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t-Quark Mass in $p\overline{p}$ Collisions

The t quark has been observed. Its mass is sufficiently high that decay is expected to occur before hadronization. OUR EVALUATION is an AVERAGE which incorporates correlations between systematic errors of the five different measurements. The average was done by a joint CDF/DØ working group and is reported in DEMORTIER 99, an FNAL Technical Memo. They report 174.3 \pm 3.2 \pm 4.0 GeV, which yields "OUR EVALUATION" when statistical and systematic errors are combined.

For earlier search limits see the Review of Particle Physics, Phys. Rev. D54,1 (1996).

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT		
174.3± 5.1 OUR EVALUATION						
$167.4 \pm 10.3 \pm 4.8$	¹ ABE	99 B	CDF	dilepton		
$168.4 \pm 12.3 \pm 3.6$	² ABBOTT	98 D	D0	dilepton		
$173.3 \pm 5.6 \pm 5.5$	² ABBOTT	98F	D0	lepton + jets		
	^{1,3} ABE	98E	CDF	lepton + jets		
$186 \pm 10 \pm 5.7$	^{1,4} ABE	97 R	CDF	6 or more jets		
• • • We do not use the following	data for averages	s, fits	, limits,	etc. • • •		
176.0± 6.5	⁵ ABE	99 B	CDF	dilepton, lepton+jets, and all jets		
$161 \pm 17 \pm 10$	¹ ABE	98F	CDF	dilepton		
$172.1 \pm 5.2 \pm 4.9$	⁶ BHAT	98 B	RVUE	dilepton and lepton $+$ jets		
173.8± 5.0	⁷ BHAT	98 B	RVUE	dilepton, lepton+jets, and all jets		
$173.3\pm\ 5.6\pm\ 6.2$	² ABACHI	97E	D0	lepton + jets		
199 $^{+19}_{-21}$ ± 22	ABACHI	95	D0	lepton + jets		
$176 \pm 8 \pm 10$	ABE	95F	CDF	$lepton + \mathit{b}-jet$		
$174 \pm 10 \begin{array}{c} +13 \\ -12 \end{array}$	ABE	94E	CDF	lepton + b-jet		

 $^{^{1}}$ Result is based on 109 \pm 7 pb $^{-1}$ of data at $\sqrt{s}=$ 1.8 TeV. 2 Result is based on 125 pb $^{-1}$ of data at $\sqrt{s}=$ 1.8 TeV.

³The updated systematic error is listed. See ABE 99B.

⁴ ABE 97R result is based on the first observation of all hadronic decays of $t\bar{t}$ pairs. Single b-quark tagging with jet-shape variable constraints was used to select signal enriched multi-jet events. The updated systematic error is listed. See ABE 99B.

⁵ ABE 99B result is obtained by combining the CDF results of m_t (GeV)=167.4 \pm 10.3 \pm 4.8 from 8 dilepton events, m_t (GeV)=175.9 \pm 4.8 \pm 5.3 from lepton+jet events (ABE 98E), and m_t (GeV)=186.0 \pm 10.0 \pm 5.7 from all-jet events (ABE 97R). The systematic errors in the latter two measurements are changed in this paper.

 $^{^6}$ BHAT 98B result is obtained by combining the DØ $\,$ results of $m_t({
m GeV}){=}168.4\pm12.3\pm100$ 3.6 from 6 dilepton events and $m_t(\text{GeV}) = 173.3 \pm 5.6 \pm 5.5$ from 77 lepton+jet events.

 $^{^7}$ BHAT 98B result is obtained by combining the DØ results from dilepton and lepton+jet events, and the CDF results (ABE 99B) from dilepton, lepton+jet events, and all-jet events.

t-Quark Decay Branching Fractions

<u>VALUE</u>	<u>CL%</u>	DOCUMENT ID	<u>TECN</u> <u>COMMENT</u>	
• • • We do not us	e the followi	ng data for average	es, fits, limits, etc. • • •	
< 0.33	95	⁸ ABE	98G CDF $t \rightarrow q Z (q=u,c)$	
< 0.032	95	⁹ ABE	98G CDF $t \rightarrow q \gamma (q=u,c)$	
0.99 ± 0.29		¹⁰ CHIARELLI	98 RVUE $t \rightarrow bW$	
		¹¹ ABE	97V CDF ℓau + jets	

⁸ ABE 98G looked for $t\bar{t}$ events where one t decays into three jets and the other decays into qZ with $Z\to\ell\ell$.

Indirect t-Quark Mass from Standard Model Electroweak Fit

"OUR EVALUATION" below is from the fit to electroweak data described in the "Electroweak Model and Constraints on New Physics" section of this Review. This fit result does not include direct measurements of m_t . The central value and first uncertainty are for $M_H=M_Z$. The second uncertainty is the shift from changing M_H to 300 GeV.

The RVUE values are based on the data described in the footnotes. RVUE's published before 1994 and superseded analyses are now omitted. For more complete listings of earlier results, see the 1994 edition (Physical Review **D50** 1173 (1994)).

VALUE (GeV) DOCUMENT ID TECN COMMENT

170 \pm 7 (+14) OUR EVALUATION

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

• • • We do not use the following data for averages, fits, fillits, etc. • • •						
172.0^{+}_{-} $\begin{array}{c} 5.8 \\ 5.7 \end{array}$	¹² DEBOER	97 B	RVUE	Electroweak + Direct		
$157 \begin{array}{c} +16 \\ -12 \end{array}$	¹³ ELLIS	96 C	RVUE	Z parameters, m_W , low energy		
175 ± 11 $^{+17}_{-19}$	¹⁴ ERLER	95	RVUE	Z parameters, m_W , low energy		
$180 \pm 9^{+19}_{-21} \mp 2.6 \pm 4.8$	¹⁵ MATSUMOTO	95	RVUE	56)		
$157 \begin{array}{ccc} +36 & +19 \\ -48 & -20 \end{array}$	¹⁶ ABREU	94	DLPH	Z parameters		
158 $^{+32}_{-40}$ ± 19	¹⁷ ACCIARRI	94	L3	Z parameters		
$132 \begin{array}{ccc} +41 & +24 \\ -48 & -18 \end{array}$	¹⁸ AKERS	94	OPAL	Z parameters		

⁹ ABE 98G looked for $t\overline{t}$ events where one t decays into $q\gamma$ while the other decays into bW.

 $^{^{10}}$ CHIARELLI 98 measurement of B(t $\rightarrow bW$) assumes that non-W decays of the top quark are negligible. The corresponding 95%CL lower bounds are B> 0.58 and $|V_{t\,b}|>$ 0.76 in the three-generation model assuming unitarity.

¹¹ ABE 97V searched for $t\,\overline{t} \to (\ell\nu_\ell) (\tau\nu_\tau) b\,\overline{b}$ events in 109 pb⁻¹ of $p\,\overline{p}$ collisions at $\sqrt{s}=1.8$ TeV. They observed 4 candidate events where one expects ~ 1 signal and ~ 2 background events. Three of the four observed events have jets identified as b candidates.

190	$^{+39}_{-48}$	$^{+12}_{-14}$	¹⁹ ARROYO	94	CCFR	$ u_{\mu}$ iron scattering
184	$^{+25}_{-29}$	$^{+17}_{-18}$	²⁰ BUSKULIC	94	ALEP	Z parameters
153	± 15		²¹ ELLIS	94 B	RVUE	Electroweak
177	± 9	$^{+16}_{-20}$	²² GURTU	94	RVUE	Electroweak
174	$^{+11}_{-13}$	$^{+17}_{-18}$	²³ MONTAGNA	94	RVUE	Electroweak
171	± 12	$+15 \\ -21$	²⁴ NOVIKOV	94 B	RVUE	Electroweak
160	$^{+50}_{-60}$		²⁵ ALITTI	92 B	UA2	m_W, m_Z

 $^{^{12}}$ DEBOER 97B result is from the five-parameter fit which varies $m_Z,~m_t,~m_H,~\alpha_S,$ and $\alpha(m_Z)$ under the contraints: $m_t{=}175\pm6$ GeV, $1/\alpha(m_Z){=}128.896\pm0.09.$ They found $m_H{=}141^{+}_{-}140$ GeV and $\alpha_S(m_Z){=}0.1197\pm0.0031.$

 $^{^{13}}$ ELLIS 96C result is a the two-parameter fit with free m_t and m_H , yielding also m_H =65 $^+_{37}$ GeV.

¹⁴ ERLER 95 result is from fit with free m_t and $\alpha_s(m_Z)$, yielding $\alpha_s(m_Z) = 0.127(5)(2)$.

 $^{^{15}}$ MATSUMOTO 95 result is from fit with free m_t to Z parameters, M_W , and low-energy neutral-current data. The second error is for $m_H=300^{+700}_{-240}$ GeV, the third error is for $\alpha_{\rm S}(m_Z)=0.116\pm0.005$, the fourth error is for $\delta\alpha_{\rm had}=0.0283\pm0.0007$.

 $^{^{16}}$ ABREU 94 value is for $\alpha_s(m_Z)$ constrained to 0.123 \pm 0.005. The second error corresponds to $m_H=300^{+700}_{-240}$ GeV.

 $^{^{17}}$ ACCIARRI 94 value is for $\alpha_s(m_Z)$ constrained to 0.124 \pm 0.006. The second error corresponds to $m_H=300^{+700}_{-240}$ GeV.

 $^{^{18}}$ AKERS 94 result is from fit with free α_s . The second error corresponds to $m_H = 300 \, {}^{+}700 \,$ GeV. The 95%CL limit is $m_t <$ 210 GeV.

 $^{^{19}}$ ARROYO 94 measures the ratio of the neutral-current and charged-current deep inelastic scattering of ν_{μ} on an iron target. By assuming the SM electroweak correction, they obtain $1-m_W^2/m_Z^2=0.2218\pm0.0059,$ yielding the quoted m_t value. The second error corresponds to $m_H=300^{+700}_{-240}$ GeV.

²⁰ BUSKULIC 94 result is from fit with free α_s . The second error is from m_H =300 $^{+700}_{-240}$ GeV.

²¹ ELLIS 94B result is fit to electroweak data available in spring 1994, including the 1994 A_{LR} data from SLD. m_t and m_H are two free parameters of the fit for $\alpha_s(m_Z)=0.118\pm0.007$ yielding m_t above, and $m_H=35^{+70}_{-22}$ GeV. ELLIS 94B also give results for fits including constraints from CDF's direct measurement of m_t and CDF's and DØ 's production cross-section measurements. Fits excluding the A_{LR} data from SLD are also given.

²² GURTU 94 result is from fit with free m_t and $\alpha_s(m_Z)$, yielding m_t above and $\alpha_s(m_Z)$ = 0.125 \pm 0.005 $^{+0.003}_{-0.001}$. The second errors correspond to $m_H = 300^{+700}_{-240}$ GeV. Uses LEP, M_W , ν N, and SLD electroweak data available in spring 1994.

 $^{^{23}}$ MONTAGNA 94 result is from fit with free m_t and $\alpha_s(m_Z)$, yielding m_t above and $\alpha_s(m_Z)=0.124$. The second errors correspond to $m_H=300^{+700}_{-240}$ GeV. Errors in $\alpha(m_Z)$ and m_b are taken into account in the fit. Uses LEP, SLC, and M_W/M_Z data available in spring 1994.

- 24 NOVIKOV 94B result is from fit with free m_t and $\alpha_s(m_Z)$, yielding m_t above and $\alpha_s(m_Z)=0.125\pm0.005\pm0.002.$ The second errors correspond to $m_H=300^{+700}_{-240}$ GeV. Uses LEP and CDF electroweak data available in spring 1994.
- 25 ALITTI 92B assume $m_H=100$ GeV. The 95%CL limit is $m_t<250$ GeV for $m_H<1\,{\rm TeV}.$

t-Quark REFERENCES

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MONTAGNA 94 PL B335 484 + Nicrosini, Passarino, Piccinini (INFN, PAVI, CERN, TORI)	ELLIS	94B	PL B333 118	+Fogli, Lisi	` (CERN, BARI)
	GURTU	94	MPL A9 3301		(TATA)
NOVIKOV 94B MPL A9 2641 +Okun, Rozanov, Vysotsky (GUEL, CERN, ITEP)	MONTAGNA	94	PL B335 484	+Nicrosini, Passarino, Piccinini (INFN, F	PAVI, CERN, TORI)
	NOVIKOV	94B	MPL A9 2641		
PDG 94 PR D50 1173 Montanet+ (CERN, LBL, BOST, IFIC+)	-	-			,
ALITTI 92B PL B276 354 +Ambrosini, Ansari, Autiero, Bareyre+ (UA2 Collab.)	ALITTI	92B	PL B276 354	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)