t' (4th Generation) Quark, Searches for

t'-quark/hadron mass limits in $p\overline{p}$ and pp collisions

VALUE (GeV)	CL%	DOCUMENT ID		TECN	COMMENT
>420	95	[1] AAD	12C	ATLS	$t' \to t\,X$ ($m_X < 140$ GeV)
>358	95	[2] AALTONEN	11AL	CDF	$t' \to W\,b$
>340	95	[2] AALTONEN	11AL	CDF	$t' \to W\,q$ ($q=d,s,b$)

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

VALUE (GeV)	CL%	DOCUMENT ID		TECN	COMMENT
>400	95	[3] AALTONEN	11AH	CDF	$t' \to t\,X$ ($m_X < 70$ GeV)
>360	95	[4] AALTONEN	11O	CDF	$t' \to t\,X$ ($m_X < 100$ GeV)
>285	95	[5] ABAZOV	11Q	D0	$t' \to W\,q$ ($q=d,s,b$)
>256	95	[6,7] AALTONEN	08H	CDF	$t' \to W\,q$

[1] Based on 1.04 fb^{-1} of data in pp collisions at 7 TeV. AAD 12C looked for $t'\overline{t}'$ production followed by t' decaying into a top quark and X, an invisible particle, in a final state with an isolated high-P_T lepton, four or more jets, and a large missing transverse energy. No excess over the SM ttbar production gives the upper limit on $t'\overline{t}'$ production cross section as a function of $m_{t'}$ and m_X. The result is obtained for B($t' \to t\,W$) = 1.

[2] Based on 5.6 fb^{-1} of data in ppbar collisions at 1.96 TeV. AALTONEN 11AL looked for $\ell + \ge 4$j events and set upper limits on $\sigma(t'\overline{t}')$ as functions of $m_{t'}$.

[3] Based on 5.7 fb^{-1} of data in $p\overline{p}$ collisions at 1.96 TeV. AALTONEN 11AH looked for $t'\overline{t}'$ production followed by t' decaying into a top quark and X, an invisible particle, in the all hadronic decay mode of $t\overline{t}$. No excess over the SM ttbar production gives the upper limit on $t'\overline{t}'$ production cross section as a function of $m_{t'}$ and m_X. The result is obtained for B($t' \to t\,X$) = 1.

[4] Based on 4.8 fb^{-1} of data in $p\overline{p}$ collisions at 1.96 TeV. AALTONEN 11O looked for $t'\overline{t}'$ production signal when t' decays into a top quark and X, an invisible particle, in $\ell + \not{E}_T + $ jets channel. No excess over the SM ttbar production gives the upper limit on $t'\overline{t}'$ production cross section as a function of $m_{t'}$ and m_X. The result is obtained for B($t' \to t\,X$) = 1.

[5] Based on 5.3 fb^{-1} of data in $p\overline{p}$ collisions at 1.96 TeV. ABAZOV 11Q looked for $\ell + \not{E}_T + \ge 4$j events and set upper limits on $\sigma(t'\overline{t}')$ as functions of $m_{t'}$.

[6] Searches for pair production of a new heavy top-like quark t' decaying to a W boson and another quark by fitting the observed spectrum of total transverse energy and reconstructed t' mass in the lepton + jets events.

[7] HUANG 08 reexamined the t' mass lower bound of 256 GeV obtained in AALTONEN 08H that assumes B($b' \to q\,Z$) = 1 for $q = u, c$ which does not hold when $m_{b'} < m_{t'} - m_W$ or the mixing $\sin^2(\theta_{b\,t'})$ is so tiny that the decay occurs outside of the vertex detector. Fig. 1 gives that lower bound on $m_{t'}$ in the plane of $\sin^2(\theta_{b\,t'})$ and $m_{b'}$.

t' mass limits from single production in $p\overline{p}$ and pp collisions

VALUE (GeV)	CL%	DOCUMENT ID		TECN	COMMENT
>403	95	[8] ABAZOV	11F	D0	$q\,d \to q'\,t' \to q'(W\,d)$ $\widetilde{\kappa}_{d\,t'}=1$, B($t' \to W\,d$)=1
>551	95	[8] ABAZOV	11F	D0	$q\,u \to q\,t' \to q(Z\,u)$ $\widetilde{\kappa}_{u\,t'}=\sqrt{2}$, B($t' \to Z\,u$)=1

[8] Based on 5.4 fb^{-1} of data in ppbar collisions at 1.96 TeV. ABAZOV 11F looked for single production of t' via the Z or E coupling to the first generation up or down quarks, respectively. Model independent cross section limits for the single production processes $p\overline{p} \to t' q \to (W d)q$, and $p\overline{p} \to t' q \to (Z d)q$ are given in Figs. 3 and 4, respectively, and the mass limits are obtained for the model of ATRE 09 with degenerate bi-doublets of vector-like quarks.

REFERENCES FOR Searches for (Fourth Generation) t' Quark

AAD	12C	PRL 108 041805	G. Aad *et al.*	(ATLAS Collab.)
AALTONEN	11AH	PRL 107 191803	T. Aaltonen *et al.*	(CDF Collab.)
AALTONEN	11AL	PRL 107 261801	T. Aaltonen *et al.*	(CDF Collab.)
AALTONEN	11O	PRL 106 191801	T. Aaltonen *et al.*	(CDF Collab.)
ABAZOV	11F	PRL 106 081801	V.M. Abazov *et al.*	(D0 Collab.)
ABAZOV	11Q	PRL 107 082001	V.M. Abazov *et al.*	(D0 Collab.)
ATRE	09	PR D79 054018	A. Atre *et al.*	
AALTONEN	08H	PRL 100 161803	T. Aaltonen *et al.*	(CDF Collab.)
HUANG	08	PR D77 037302	P.Q. Hung, M. Sher	(UVA, WILL)