
1.196 ± 0.059 ± 0.050	¹⁰ AUBERT 10A	BABR	$\overline{\text{MS}}$ scheme
1.28 ± 0.04	¹¹ BLOSSIER 10	LATT	$\overline{\text{MS}}$ scheme
1.273 ± 0.006	¹² MCNEILE 10	LATT	$\overline{\text{MS}}$ scheme
1.279 ± 0.013	¹³ CHETYRKIN 09	THEO	$\overline{\text{MS}}$ scheme
1.25 ± 0.04	¹⁴ SIGNER 09	THEO	$\overline{\text{MS}}$ scheme
1.295 ± 0.015	¹⁵ BOUGHEZAL 06	THEO	$\overline{\text{MS}}$ scheme
1.24 ± 0.09	¹⁶ BUCHMULLER06	THEO	$\overline{\text{MS}}$ scheme
1.224 ± 0.017 ± 0.054	¹⁷ HOANG 06	THEO	$\overline{\text{MS}}$ scheme
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1.01 ± 0.09 ± 0.03	¹⁸ ALEKHIN 11	THEO	$\overline{\text{MS}}$ scheme
1.299 ± 0.026	¹⁹ BODENSTEIN 10	THEO	$\overline{\text{MS}}$ scheme
1.261 ± 0.018	²⁰ NARISON 10	THEO	$\overline{\text{MS}}$ scheme
1.268 ± 0.009	²¹ ALLISON 08	LATT	$\overline{\text{MS}}$ scheme
1.286 ± 0.013	²² KUHN 07	THEO	$\overline{\text{MS}}$ scheme
1.33 ± 0.10	²³ AUBERT 04X	THEO	$\overline{\text{MS}}$ scheme
1.29 ± 0.07	²⁴ HOANG 04	THEO	$\overline{\text{MS}}$ scheme
1.319 ± 0.028	²⁵ DEDIVITIIS 03	LATT	$\overline{\text{MS}}$ scheme
1.19 ± 0.11	²⁶ EIDEMULLER 03	THEO	$\overline{\text{MS}}$ scheme
1.289 ± 0.043	²⁷ ERLER 03	THEO	$\overline{\text{MS}}$ scheme
1.26 ± 0.02	²⁸ ZYABLYUK 03	THEO	$\overline{\text{MS}}$ scheme

¹ ABRAMOWICZ 13C determines m_c from charm production in deep inelastic ep scattering, using the QCD prediction at NLO order. The uncertainties from model and parameterization assumptions, and the value of α_s , of ± 0.03 , ± 0.02 , and ± 0.02 respectively, have been combined in quadrature.

² ALEKHIN 13 determines m_c from charm production in deep inelastic scattering at HERA using approximate NNLO QCD.

- ³ DEHNADI 13 determines m_c using QCD sum rules for the charmonium spectrum and charm continuum to order α_s^3 (N3LO). The statistical and systematic experimental errors of ± 0.006 and ± 0.009 have been combined in quadrature. The theoretical uncertainties ± 0.019 from truncation of the perturbation series, ± 0.010 from α_s , and ± 0.002 from the gluon condensate have been combined in quadrature.
- ⁴ NARISON 13 determines m_c using QCD spectral sum rules to order α_s^2 (NNLO) and including condensates up to dimension 6.
- ⁵ SAMOYLOV 13 determines m_c from a study of charm dimuon production in neutrino-iron scattering using the NLO QCD result for the charm quark production cross section.
- ⁶ ALEKHIN 12 determines m_c from heavy quark production in deep inelastic scattering at HERA using approximate NNLO QCD.
- ⁷ NARISON 12A determines m_c using sum rules for the vector current correlator to order α_s^3 , including the effect of gluon condensates up to dimension eight.
- ⁸ BODENSTEIN 11 determine $\overline{m}_c(3 \text{ GeV}) = 0.987 \pm 0.009 \text{ GeV}$ and $\overline{m}_c(\overline{m}_c) = 1.278 \pm 0.009 \text{ GeV}$ using QCD sum rules for the charm quark vector current correlator.
- ⁹ LASCHKA 11 determine the c 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.
- ¹⁰ 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{MS} scheme).
- ¹¹ BLOSSIER 10 determines quark masses from a computation of the hadron spectrum using $N_f=2$ dynamical twisted-mass Wilson fermions.
- ¹² MCNEILE 10 determines m_c by comparing the order α_s^3 perturbative results for the pseudo-scalar current to lattice simulations with $N_f = 2+1$ sea-quarks by the HPQCD collaboration.
- ¹³ CHETYRKIN 09 determine m_c and m_b from the $e^+e^- \rightarrow Q\overline{Q}$ cross-section and sum rules, using an order α_s^3 computation of the heavy quark vacuum polarization. They also determine $m_c(3 \text{ GeV}) = 0.986 \pm 0.013 \text{ GeV}$.
- ¹⁴ SIGNER 09 determines the c -quark mass using non-relativistic sum rules to analyze the $e^+e^- \rightarrow c\overline{c}$ cross-section near threshold. Also determine the PS mass $m_{PS}(\mu_F = 0.7 \text{ GeV}) = 1.50 \pm 0.04 \text{ GeV}$.
- ¹⁵ BOUGHEZAL 06 result comes from the first moment of the hadronic production cross-section to order α_s^3 .
- ¹⁶ BUCHMULLER 06 determine m_b and m_c by a global fit to inclusive B decay spectra.
- ¹⁷ HOANG 06 determines $\overline{m}_c(\overline{m}_c)$ from a global fit to inclusive B decay data. The B decay distributions were computed to order $\alpha_s^2\beta_0$, and the conversion between different m_c mass schemes to order α_s^3 .
- ¹⁸ ALEKHIN 11 determines m_c from heavy quark production in deep inelastic scattering using fixed target and HERA data, and approximate NNLO QCD.
- ¹⁹ BODENSTEIN 10 determines $\overline{m}_c(3 \text{ GeV}) = 1.008 \pm 0.026 \text{ GeV}$ using finite energy sum rules for the vector current correlator. The authors have converted this to $\overline{m}_c(\overline{m}_c)$ using $\alpha_s(M_Z) = 0.1189 \pm 0.0020$.
- ²⁰ NARISON 10 determines m_c from ratios of moments of vector current correlators computed to order α_s^3 and including the dimension-six gluon condensate.
- ²¹ ALLISON 08 determine m_c by comparing four-loop perturbative results for the pseudo-scalar current correlator to lattice simulations by the HPQCD collaboration. The result has been updated in MCNEILE 10.
- ²² KUHN 07 determine $\overline{m}_c(\mu = 3 \text{ GeV}) = 0.986 \pm 0.013 \text{ GeV}$ and $\overline{m}_c(\overline{m}_c)$ from a four-loop sum-rule computation of the cross-section for $e^+e^- \rightarrow$ hadrons in the charm threshold region.

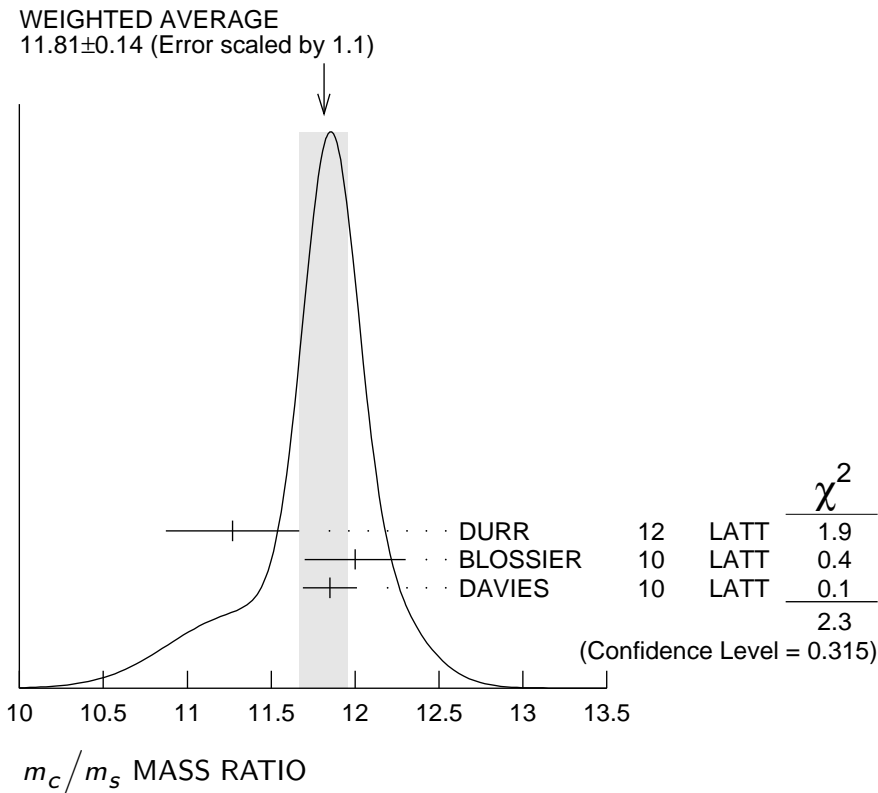
- ²³ AUBERT 04X obtain m_c from a fit to the hadron mass and lepton energy distributions in semileptonic B decay. The paper quotes values in the kinetic scheme. The \overline{MS} value has been provided by the BABAR collaboration.
- ²⁴ HOANG 04 determines $\overline{m}_c(\overline{m}_c)$ from moments at order α_s^2 of the charm production cross-section in e^+e^- annihilation.
- ²⁵ DEDIVITIIS 03 use a quenched lattice computation of heavy-heavy and heavy-light meson masses.
- ²⁶ EIDEMULLER 03 determines m_b and m_c using QCD sum rules.
- ²⁷ ERLER 03 determines m_b and m_c using QCD sum rules. Includes recent BES data.
- ²⁸ ZYABLYUK 03 determines m_c by using QCD sum rules in the pseudoscalar channel and comparing with the η_c mass.



m_c/m_s MASS RATIO

VALUE	DOCUMENT ID	TECN
11.81±0.14 OUR AVERAGE	Error includes scale factor of 1.1. See the ideogram below.	
11.27±0.30±0.26	¹ DURR 12	LATT
12.0 ±0.3	² BLOSSIER 10	LATT
11.85±0.16	³ DAVIES 10	LATT

- ¹ DURR 12 determine m_c/m_s using a lattice computation with $N_f = 2$ dynamical fermions. The result is combined with other determinations of m_c to obtain $m_s(2 \text{ GeV}) = 97.0 \pm 2.6 \pm 2.5 \text{ MeV}$.
- ² BLOSSIER 10 determine m_c/m_s from a computation of the hadron spectrum using $N_f = 2$ dynamical twisted-mass Wilson fermions.
- ³ DAVIES 10 determine m_c/m_s from meson masses calculated on gluon fields including u , d , and s sea quarks with lattice spacing down to 0.045 fm. The Highly Improved Staggered quark formalism is used for the valence quarks.



$m_b - m_c$ QUARK MASS DIFFERENCE

VALUE (GeV)	DOCUMENT ID	TECN
3.45 ± 0.05	OUR EVALUATION	

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

3.472 ± 0.032	¹ AUBERT	10A	BABR
3.42 ± 0.06	² ABDALLAH	06B	DLPH
3.44 ± 0.03	³ AUBERT	04X	BABR
3.41 ± 0.01	³ BAUER	04	THEO

¹ 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.

² ABDALLAH 06B determine $m_b - m_c$ from moments of the hadron invariant mass and lepton energy spectra in semileptonic inclusive B decays.

³ Determine $m_b - m_c$ from a global fit to inclusive B decay spectra.

c -QUARK REFERENCES

ABRAMOWICZ 13C	EPJ C73 2311	H. Abramovicz <i>et al.</i>	(H1 and Zeus Collab.)
ALEKHIN 13	PL B720 172	S. Alekhin <i>et al.</i>	(SERP, DESYZ, WUPP+)
DEHNADI 13	JHEP 1309 103	B. Dehnadi <i>et al.</i>	(SHRZ, VIEN, MPIM+)
NARISON 13	PL B718 1321	S. Narison	(MONP)
SAMOYLOV 13	NP B876 339	O. Samoylov <i>et al.</i>	(NOMAD Collab.)
ALEKHIN 12	PL B718 550	S. Alekhin <i>et al.</i>	(SERP, WUPP, DESY+)
DURR 12	PRL 108 122003	S. Durr, G. Koutsou	(WUPP, JULI, CYPR)
NARISON 12A	PL B706 412	S. Narison	(MONP)
ALEKHIN 11	PL B699 345	S. Alekhin, S. Moch	(DESY, SERP)
BODENSTEIN 11	PR D83 074014	S. Bodenstein <i>et al.</i>	
LASCHKA 11	PR D83 094002	A. Laschka, N. Kaiser, W. Weise	
AUBERT 10A	PR D81 032003	B. Aubert <i>et al.</i>	(BABAR Collab.)
BLOSSIER 10	PR D82 114513	B. Blossier <i>et al.</i>	(ETM Collab.)
BODENSTEIN 10	PR D82 114013	S. Bodenstein <i>et al.</i>	
DAVIES 10	PRL 104 132003	C.T.H. Davies <i>et al.</i>	(HPQCD Collab.)

MCNEILE	10	PR D82 034512	C. McNeile <i>et al.</i>	(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 <i>et al.</i>	(KARL, BNL)
SIGNER	09	PL B672 333	A. Signer	(DURH)
ALLISON	08	PR D78 054513	I. Allison <i>et al.</i>	(HPQCD Collab.)
KUHN	07	NP B778 192	J.H. Kuhn, M. Steinhauser, C. Sturm	
ABDALLAH	06B	EPJ C45 35	J. Abdallah <i>et al.</i>	(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)
HOANG	06	PL B633 526	A.H. Hoang, A.V. Manohar	
AUBERT	04X	PRL 93 011803	B. Aubert <i>et al.</i>	(BABAR Collab.)
BAUER	04	PR D70 094017	C. Bauer <i>et al.</i>	
HOANG	04	PL B594 127	A.H. Hoang, M. Jamin	
DEDIVITIIS	03	NP B675 309	G.M. de Divitiis <i>et al.</i>	
EIDEMULLER	03	PR D67 113002	M. Eidemuller	
ERLER	03	PL B558 125	J. Erler, M. Luo	
ZYABLYUK	03	JHEP 0301 081	K.N. Zybalyuk	(ITEP)
