# Technicolor

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The latest unpublished results are described in "Dynamical Electroweak Symmetry Breaking" review.

### MASS LIMITS for Resonances in Models of Dynamical Electroweak Symmetry Breaking

| VALUE (GeV) | CL% | DOCUMENT ID | | TECN | COMMENT |
|---|---|---|---|---|---|
| • • • We do not use the following data for averages, fits, limits, etc. • • • | | | | | |
| >2400 | 95 | [1] KHACHATRY... | 16E | CMS | top-color $Z'$ |
| | | [2] AAD | 15AB | ATLS | $h \rightarrow \pi_v \pi_v$ |
| >1800 | 95 | [3] AAD | 15AO | ATLS | top-color $Z'$ |
| | | [4] AAD | 15BB | ATLS | $pp \rightarrow \rho_T/a_{1T} \rightarrow Wh$ or $Zh$ |
| | | [5] AAD | 15Q | ATLS | $h \rightarrow \pi_v \pi_v$ |
| | | [6] AAIJ | 15AN | LHCB | $h \rightarrow \pi_v \pi_v$ |
| >1140 | 95 | [7] KHACHATRY... | 15C | CMS | $\rho_T \rightarrow WZ$ |
| | | [8] KHACHATRY... | 15W | CMS | $H \rightarrow \pi_v \pi_v$ |
| none 200–700, 750–890 | 95 | [9] AAD | 14AT | ATLS | $pp \rightarrow \omega_T \rightarrow Z\gamma$ |
| none 275–960 | 95 | [9] AAD | 14AT | ATLS | $pp \rightarrow a_T \rightarrow W\gamma$ |
| | | [10] AAD | 14V | ATLS | color singlet techni-vector |
| > 703 | | [11] AAD | 13AN | ATLS | $pp \rightarrow a_T \rightarrow W\gamma$ |
| > 494 | | [12] AAD | 13AN | ATLS | $pp \rightarrow \omega_T \rightarrow Z\gamma$ |
| none 500–1740 | 95 | [13] AAD | 13AQ | ATLS | top-color $Z'$ |
| >1300 | 95 | [14] CHATRCHYAN | 13AP | CMS | top-color $Z'$ |
| >2100 | 95 | [13] CHATRCHYAN | 13BM | CMS | top-color $Z'$ |
| | | [15] BAAK | 12 | RVUE | QCD-like technicolor |
| none 167–687 | 95 | [16] CHATRCHYAN | 12AF | CMS | $\rho_T \rightarrow WZ$ |
| > 805 | 95 | [13] AALTONEN | 11AD | CDF | top-color $Z'$ |
| > 805 | 95 | [13] AALTONEN | 11AE | CDF | top-color $Z'$ |
| | | [17] CHIVUKULA | 11 | RVUE | top-Higgs |
| | | [18] CHIVUKULA | 11A | RVUE | techini-$\pi$ |
| | | [19] AALTONEN | 10I | CDF | $p\overline{p} \rightarrow \rho_T/\omega_T \rightarrow W\pi_T$ |
| none 208–408 | 95 | [20] ABAZOV | 10A | D0 | $\rho_T \rightarrow WZ$ |
| | | [21] ABAZOV | 07I | D0 | $p\overline{p} \rightarrow \rho_T/\omega_T \rightarrow W\pi_T$ |
| > 280 | 95 | [22] ABULENCIA | 05A | CDF | $\rho_T \rightarrow e^+e^-$, $\mu^+\mu^-$ |
| | | [23] CHEKANOV | 02B | ZEUS | color octet techni-$\pi$ |
| > 207 | 95 | [24] ABAZOV | 01B | D0 | $\rho_T \rightarrow e^+e^-$ |
| none 90–206.7 | 95 | [25] ABDALLAH | 01 | DLPH | $e^+e^- \rightarrow \rho_T$ |
| | | [26] AFFOLDER | 00F | CDF | color-singlet techni-$\rho$, $\rho_T \rightarrow W\pi_T$, $2\pi_T$ |
| > 600 | 95 | [27] AFFOLDER | 00K | CDF | color-octet techni-$\rho$, $\rho_{T8} \rightarrow 2\pi_{LQ}$ |
| none 350–440 | 95 | [28] ABE | 99F | CDF | color-octet techni-$\rho$, $\rho_{T8} \rightarrow \overline{b}b$ |
| | | [29] ABE | 99N | CDF | techni-$\omega$, $\omega_T \rightarrow \gamma\overline{b}b$ |
| none 260–480 | 95 | [30] ABE | 97G | CDF | color-octet techni-$\rho$, $\rho_{T8} \rightarrow$ 2jets |

[1] KHACHATRYAN 16E search for top-color $Z'$ decaying to $t\overline{t}$. The quoted limit is for $\Gamma_{Z'}/m_{Z'} = 0.012$. Also exclude $m_{Z'} < 2.9$ TeV for wider topcolor $Z'$ with $\Gamma_{Z'}/m_{Z'} = 0.1$.

[2] AAD 15AB search for long-lived hidden valley $\pi_V$ particles which are produced in pairs by the decay of a scalar boson. $\pi_V$ is assumed to decay into dijets. See their Fig. 10 for the limit on $\sigma B$.

[3] AAD 15AO search for top-color $Z'$ decaying to $t\overline{t}$. The quoted limit is for $\Gamma_{Z'}/m_{Z'} = 0.012$.

[4] AAD 15BB search for minimal walking technicolor (MWT) isotriplet vector and axial-vector resonances decaying to $Wh$ or $Zh$. See their Fig. 3 for the exclusion limit in the MWT parameter space.

[5] AAD 15Q search for long-lived hidden valley $\pi_V$ particles which are produced in pairs by the decay of scalar boson. $\pi_V$ is assumed to decay into dijets. See their Fig. 5 and Fig. 6 for the limit on $\sigma B$.

[6] AAIJ 15AN search for long-lived hidden valley $\pi_V$ particles which are produced in pairs by the decay of scalar boson with a mass of 120GeV. $\pi_V$ is assumed to decay into dijets. See their Fig. 4 for the limit on $\sigma B$.

[7] KHACHATRYAN 15C search for a vector techni-resonance decaying to $WZ$. The limit assumes $M_{\pi_T} = (3/4)\ M_{\rho_T} - 25$ GeV. See their Fig.3 for the limit in $M_{\pi_T} - M_{\rho_T}$ plane of the low scale technicolor model.

[8] KHACHATRYAN 15W search for long-lived hidden valley $\pi_V$ particles which are produced in pairs in the decay of heavy higgs boson $H$. $\pi_V$ is assumed to decay into $\ell^+\ell^-$. See their Fig. 7 and Fig. 8 for the limits on $\sigma B$.

[9] AAD 14AT search for techni-$\omega$ and techni-$a$ resonances decaying to $V\gamma$ with $V = W(\rightarrow \ell\nu)$ or $Z(\rightarrow \ell^+\ell^-)$.

[10] AAD 14V search for vector techni-resonances decaying into electron or muon pairs in $pp$ collisions at $\sqrt{s} = 8$ TeV. See their table IX for exclusion limits with various assumptions.

[11] AAD 13AN search for vector techni-resonance $a_T$ decaying into $W\gamma$.

[12] AAD 13AN search for vector techni-resonance $\omega_T$ decaying into $Z\gamma$.

[13] Search for top-color $Z'$ decaying to $t\overline{t}$. The quoted limit is for $\Gamma_{Z'}/m_{Z'} = 0.012$.

[14] CHATRCHYAN 13AP search for top-color leptophobic $Z'$ decaying to $t\overline{t}$. The quoted limit is for $\Gamma_{Z'}/m_{Z'} = 0.012$.

[15] BAAK 12 give electroweak oblique parameter constraints on the QCD-like technicolor models. See their Fig. 28.

[16] CHATRCHYAN 12AF search for a vector techni-resonance decaying to $WZ$. The limit assumes $M_{\pi_T} = (3/4)\ M_{\rho_T} - 25$ GeV. See their Fig. 3 for the limit in $M_{\pi_T} - M_{\rho_T}$ plane of the low scale technicolor model.

[17] Using the LHC limit on the Higgs boson production cross section, CHIVUKULA 11 obtain a limit on the top-Higgs mass $> 300$ GeV at 95% CL assuming 150 GeV top-pion mass.

[18] Using the LHC limit on the Higgs boson production cross section, CHIVUKULA 11A obtain a limit on the techinipion mass ruling out the region 110 GeV $< m_P < 2m_t$. Existence of color techni-fermions, top-color mechanism, and $N_{TC} \geq 3$ are assumed.

[19] AALTONEN 10I search for the vector techni-resonances ($\rho_T$, $\omega_T$) decaying into $W\pi_T$ with $W \rightarrow \ell\nu$ and $\pi_T \rightarrow b\overline{b}$, $b\overline{c}$, or $b\overline{u}$. See their Fig. 3 for the exclusion plot in $M_{\pi_T} - M_{\rho_T}$ plane.

[20] ABAZOV 10A search for a vector techni-resonance decaying into $WZ$. The limit assumes $M_{\rho_T} < M_{\pi_T} + M_W$.

[21] ABAZOV 07I search for the vector techni-resonances ($\rho_T$, $\omega_T$) decaying into $W\pi_T$ with $W \rightarrow e\nu$ and $\pi_T \rightarrow b\overline{b}$ or $b\overline{c}$. See their Fig. 2 for the exclusion plot in $M_{\pi_T} - M_{\rho_T}$ plane.

[22] ABULENCIA 05A search for resonances decaying to electron or muon pairs in $p\overline{p}$ collisions. at $\sqrt{s} = 1.96$ TeV. The limit assumes Technicolor-scale mass parameters $M_V = M_A = 500$ GeV.

[23] CHEKANOV 02B search for color octet techni-$\pi$ $P$ decaying into dijets in $e p$ collisions. See their Fig. 5 for the limit on $\sigma(e p \rightarrow e P X)\cdot B(P \rightarrow 2j)$.

[24] ABAZOV 01B searches for vector techni-resonances ($\rho_T$,$\omega_T$) decaying to $e^+ e^-$. The limit assumes $M_{\rho_T} = M_{\omega_T} < M_{\pi_T} + M_W$.

[25] The limit is independent of the $\pi_T$ mass. See their Fig. 9 and Fig. 10 for the exclusion plot in the $M_{\rho_T}$–$M_{\pi_T}$ plane. ABDALLAH 01 limit on the techni-pion mass is $M_{\pi_T} > 79.8$ GeV for $N_D$=2, assuming its point-like coupling to gauge bosons.

[26] AFFOLDER 00F search for $\rho_T$ decaying into $W \pi_T$ or $\pi_T \pi_T$ with $W \rightarrow \ell\nu$ and $\pi_T \rightarrow \overline{b} b$, $\overline{b} c$. See Fig. 1 in the above Note on "Dynamical Electroweak Symmetry Breaking" for the exclusion plot in the $M_{\rho_T} - M_{\pi_T}$ plane.

[27] AFFOLDER 00K search for the $\rho_{T8}$ decaying into $\pi_{LQ} \pi_{LQ}$ with $\pi_{LQ} \rightarrow b\nu$. For $\pi_{LQ} \rightarrow c\nu$, the limit is $M_{\rho_{T8}} >$510 GeV. See their Fig. 2 and Fig. 3 for the exclusion plot in the $M_{\rho_{T8}} - M_{\pi_{LQ}}$ plane.

[28] ABE 99F search for a new particle $X$ decaying into $b\overline{b}$ in $p\overline{p}$ collisions at $E_{cm}$= 1.8 TeV. See Fig. 7 in the above Note on "Dynamical Electroweak Symmetry Breaking" for the upper limit on $\sigma(p\overline{p} \rightarrow X)\times B(X \rightarrow b\overline{b})$. ABE 99F also exclude top gluons of width $\Gamma$=0.3$M$ in the mass interval 280 $< M <$ 670 GeV, of width $\Gamma$=0.5$M$ in the mass interval 340 $< M <$ 640 GeV, and of width $\Gamma$=0.7$M$ in the mass interval 375 $< M <$ 560 GeV.

[29] ABE 99N search for the techni-$\omega$ decaying into $\gamma\pi_T$. The technipion is assumed to decay $\pi_T \rightarrow b\overline{b}$. See Fig. 2 in the above Note on "Dynamical Electroweak Symmetry Breaking" for the exclusion plot in the $M_{\omega_T} - M_{\pi_T}$ plane.

[30] ABE 97G search for a new particle $X$ decaying into dijets in $p\overline{p}$ collisions at $E_{cm}$= 1.8 TeV. See Fig. 5 in the above Note on "Dynamical Electroweak Symmetry Breaking" for the upper limit on $\sigma(p\overline{p} \rightarrow X)\times B(X \rightarrow 2j)$.

## REFERENCES FOR Technicolor


| | | | | |
|---|---|---|---|---|
| KHACHATRY... | 16E | PR D93 012001 | V. Khachatryan *et al.* | (CMS Collab.) |
| AAD | 15AB | PR D92 012010 | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 15AO | JHEP 1508 148 | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 15BB | EPJ C75 263 | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 15Q | PL B743 15 | G. Aad *et al.* | (ATLAS Collab.) |
| AAIJ | 15AN | EPJ C75 152 | R. Aaij *et al.* | (LHCb Collab.) |
| KHACHATRY... | 15C | PL B740 83 | V. Khachatryan *et al.* | (CMS Collab.) |
| KHACHATRY... | 15W | PR D91 052012 | V. Khachatryan *et al.* | (CMS Collab.) |
| AAD | 14AT | PL B738 428 | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 14V | PR D90 052005 | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 13AN | PR D87 112003 | G. Aad *et al.* | (ATLAS Collab.) |
| Also | | PR D91 119901 (errat.) | G. Aad *et al.* | (ATLAS Collab.) |
| AAD | 13AQ | PR D88 012004 | G. Aad *et al.* | (ATLAS Collab.) |
| CHATRCHYAN | 13AP | PR D87 072002 | S. Chatrchyan *et al.* | (CMS Collab.) |
| CHATRCHYAN | 13BM | PRL 111 211804 | S. Chatrchyan *et al.* | (CMS Collab.) |
| Also | | PRL 112 119903 (errat.) | S. Chatrchyan *et al.* | (CMS Collab.) |
| BAAK | 12 | EPJ C72 2003 | M. Baak *et al.* | (Gfitter Group) |
| CHATRCHYAN | 12AF | PRL 109 141801 | S. Chatrchyan *et al.* | (CMS Collab.) |
| AALTONEN | 11AD | PR D84 072003 | T. Aaltonen *et al.* | (CDF Collab.) |
| AALTONEN | 11AE | PR D84 072004 | T. Aaltonen *et al.* | (CDF Collab.) |
| CHIVUKULA | 11 | PR D84 095022 | R.S. Chivukula *et al.* | |
| CHIVUKULA | 11A | PR D84 115025 | R. S. Chivukula *et al.* | |
| AALTONEN | 10I | PRL 104 111802 | T. Aaltonen *et al.* | (CDF Collab.) |
| ABAZOV | 10A | PRL 104 061801 | V.M. Abazov *et al.* | (D0 Collab.) |
| ABAZOV | 07I | PRL 98 221801 | V.M. Abazov *et al.* | (D0 Collab.) |
| ABULENCIA | 05A | PRL 95 252001 | A. Abulencia *et al.* | (CDF Collab.) |
| CHEKANOV | 02B | PL B531 9 | S. Chekanov *et al.* | (ZEUS Collab.) |
| ABAZOV | 01B | PRL 87 061802 | V.M. Abazov *et al.* | (D0 Collab.) |
| ABDALLAH | 01 | EPJ C22 17 | J. Abdallah *et al.* | (DELPHI Collab.) |
| AFFOLDER | 00F | PRL 84 1110 | T. Affolder *et al.* | (CDF Collab.) |
| AFFOLDER | 00K | PRL 85 2056 | T. Affolder *et al.* | (CDF Collab.) |

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|---|---|---|---|---|
| ABE | 99F | PRL 82 2038 | F. Abe *et al.* | (CDF Collab.) |
| ABE | 99N | PRL 83 3124 | F. Abe *et al.* | (CDF Collab.) |
| ABE | 97G | PR D55 R5263 | F. Abe *et al.* | (CDF Collab.) |