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On behalf of ATLAS and CMS

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Outline



- Desperately seeking SUSY
- Hunting in the exotic land
- Summary



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DIRECTED BY SUSAN SEIDELMAN

Desperately Seeking SUSY





ORION

1985 Movie

- -- SUSY searches predate this
- -- may have better luck this time...

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SUSY



- Main motivation for SUSY:
 - cancel quadratic divergent in Higgs mass
 - bonus: provide dark matter candidate
 - bonus: convergent of gauge couplings at Planck scale
- Experimental search strategy:
 - assume R-parity is conserved
 - ➡ lightest supersymmetric particle (LSP) is stable
 - \Rightarrow large missing transverse energy (E_T)
 - will also present searches with R-parity violation
- caveat: SUSY has many free parameters
 - ➡ conversion of result into exclusion limits require assumptions:
 - decay chains
 - masses and branching fractions





Search for Stop-Pair Production













arXiv:1303.2985







2-3 jets + 1-2 b jets + missing E_T





• signature: 3 leptons + missing E_T









Pheno2013







Summary of ATLAS SUSY Searches



	ATLAS SUSY Searches* - 95% CL Lower Limits (Status: March 26, 2013)					
MSUGRA/CMSSM : 0 lep + i's + F	1-5.8 (b ⁻¹ .8 TeV [ATL AS_CONE_2012_100]					
$MSUGRA/CMSSM : 1 lep + i's + E_{T,miss}$	L=5.6 fb ⁻¹ .8 TeV [ATLAS-CONF-2012-103]	$\vec{a} = \vec{a}$ mass				
ω Pheno model : 0 lep + j's + $E_{T miss}$	L=5.8 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-109] 1.18	\widetilde{g} mass $(m(\widetilde{g}) < 2 \text{ TeV}, \text{ light } \widetilde{\chi}^0)$ ATLAS				
• Pheno model : 0 lep + j's + $E_{T,miss}$	L=5.8 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-109] 1.	B TEV \widetilde{q} mass $(m(\widetilde{g}) < 2 \text{ TeV}, \text{ light } \widetilde{\chi}_{4}^{0})$ Preliminary				
$\int C = Gun d m d \overline{\chi} (\tilde{g} \rightarrow q \bar{q} \tilde{\chi}^{\pm}) : 1 \text{ lep } + j \text{'s } + E_{\tau \text{ miss}}$	L=4.7 fb ⁻¹ , 7 TeV [1208.4688] 900 GeV	MASS $(m(\tilde{\chi}^0_{,1}) < 200 \text{ GeV}, m(\tilde{\chi}^{\pm}) = \frac{1}{2}(m(\tilde{\chi}^0) + m(\tilde{g}))$				
GMSB (INLSP) : 2 lep (OS) + j's + E _{T miss}	L=4.7 fb ⁻¹ , 7 TeV [1208.4688] 1.24	\widetilde{g} mass $(\tan\beta < 15)$				
$GMSB (\tilde{\tau} NLSP)': 1-2\tau + j's + E_{T miss}$	L=20.7 fb ⁻¹ , 8 TeV [1210.1314]	0 TeV $\widetilde{\mathbf{g}}$ mass $(\tan\beta > 18)$				
$GGM (bino NLSP) : \gamma \gamma + E^{T,miss}$	L=4.8 fb ⁻¹ , 7 TeV [1209.0753]	$\tilde{g} \text{ mass } (m(\tilde{\chi}_1^0) > 50 \text{ GeV})$				
\overline{O} GGM (WINO NLSP) : γ + lep + E	L=4.8 fb ⁻¹ , 7 TeV [ATLAS-CONF-2012-144] 619 GeV ĝ mas	$\int L dt = (4.4 - 20.7) \text{ ID}$				
GGM (niggsino-bino NLSP) $\gamma + b + E$	L=4.8 fb ⁻¹ , 7 TeV [1211.1167] 900 GeV	$\max_{\alpha} \max_{(m(\widetilde{\chi}_{1}^{0}) > 220 \text{ GeV})} = 7.8 \text{ TeV}$				
GGM (niggsino NLSP) : $Z + jets + E_{T,miss}$	L=5.8 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-152] 690 GeV g ma	6S $(m(H) > 200 \text{ GeV})$				
Gravitino LSP : monojet + $E_{T,miss}$	L=10.5 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-147] 645 GeV F SC	alle $(m(G) > 10^{-4} \text{ eV})$				
$g \rightarrow bb\overline{\chi}^\circ$: 0 lep + 3 b-j's + $E_{T,miss}$	L=12.8 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-145] 1.24	rev g mass $(m(\tilde{\chi}_{1}) < 200 \text{ GeV})$ 8 TeV all 2012 data				
$g \rightarrow tt\chi$: 2 SS-lep + (0-3D-)]'S + $E_{T,miss}$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-007] 900 GeV	$\widetilde{a} = \max_{\lambda_1 \in \mathcal{A}} \max_{\lambda_2 \in \mathcal{A}} \max_{\lambda_1 \in \mathcal{A}} \max_{\lambda_2 \in A$				
$\Im \rightarrow \mathfrak{ll} \chi$. 0 lep + 11ulti-j S + $\mathcal{L}_{T,miss}$	L=5.8 1D , 8 1eV [ATLAS-CONF-2012-103] 1.00 1eV	g mass $(m(\chi_1) < 300 \text{ GeV})$ 8 TeV, partial 2012 da				
$g \rightarrow ii\chi$. 0 lep + 3 b ⁻¹ S + $E_{T,miss}$		\sqrt{g} (m(χ_1) < 200 GeV) 7 ToV all 2011 data				
$\begin{array}{ccc} \text{DD}, \text{D}_1 \rightarrow \text{D}\chi & \text{O} \text{ Iep } + 2\text{-D-Jets} + \mathcal{L}_{T,\text{miss}} \\ \text{O} & & & & & & & & & \\ \end{array}$	L=12.8 m , 8 rev [A1LAS-CONF-2012-105] 020 GeV D 11103	$(m(\chi_1) < 120 \text{ GeV})$ 7 TeV, all 2011 data				
$\begin{array}{ccc} & & & & \\ & & & & \\ & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & & \\ & & & & \\ & & & & & \\ & & & & & \\$	(m_{1})	$() = \sum_{i=1}^{n} (X_i)$				
$\widetilde{tt} (ngdiy), \widetilde{t} \to \widetilde{bp} (t \to lop (t \to lop), t \to lop (t \to lop (t \to lop)), t \to lop (t \to $	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-037]	$= 0 \text{ GeV}. m(\tilde{v}^{\pm}) = 150 \text{ GeV}$				
$\mathbf{C}_{\mathbf{A}}$ $\mathbf{T}_{\mathbf{A}}$	L=13.0 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-167]	$(\tilde{y}_{1}^{\pm}) = 0 \text{ GeV}. m(\tilde{y}_{1}^{\pm}) = 10 \text{ GeV})$				
$\sum_{i} \bigcup_{j \in I} \bigcup_{i \in I} (heavy), \tilde{t} \rightarrow t\tilde{\chi}^{0}$: 1 lep + b-jet + $E_{T,miss}$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-037] 200-610 GeV T Mass	$(m\overline{\mathbb{S}}^0) = 0$				
\widetilde{tt} (heavy), $\widetilde{t} \rightarrow t\widetilde{\chi}^0$: 0 lep + 6(2b-) jets + $E_{\tau,\text{miss}}$	L=20.5 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-024] 320-660 GeV t mas	$(n \widetilde{\chi}^0) = 0$				
సార్ tt (natural GMSB) : Z(→II) + b-jet + E	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-025] 500 GeV	$(n(\tilde{\chi}^0_1) > 150 \text{ GeV})$				
$\widetilde{t}_{2}\widetilde{t}_{2}, \widetilde{t}_{2} \rightarrow \widetilde{t}_{1} + Z : Z(\rightarrow II) + 1 \text{ lep } + b \text{ -jet } + E_{T \text{ miss}}^{7, \text{miss}}$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-025] 520 GeV t ₂ mass	$(m(\tilde{t}_1) = m(\tilde{\chi}_1^0) + 180 \text{ GeV})$				
$\widetilde{I}_{1}\widetilde{I}_{1},\widetilde{I}_{2} \rightarrow \widetilde{\chi}_{2}^{0}: 2 \text{ lep } + E_{T \text{ miss}}$	L=4.7 fb ⁻¹ , 7 TeV [1208.2884] 85-195 GeV I MASS $(m(\tilde{\chi}_1^0) = 0)$					
$\widetilde{\chi}^+ \widetilde{\chi}, \widetilde{\chi}^+ \rightarrow \widetilde{h} (l \widetilde{v}) : 2 \text{ lep } + E_{T, \text{miss}}$	L=4.7 fb ⁻¹ , 7 TeV [1208.2884] 110-340 GeV $\widetilde{\chi}_1^{\pm}$ mass $(m(\widetilde{\chi}_1^0))$	< 10 GeV, $m(\widetilde{l},\widetilde{v}) = \frac{1}{2}(m(\widetilde{\chi}_{1}^{\pm}) + m(\widetilde{\chi}_{j}^{0})))$				
$\sum_{i=1}^{\infty} \sum_{j=1}^{\infty} \sum_{i=1}^{\infty} \overline{v}_{i} (\tau \widetilde{v}) : 2\tau + E_{T,\text{miss}}$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-028] 180-330 GeV $\widetilde{\chi}_1^{\pm}$ mass $(m(\chi_1^0))$	$10 \text{ GeV}, m(\tilde{\tau}, \tilde{v}) = \frac{1}{2} (m(\tilde{\chi}_1^{\pm}) + m(\tilde{\chi}_1^{0})))$				
$\overline{\chi}_1^* \overline{\chi}_2^* \rightarrow [v_1] [(\overline{v}v), \overline{v} , (\overline{v}v)] : 3 \text{ lep } + E_{T,\text{miss}}$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-035] 600 GeV $\tilde{\chi}_1^{\perp}$ mas	$(m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0) = 0, m(\tilde{l}, \tilde{v}) \text{ as above})$				
$\widetilde{\chi}_{\tau}^* \widetilde{\chi}_{2}^* \to W^{**} \widetilde{\chi}_{\tau}^* Z^{**} \widetilde{\chi}_{\tau}^* : 3 \text{ lep } + E_{\tau, \text{miss}}$	L=20.7 fb⁻¹, 8 TeV [ATLAS-CONF-2013-035] 315 GeV χ_1^- Mass $(m(\tilde{\chi}_1^+) = \tilde{\chi}_1^+)$	$m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0) = 0$, sleptons decoupled)				
Direct χ_1^- pair prod. (AMSB) : long-lived χ_1^-	L=4.7 fb ⁻¹ , 7 TeV [1210.2852] 220 GeV χ_1 mass $(1 < \tau(\tilde{\chi}_1^z) < 10 \text{ ns})$	~				
State \hat{g} , R-hadrons : low β , $\beta\gamma$	L=4.7 fb ⁻¹ , 7 TeV [1211.1597] 985 GeV	g mass				
	L=4.7 fb ⁻¹ , 7 TeV [1211.1597] 300 GeV T [IIIdSS (5 < tanβ < 50 m 2000 (5 m 2000 ((D)				
$\tilde{\sigma} \approx \tilde{\sigma} \approx GMSB, \chi \rightarrow \gamma G$: non-pointing photons	L=4.7 fb ⁻ , 7 TeV [ATLAS-CONF-2013-016] 230 GeV χ_1 IIIdSS $(0.4 < \tau(\chi_1) < 2 m)$) PP (1 mm 1 m ² decounted)				
$\chi_{\perp} \rightarrow qq\mu (RPV) \cdot \mu + heavy displaced vertex$	L=4.4 fb ', 7 lev [1210.7451] 700 GeV Q IIIc	\widetilde{M} (1 mm < ct < 1 m, g decoupled)				
$L = V \cdot p \rightarrow v_{\tau} + \Lambda, v_{\tau} \rightarrow e + \mu$ resonance	L=4.0 ID , / Iev [1212.12/2]	1.51 lev v_{τ} (mass $(\lambda_{311}^2 = 0.10, \lambda_{132}^2 = 0.05)$				
D D R ilinear BPV CMSSM : 1 len + 7 i's + F_{-}	L=4.0 iD , 7 feV [1212.1272] 1.10 fe	$\tilde{V}_{\tau} = \tilde{\Omega} = \tilde{\Omega} = 0.10, x_{1(2)33} = 0.03)$				
$\widetilde{\nabla}^{+}\widetilde{\nabla}^{-}\widetilde{\nabla}^{+} \rightarrow W\widetilde{\nabla}^{0}\widetilde{\nabla}^{0} \rightarrow eev euv$ 4 len + E	$L=20.7 \text{ fb}^{-1}$ 8 TeV [ATLAS-CONF-2013-036] 760 GeV $\tilde{\chi}^+$	$\begin{array}{l} \text{Dass} \qquad (m(\overline{\gamma}^0) > 300 \text{ GeV}, \lambda > 0) \end{array}$				
χ_{χ_1,χ_2} χ_{χ_1,χ_2} χ_{χ_2,χ_3} χ_{χ_1,χ_2} χ_{χ_2,χ_3} χ_{χ_1,χ_2} χ_{χ_2,χ_3} χ_{χ_1,χ_2} χ_{χ_2,χ_3} χ_{χ_1,χ_2} χ_{χ_2,χ_3} χ_{χ_1,χ_2} χ_{χ_2,χ_3}	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-036] 350 GeV $\tilde{\chi}^+$ mass (m($\tilde{\chi}$	$ \lambda_{12} ^{-1} > 80 \text{ GeV}, \lambda_{12} > 0)$				
$\widetilde{\alpha} \rightarrow \alpha \alpha \alpha$: 3-iet resonance pair	L=4.6 fb ⁻¹ . 7 TeV [1210.4813] 666 GeV \widetilde{Q} mas	S				
$\widetilde{g} \rightarrow \widetilde{t}t, \widetilde{t} \rightarrow bs : 2 SS-lep + (0-3b-)j's + E$	L=20.7 fb ⁻¹ , 8 TeV [ATLAS-CONF-2013-007] 880 GeV	mass (any $m(\tilde{t})$)				
Scalar gluon : 2-jet resonance pair	L=4.6 fb ⁻¹ , 7 TeV [1210.4826] 100-287 GeV Sgluon mass (incl.	mit from 1110.2693)				
WIMP interaction (D5, Dirac χ) : 'monojet' + $E_{\tau \text{ miss}}$	L=10.5 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-147] 704 GeV M* S	cale $(m_{\chi} < 80 \text{ GeV}, \text{ limit of } < 687 \text{ GeV for D8})$				
· ,						
	10 ⁻¹	1 10				

*Only a selection of the available mass limits on new states or phenomena shown. All limits quoted are observed minus 1σ theoretical signal cross section uncertainty. 18

Mass scale [TeV]

, 2013)

partial 2012 data



Summary of SUSY Searches



- No sign of SUSY yet but...
 - SUSY has many free parameters...
 - ➡ difficult to totally exclude SUSY
 - ➡ provide job security...
 - ⇒ experimenters (and theorists) love SUSY



Hunting in the Exotic Land









- ADD solution to hierarchy problem:
 - SM particles in 4D
 - gravity in 4+n_{ED} dimensions
 - KK graviton could enhance dilepton x-section



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CMS-PAS-EXO-12-023

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- Reconstruct highly boosted tops with merged hadronic jets
- Exclude KK gluon < 1.8 TeV @ 95% CL
- Also set limits on x-sections due to Z' or non-resonant enhancement K.K. Gan 24







- *WZ* resonances predicted in many beyond SM theories:
 - technirho ($\rho_{\rm T}$) in Technicolor models
 - new heavy gauge boson in composite Higgs models





500

450

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Search for Vector-Like Quarks

- Weak Isospin singlet: $t' \rightarrow Wb, Zt, Ht$
- Weak Isospin doublet: $t' \rightarrow Zt, Ht$
- Production/decay of interest: $t'\overline{t} \rightarrow HtH\overline{t}, ZtH\overline{t}, WbH\overline{t}$
 - $H \rightarrow b\overline{b}$
 - ⇒ search for lepton
 + ≥ 6 jets (≥ 2 b jets)
- Weak-isospin doublet: mass > 790 GeV @95%CL
- Weak-isospin singlet: mass > 640 GeV @95%CL K.K. Gan



Search for Top-Pair Resonace

- Many BSM theories predicts enhanced couplings to 3rd generation quarks
- Search for $e/\mu + \ge 2$ jets
- Some examples of 95% CL mass exclusion limits:
 - Topcolor Z'
 Γ/M = 1.2%: M > 2.1 TeV
 Γ/M = 10%: M > 2.7 TeV
 - KK excited gluon in RS model: M > 2.5 TeV
- Also set limits on x-sections times branching ratio of other models (not shown)



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earch for 2nd Generation Lepto-Quarl Lepto-quarks are predicted in grand unified theories, technicolor, and composite models $LQLQ \rightarrow \mu q \mu q \rightarrow 2 \mu + 2 jets$ $\sqrt{s} = 8 \text{ TeV}, 19.6 \text{ fb}^{-1}$ M(LQ) > 1.07 TeVCMS Preliminary @95%CL Data 10² $H \to Z/\gamma^* + jets$ $\frac{1}{1}$ t \overline{t} + jets Other Background Events/Bin Unc. (stat + syst) 10 LQ, M = 900 GeV 10⁻¹ CMS-PAS-EXO-12-042 800 1000 1200 1400 1600 1800 2000 400 600 200 29 $M_{min}(\mu, jet)$ [GeV]



 $LQLQ \rightarrow \tau b\tau b \rightarrow e - hadron bb$





- Search for enhancement in scalar sum of transverse momentum (S_T) • Mass > 534 GeV @95%CI arXiv:1303.0526
- Mass > 534 GeV @95%CL K.K. Gan



Search for Long-Lived Particles



Many BSM have heavy, long-lived charged particles that are slow or have fractional or multiple charges ($\geq 2 e$) Search for long lived charged particles with high/low ionizing

- - high/low ionizing energy loss (dE/dx)
 - long time of flight
- Also limits on fractionally charged particles (not shown) K.K. Gan



Summary of ATLAS Exotics Searches* - 95% CL Lower Limits (Status: HCP 2012)



Lorgo ED (ADD) - monoiot + E				<u> </u>	
Large ED (ADD) : monophoton + E	L=4.7 fB , 7 lev [1210.4491]		$4.37 \text{ lev} M_D(0=2)$		
\mathcal{L} argo ED (ADD) : Honophoton + $\mathcal{L}_{T,\text{miss}}$	L=4.6 fD , 7 lev [1209.4625]			2 NLO	TLAS
$\frac{2}{9} = \frac{1}{9} $	L=4.7 fb , 7 lev [1211.1150]		4.18 lev M_S (ΠLZ 0=	P	reliminary
2 $1/7$ $1/7$ $1/7$	L=4.8 fb ⁻¹ , 7 lev [AILAS-CONF-2012-072]	1.4			
$S/Z_2 ED$: dilepton, m_1	L=4.9-5.0 fb , 7 lev [1209.2535]			(1.0	
\tilde{E} RST uphoton & dilepton, $m_{\gamma\gamma}$	L=4.7-5.0 fb , 7 TeV [1210.8389]			$_{PI} = 0.1)$	
	j L=1.0 fb ⁻¹ , 7 TeV [1203.0718]	845 GeV	raviton mass $(K/M_{Pl} = 0.1)$	$\int dt = (1.0)^{-1}$	12 0) fb ⁻¹
$m_{T,kvk}$	L=4.7 fb ⁻¹ , 7 TeV [1208.2880]	1.23 T	• Graviton mass $(k/M_{\rm Pl} = 0.1)$	Lui = (1.0 - 1)	13.0) 10
$HS \ g \rightarrow ((DH - 0.925)) \cdot (I \rightarrow H) \ estimate for the second sec$	L=4.7 fb ⁻¹ , 7 TeV [ATLAS-CONF-2012-136]		1.9 TeV 9 mass	s =	7. 8 TeV
$\square \qquad \text{ADD BH } (M_{\text{TH}} / M_{\text{D}} = 3) : \text{SS dimuon}, N_{\text{ch. part}}$	L=1.3 fb ⁻¹ , 7 TeV [1111.0080]	1.25 1	$eV M_D (\delta=6)$	10	,
ADD BH $(M_{TH} / M_D = 3)$: leptons + jets, $2p$	L=1.0 fb ⁻¹ , 7 TeV [1204.4646]	1	5 TeV Μ _D (δ=6)		
Quantum black noie : dijet, $F_{\chi}(m_{ij})$	L=4.7 fb ⁻¹ , 7 TeV [1210.1718]		4.11 TeV M _D (δ=6)		
	L=4.8 fb ⁻¹ , 7 TeV [ATLAS-CONF-2012-038]		7.8 TeV Λ		
SONTACT INTERACTORS "	L=4.9-5.0 fb ⁻¹ , 7 TeV [1211.1150]		13.9	Tev Λ (constructive	int.)
dutt CI : SS dilepton \neq jets $+E_{T,miss}$	L=1.0 fb ⁻¹ , 7 TeV [1202.5520]		1.7 TeV Λ		
Z' (SSM) : <i>m</i> _{ee/µµ}	L=5.9-6.1 fb ⁻¹ , 8 TeV [ATLAS-CONF-2012-129]		2.49 TeV Z' mass		
Z' (SSM) : <i>m</i> _v	L=4.7 fb ⁻¹ , 7 TeV [1210.6604]	1.4	TeV Z' mass		
W' (SSM) : m _{T,e/r}	L=4.7 fb ⁻¹ , 7 TeV [1209.4446]		2.55 TeV W' mass		
$W' (\rightarrow tq, g_{B}=1) : m_{tr}$	L=4.7 fb ⁻¹ , 7 TeV [1209.6593]	30 GeV W' mass			
$W'_{R} (\rightarrow tb, SSM) : m_{tt}$	L=1.0 fb ⁻¹ , 7 TeV [1205.1016]	1.13 Te	/ W' mass		
W* : <i>m</i> _{T.e/t}	L=4.7 fb ⁻¹ , 7 TeV [1209.4446]		2.42 TeV W* mass		
Scalar LQ pair (&=1) : kin. vars. in eejj, evj	L=1.0 fb ⁻¹ , 7 TeV [1112.4828]	660 GeV 1 st ge	n. LQ mass		
Pht raa I Qair ¥i & kin. vars. in µµjj, µvj	L=1.0 fb ⁻¹ , 7 TeV [1203.3172]	685 GeV 2 nd 0	en. LQ mass		
Scalar LQ pair (β=1) : kin. vars. in ττjj, τνj	L=4.7 fb ⁻¹ , 7 TeV [Preliminary]	538 GeV 3rd gen.	LQ mass		
4 th generation : t't'→ WbWb	L=4.7 fb ⁻¹ , 7 TeV [1210.5468]	656 Gev t' ma	s eV		
4^{th} generation : b'b'($T_{5/3}$) \rightarrow WtW	L=4.7 fb ⁻¹ , 7 TeV [ATLAS-CONF-2012-130]	670 GeV b' (T	") mass		
New guark b' : $b'b' \rightarrow Zb+X, m_{\tau_1}$	L=2.0 fb ⁻¹ , 7 TeV [1204.1265] 40	o Gev b' mass	0/3*		
NCW top part of $(T_{\rm A}, A_0, A_0)$ (dilepton, $M_{\rm A}$)	L=4.7 fb ⁻¹ , 7 TeV [1209.4186]	483 GeV T mass (n(A_) < 100 GeV)		
Vector-like quark : CC, m	L=4.6 fb ⁻¹ , 7 TeV [ATLAS-CONF-2012-137]	1.12 Te	VLQ mass (charge -1/3, coupli	$\log \kappa_{m} = v/m_0$	
Vector-like guark : NC, m	L=4.6 fb ⁻¹ . 7 TeV [ATLAS-CONF-2012-137]	1.08 Te\	VLQ mass (charge 2/3, couplin	$a_{K_{n0}} = v/m_{o}$	
Excited quarks γ-jet resonance, m	L=2.1 fb ⁻¹ , 7 TeV [1112.3580]		2.46 TeV g* mass	J qu Qr	
Expited marks dijet resonance. $m_{\rm e}$	L=13.0 fb ⁻¹ . 8 TeV [ATLAS-CONF-2012-148]		3.84 TeV g* mass		
ACILCU Excileduepton - y resonance, m	/=13.0 fb ⁻¹ .8 TeV [ATLAS-CONE-2012-146]		2.2 TeV $ ^*$ mass $(\Lambda = m(^*))$		
Techni-hadrons (LSTC) : dilepton.m.	$I = 4.9-5.0 \text{ fb}^{-1}$ 7 TeV [1209.2535]	850 GeV ($/\omega$ mass $(m(\alpha / \omega) - m(\pi)) = M$)	
Techni-hadrons (LSTC) : WZ resonance (vIII). m	$l = 1.0 \text{ fb}^{-1}$ 7 TeV [1204 1648]	483 GeV 0 mass	$m(0) = m(\pi_{-}) + m_{} m(a) = 1.1 m_{W}$	(o))	
$1 \qquad \text{Major peutr (I RSM no mixing) : 2-lep + iet}$	$l = 2.1 \text{ fb}^{-1} \text{ 7 TeV} [1203.5420]$	P _T mass	5 TeV N mass $(m(W)) = 2$ TeV)	(r _T)	
W_{a} (LRSM, no mixing) · 2-lep + jets	$1 = 2.1 \text{ fb}^{-1} 7 \text{ TeV} [1203.5420]$		2.4 TeV W mass $(m(N) < 1$	4 TeV)	
$H^{\pm\pm}(DY \text{ prod } BB(H^{\pm\pm} \rightarrow II)=1) \cdot SS ee (uu) m$	$1 - 4.7 \text{ fb}^{-1} 7 \text{ TeV} [1210.5070]$	Gev H ^{±±} mass (I	mit at 398 GeV for μ_{R}		
$H^{\pm\pm}$ (DY prod BR($H^{\pm\pm} \rightarrow e\mu$)=1) · SS $e\mu m^{-1}$	$L = 4.7 \text{ fb}^{-1}$, 7 TeV [1210.5070] 40				
Color octet scalar : dijet resonance m	$L = 4.7 \text{ m}^3$, 7 TeV [1210.3070] 373	nev n _L mass	1 % Toy Scalar resonance mass	e	
		1 1 1 1 1 1 1		<u>í </u>	
	10 ⁻¹		1 1	0	<u> </u>
	10	1 0010		·	
K.K. Gan	, , P	heno2013		Mass sca	le [TeV]

*Only a selection of the available mass limits on new states or phenomena shown





Physicists busy searching for new particles with papers and pens



Nothing new yet...

LHC tree? -

- Restart LHC in 2014 at ~13 TeV
 - expect 300 fb⁻¹
 by 2017



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