



Searches for new physics at ATLAS and CMS

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Disclaimer

- CMS and ATLAS searches hundreds of new physics models
- Today, I will only show some personal collections



Complete information about all results:

- ATLAS
 - https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ExoticsPublicResults
 - https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults
- CMS
 - https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsEXO
 - https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSUS

Introduction

The Standard Model is a (very) effective theory that breaks down at a certain scale

→ Hierarchy:quadratic divergence of the Higgs mass, extremely fine-tuned

 \rightarrow What is the underlying nature of EWSB?

Dark Matter

 \rightarrow cannot be explained by SM

Neutrinos have mass

 \rightarrow where are the right-handed neutrinos?



CMS and ATLAS



- 3.8T solenoid containing calorimeters
- Silicon tracker: $\sigma(p_T)/p_T \sim 15\%$ at 1TeV
- EM cal: homogeneous Lead-Tungstate crystal, σ_E/E ~ 3%/√E[GeV] ⊕ 0.5%
- HAD cal: Brass-scint., ≥7λ₀ σ_E/E ~ 100%/√E[GeV] **⊕** 5%
- Iron return yoke muon spectrometer
- 2T solenoid inside calorimeters
- Silicon+TRT tracker + electron ID
- EM cal: Longitudinally segmented Lead-Ar: σ_E/E ~ 10%/√E[GeV] ⊕ 0.7%
- HAD cal: Fe-scint + Cu-Ar, ≥11 λ_0 $\sigma_E/E \sim 50\%/\sqrt{E[GeV]}$ ⊕ 3%
- Air-toroid muon sp.: $\int \sqrt{B.dI} = 1$ to 7 T.m



More models more fun

- Many extensions of the SM have been
 developed over the past decades:
- Supersymmetry^{*}
- Extra-Dimensions
- Technicolor(s)
- Little Higgs
- No Higgs
- GUT
- Hidden Valley
- Leptoquarks
- Compositeness
- 4th generation (t', b')
- LRSM, heavy neutrino,
- etc...

(for illustration only)

1 jet + MET jets + MET 1 lepton + MET Same-sign di-lepton Dilepton resonance **Diphoton resonance** Diphoton + MET Multileptons Lepton-jet resonance Lepton-photon resonance Gamma-jet resonance Diboson resonance Z+MET W/Z+Gamma resonance Top-antitop resonance Slow-moving particles Long-lived particles **Top-antitop production** Lepton-Jets Microscopic blackholes **Dijet resonance**

etc...

Supersymmetry



- Supersymmetry links fermions and bosons
- Elegant solution to the hierarchy problem
- Unification of the gauge couplings



Same sign dilepton



SS dilepton can arise from e.g. gluino squark production







Results in some benchmark models

- search for squark/ gluino production in final states with jets, missing E_T, and 0/1 lepton
- Sensitive to final states from squarks mass scale





Same sign dilepton with bjet

CMS Preliminary, $\sqrt{s} = 7$ TeV, $L_{int} = 4.7$ fb⁻¹ SS Dileptons + 2b-jets 10² BR pb - NLO+NLL $\widetilde{g} \, \widetilde{g} \rightarrow \overline{b} \, \widetilde{b}_{1}, \ m(\widetilde{b}_{1}) = 500 \text{ GeV}, \ m(\widetilde{\chi^{*}}) = 200 \text{ GeV}, \ m(\widetilde{\chi^{0}}) = 50 \text{ GeV}$ ••••• $\tilde{g} \tilde{g} \rightarrow \tilde{t} \tilde{t}_{s}$ m(\tilde{t}_{s}) = 530 GeV, m($\tilde{\chi}^{0}$) = 50 GeV • Similar to SS dilepton analysis: хb 10 ••••• $\tilde{g} \tilde{g} \rightarrow \tilde{t} \tilde{t}$, $m(\tilde{t}) = 280 \text{ GeV}, m(\tilde{\chi}) = 50 \text{ GeV}$ just add 2 b-tagged jets —— ĝ̃ĝ → 4top + 2χ̃, m(χ̃) = 50 GeV • Fake lepton background from b's 1 505-22-020 dramatically smaller! 10⁻¹ • top contribution expected to decrease by factor of 2! 10⁻² · More exclusive search • same-sign top production 10⁻³ L... 500 600 700 800 900 1000 1100 1200 • SUSY 4 top final states m(g) GeV • SUSY sbottom pair production CMS Preliminary, $\sqrt{s} = 7$ TeV, L_{int} = 4.7 fb⁻ • SUSY 464W final states 10 $\sigma \ge BR (\tilde{b}_1 \tilde{b}_1^* \rightarrow 4W+2b + 2\tilde{\chi}_1^0) pb$ 10⁻¹ R. Cavanaugh Chicago 2012, May 2nd, 2012 NLO+NLL 10⁻² Same Sign dileptons with btags, $m(\tilde{\chi_{+}^{*}}) = 110 \text{ GeV}, m(\tilde{\chi_{-}^{0}}) = 50 \text{ GeV}$

300

250

350

400

450

500

m(b̃,) GeV





Dilepton Resonances 1/3 Mass Spectrum



Expected in many new physics models:

- Z'
- gravitons
- Technicolor



Dilepton resonance 2/3

CMS search in 4.7 fb⁻¹

- μµ and ee channels
- Z'_{SSM} > 1.94 TeV
- Z'_{ψ} > 1.62 TeV
- RS1 graviton
 - k/M_{Pl} = 0.05: m_G > 1.45 TeV
 - $k/M_{Pl} = 0.10: m_{G} > 1.78 \text{ TeV}$

CMS PAS EXO-11-019





Dilepton Resonance 3/3

ATLAS search in 5 fb⁻¹

- μµ and ee channels
- Z'_{SSM} > 2.21 TeV
- Z'_{ψ} > 1.76 TeV
- RS1 graviton
- $k/M_{Pl} = 0.05: m_G > 1.71 \text{ TeV}$ $- k/M_{Pl} = 0.10: m_G > 2.16 \text{ TeV}$ ATLAS-CONF-2012-007



1.5

 10^{-3}

10

ee: L dt = 4.9 fb⁻¹

0.5

L dt = 5.0 fb⁻¹

m [TeV]

2.5

2





- Searching for a Z' decaying into τ⁺τ⁻ pair
- All 4 channels consistent with SM background estimates
- 95% CL limits

 Z_{SSM'} > 1.36 TeV,
 Z'_w > 1.10 TeV







Signature of some new physics models

- String balls
- GUT
- Diquark
- Excied quarks
- Axigluons
- W'
- Z'

CMS search in 1 fb⁻¹

Mass limits:

- String resonance: m > 4.00 TeV
- SSM: m_{w'} > 1.51 TeV
- Phys. Lett. B **704**, 123 (2011)

ATLAS search in 4.8 fb⁻¹

Mass limits:

- m_{q*} > 3.35 TeV
- m_{s8} > 1.94 TeV
- ATLAS-CONF-2012-038



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Monojet

Monojet is a simple and striking signal

- High- p_T jet with no object to balance p_T
- Non-interacting particle created
- •Main BG is Z→vv
- •BSM candidate here is ADD graviton
 - $-qq \rightarrow gG, qg \rightarrow qG, gg \rightarrow gG$ -Limits set on M_D, the Planck scale for n_{ED} extra dimensions











ATLAS result obtained with 1.0 fb⁻¹

- M_D > 3.4 TeV for n_{ED} =2
- M_D > 2.3 TeV for n_{ED} =4
- •ATLAS-CONF-2011-096

CMS result obtained with 4.7 fb⁻¹

- M_D > 4.44 TeV for n_{ED} =2
- $M_{\rm D}$ > 2.94 TeV for n_{ED} =4
- •Larger with NLO K-factor
- •CMS PAS EXO-11-059









Monophoton

CMS search in 4.7 fb⁻¹

- •High- p_{T} photon and not much else
- •ADD limit ($qq \rightarrow G\gamma$):
- $-M_D \gtrsim 1.59 1.66$ TeV for $3 \le n_{ED} \le 6$ •Limits on WIMP-nucleon cross section: $-\sigma B < 16-18$ fb for $1 < M_{DM} < 1000$ GeV •CMS EXO 11-096









Monojet and Monophoton Results



Best Limit for Dark Matter Mass < 3.5 GeV a region as Unexplored By Direct Detection Experiments







Search for $W' \rightarrow l \vee (\ell = e, \mu)$ Calculate mass transverse:

$$M_T = \sqrt{2 \cdot (p_T^{\mu} \cdot c) \cdot E_T^{\text{miss}} \cdot (1 - \cos \Delta \phi_{\mu,\nu})}$$

ATLAS result based on 1.0 fb⁻¹

•SSM $m_{W'}$ > 2.2 TeV •Phys. Lett. B **705**, 28 (2011)

CMS result based on 4.7 fb⁻¹

•SSM $m_{W'}$ > 2.5 TeV

•Submitted to JHEP arXiv: 1204.4764









Leptoquark Search

 Possibility of a fundamental relationship between quarks and leptons through leptoquarks

- they are colored and have fractional charge
- $\boldsymbol{\clubsuit}$ couples to quarks and leptons with coupling λ
- & branching fractions are denoted as: β(lq) and 1- β(vq)
- ✦ CMS and ATLAS search for all 3 generation of leptoquarks with following final states:
 - Ilqq (β =1) where I = e, μ
 - Iνqq (β =0.5)
 - bbvv

Limits are set on mass of leptoquarks (M_{LQ})





First generation leptoquark

- Pair produced particle decay to νq or lq
- Search both llqq and l ν qq channels

ATLAS search in 1.1 fb⁻¹

- Using eejj and eujj channels
- Limits:
 - $-m_{LQ}$ > 660 GeV for β =1
 - $-m_{LO}$ > 607 GeV for β =0.5
- Phys. Lett. B **709**, 158 (2012)







Second generation leptoquark

CMS search in 2.0 fb⁻¹ Using $\mu\mu jj$ and $\mu\nu jj$ channels Limits:

- m_{LQ} > 632 GeV for β = 1
- m_{LO} > 523 GeV for β = 0.5 **CMS PAS EXO-11-028**

ATLAS search in 1.0 fb⁻¹

Using $\mu\mu j j$ and $\mu\nu j j$ channels Limits:

- m_{LQ} > 685 GeV for β = 1
- m_{LO} > 594 GeV for β = 0.5 **ATLAS Preliminary**





Third generation leptoquark

 $R \equiv \frac{M_T^R}{M_R}$

CMS search in 1.8 fb⁻¹

- Search channel is *bbvv*
- Uses *razor* variables

Designed to search for pairs of heavy particles

Limit:

• m_{LQ} > 350 GeV for β = 0 CMS PAS EXO-11-030



Are you ready to upgrade your plan?



Welcome to 4G

✦ SM Extension: Adding one more generation of quarks is an obvious extension of SM and is also not fully excluded by electroweak precision data

◆ Due to heaviness of this new generation of quarks the CP violation can be boosted by large factor and could resolve the matter-antimatter asymmetry in the universe can provide enough CP violation to explain matterdominated universe



Fourth generation quarks 1/4

CMS and ATLAS search for heavy quarks

•Here denoted T and B; or Q for either flavor •Searches for $T \rightarrow Wb$, $B \rightarrow Wt$ and $T \rightarrow Zt$, $T \rightarrow A_0t$, $B \rightarrow Zb$ -100% branching fraction assumed for mass limits Both single and pair production considered -Mechanism and cross section depend on Q nature (chiral, vector-like)

Complicated final states, usually with bosons

ATLAS search: $Qq \rightarrow Vqq'$ in 1.0 fb⁻¹

Bosons decay leptonically

•Limits:

 $-Qq \rightarrow Wqq': m_0 > 900 \text{ GeV}$ $-Qq \rightarrow Zqq': m_0 > 760 \text{ GeV}$ arXiv:1112.5755 (submitted to PLB)

ATLAS search for $QQ \rightarrow WqWq$ in 1.0 fb⁻¹

- Both W's decay leptonically
- •Limit: *m*₀ > 350 GeV
- •arXiv:1202.3389 (submitted to PRD)









Fourth generation quarks 2/4

ATLAS search for $TT \rightarrow WbWb$ in 1.0 fb⁻¹

- •One W decays leptonically
- •One b is tagged
- •Limit: *m_T* > 404 GeV
- •arXiv:1202.3076 (submitted to PRL)

ATLAS search for $TT \rightarrow tA_0 tA_0 \rightarrow l X$ in 1.0 fb⁻¹

• A_0 is an undetected neutral particle •Limit: m_T > 420 GeV for light A_0 •PRL **108**, 041805 (2012)

ATLAS search for $BB \rightarrow WtWt$ in 1.0 fb⁻¹

- Require 1 lepton, 6 jets, high MET
 Dijet mass used to identify W-bosons
 Analysis uses bins in jet and W multiplicities
 Limit: m_B > 480 GeV
- •arXiv:1202.6540 (submitted to PRL)



4th generation quarks 3/4

ATLAS search for $BB \rightarrow (Wt)(Wt) \rightarrow llX$ in 1.0 fb⁻¹

- •2 same-sign leptons, 2+ jets, high MET
- •Limit: *m*_B > 450 GeV
- •Also limits on same-sign tt production
- •arXiv:1202.5520 (submitted to JHEP)

CMS inclusive search for chiral Q in 1.1 fb⁻¹

•Assume $m_T = m_B$, CKM4: $V_{TB} = V_{tb} \equiv A$ •Require 1 muon (trigger) and 1 b-jet •Classify events by b-tag and W multiplicities •Limit set in $A-m_Q$ plane, $m_Q > 490$ GeV •CMS PAS EXO-11-054

CMS search for $TT \rightarrow (Zt)(Zt)$ in 1.1 fb⁻¹

- •Require 3 leptons (2 with Z mass), 2+ jets
- •Limit: *m*_T > 475 GeV
- •PRL 107, 271802 (2011)





4th generation quarks 4/4

CMS search for $BB \rightarrow WtWt$ in **4.6 fb**⁻¹

- •3 leptons or 2 same-sign leptons plus a b-jet
- •Limit: *m_B* > 600 GeV
- •CMS EXO-11-036 Winter 2012

CMS search for $TT \rightarrow WbWb \rightarrow llX$ in **4.7 fb**⁻¹

- •Require 2 leptons, 2+ jets, high MET
- •Limit: *m_T* > 552 GeV
- •CMS EXO-11-050 Winter 2012

CMS search for $TT \rightarrow WbWb \rightarrow lX$ in **4.7 fb**⁻¹

Require 1 lepton, 4 jets, 1 b-tag and MET
Limit: m_T > 560 GeV

• CMS PAS FXO-11-099







ttbar resonance

ATLAS search of the dilepton channel in 1.0 fb⁻¹

- •Low mass—down to 400 GeV
- •Limit near m > 900 GeV on the RS KK gluon
- •ATLAS-CONF-2011-123

CMS search of the electron+jets channel in 4.3 fb⁻¹

• Model-independent limits for 1% width:

 $-\sigma B$ < 2.51 pb for m > 1 TeV $-\sigma B$ < 0.62 pb for m > 2 TeV •CMS PAS EXO-11-092









Heavy Neutrinos



In LRSM, these appear as right-handed partners of the light neutrinos

- • $qq \rightarrow W_R \rightarrow Nl \rightarrow W_R^* ll \rightarrow lljj$
- •Leading to a mass resonance both *ljj* and *lljj*

ATLAS searched in 2.1 fb⁻¹

- •Assume similar masses for N_e and N_{μ}
- •Limit: *m*_{WR} > 2.3 TeV
 - $-for (m_{WR} m_N) < 300 \text{ GeV}$
- •Separate limits for Dirac and Majorana
 - -But very similar results.
- •Limits also set on an effective operator model
- •ATLAS Preliminary

CMS searched in 240 pb⁻¹

- •Limits extend to about m_{WR} > 1.6 TeV
- $\bullet Separate limits for e and <math display="inline">\mu$
 - -Similar results for the two flavors
- •CMS PAS EXO-11-002





ttbar I+jets

CMS search of the lepton+jets channel in 4.7 fb⁻¹

•Leptophobic topcolor *Z*' limits:

- $-m_{Z'}$ > 1.3 TeV for narrow resonance
- $-m_{Z'}$ > 1.7 TeV for 10% width
- •KK gluon: m_{gKK} > 1.4 TeV •CMS PAS TOP-11-009





ttbar I+jets ATLAS

RS model: m(KK gluon) > 1025 GeV

Leptophobic top color Z': $m_{z'} > 860 \text{ GeV}$

Preliminary





ttbar resonance all-jets



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Many objects

Mícroscopic black-holes decaying through Hawking Radiation

The decay is democratic and isotropic. Likely large multiplicity of particles \rightarrow look for (many) jets and leptons at high mass Inclusive search: sum energy of all objects (e, μ , jets)







CMS Limits



Quantum Black Holes: 3.8 – 5.2 TeV

String Balls: 4.6 – 4.8 TeV

Published: 10.1007/JHEP04(2012)061



ATLAS-CONF-2012-038

<i>n</i> extra	Expected	Observed
dimensions	limit (TeV)	limit (TeV)
2	3.82	3.79
3	3.95	3.93
4	4.03	4.01
5	4.09	4.06
6	4.14	4.11
7	4.18	4.15

Lower limits at 95% C.L. on M_D of the QBH model with n=2 to 7 extra dimensions.

The 95% C.L. upper limits on $\sigma \times A$ as function of the reduced Planck mass M of the QBH model using F(m) (black filled circles). The D black dotted curve shows the 95% C.L. upper limit expected from Monte Carlo and the light and dark yellow shaded bands represent the 68% and 95% contours of the expected limit, respectively. Theoretical predictions of $\sigma \times A$ are shown for various numbers of extra dimensions.







Summary

- We have many new results!
- Excellent performance of CMS and ATLAS
- No evidence of new physics yet
- It's only the beginning
- CMS and ATLAS are expected to have ~30 fb⁻¹ combined from 8 TeV Collision by the end of 2012 and as of today, we have started to have some fun with more than 2 fb⁻¹ at 8 TeV
- We are very productive producing new results even our universe needs to expand



More talks about New Physics at Pheno 2012 (CMS)

- Search for Heavy Stable Charged Particles at CMS Speaker: Venkatesh Veeraraghavan (Florida State Univ.)
- Recent results from a search for Dark Matter production in the CMS experiment Speaker: Shruti Shrestha (Kansas State Univ.)
- Diboson physics at CMS Speaker: Irakli Svintradze (Kansas State Univ.)
- Measurement of Drell-Yan Cross Section Speaker: Alexey Svyatkovskiy (Purdue Univ.)
- Search for Fourth Generation Top-Like Quarks at CMS Speaker: Michael Luk (Brown Univ.)
- Study of the di-jet mass spectrum in association with a W boson Speaker: Jake Anderson (FNAL.)
- Search for Supersymmetry in Events with Photons and Missing Transverse Energy Speaker: Yueh-Feng Liu (Carnegie Mellon Univ.)
- Search of new physics in the top quark sector Speaker: Victor Eduardo Bazterra (Univ. of Illinois at Chicago)
- Search for contact interactions in the dimuon final state at CMS Speaker: Sowjanya Gollapinni (Wayne State)
- A Search for New Physics in Events with Jets and Missing Energy in pp Collisions at 7 TeV Speaker: Hongxuan Liu (Baylor University)



More talks about New Physics at Pheno 2012 (ATLAS)

- BSM Higgs searches at ATLAS GOUSSIOU, Anna
- Jet Production Measurements with ATLAS FAROOQUE, Trisha
- **Diboson production and TGCs from ATLAS** JEANTY, Laura
- **Direct Photons at ATLAS** CAPUTO, Regina
- Inclusive searches for supersymmetric signatures with the ATLAS detector HARPER, Devin
- Searches for third generation squarks with the ATLAS detector BUTLER, Bart
- Search for long-lived massive particles with the ATLAS detector MARINO, Christopher
- **Top quark pair production cross-section with ATLAS** Mr. URBANIEC, Dustin Henry
- **Physics with Tau Lepton Final States in ATLAS** MORGENSTERN, Marcus Matthias
- **Top Quark Pair Properties** with ATLAS Dr. KAUSHIK, Venkat
- Searches for direct supersymmetric gaugino production and R-parity violation in final states with leptons with the ATLAS detector OKAWA, Hideki



GRAND SUMMARY MORIOND 2012



		ATLAS Exotics Searches	* - 95% CL Lower Limits (Statu	us: Moriond	QCD 2012)		
	Large ED (ADD) : monojet	L=1.0 fb ⁻¹ (2011) [ATLAS-CONF-2011-096]	<u>3.2 TeV</u> Μ _D (δ=2)	•			
	Large ED (ADD) : diphoton	L=2.1 fb ⁻¹ (2011) [1112.2194]	<u>з.о теу</u> <i>М_S</i> (GRW си	ut-off)	ATLAS		
S	$UED : \gamma\gamma + E_{\tau,miss}$	L=1.1 fb ⁻¹ (2011) [1111.4116]	1.23 TeV Compact. scale 1/R (SPS	S8)	Preliminary		
ion	RS with $k/M_{\rm Pl} = 0.1$: diphoton, $m_{\gamma\gamma}$	L=2.1 fb ⁻¹ (2011) [1112.2194]	1.85 TeV Graviton mass				
sue	RS with $k/M_{\rm Pl} = 0.1$: dilepton, $m_{\rm H}$	L=4.9-5.0 fb ⁻¹ (2011) [ATLAS-CONF-2012-007]	2.16 TeV Graviton mass	$\int dt = 0$	04 5 0) fb ⁻¹		
lime	RS with $k/M_{Pl} = 0.1$: ZZ resonance, $m_{IIII / IIII}$	L=1.0 fb ⁻¹ (2011) [1203.0718]	845 Gev Graviton mass	$\int Ldt = (0)$.04 - 5.0) 10		
ä	RS with g_{gagKK}/g_s =-0.20 : tt \rightarrow l+jets, m_{t}	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-029]	1.03 Tev KK gluon mass	-	s = 7 TeV		
Xt	ADD BH $(M_{TH}^{quiv})M_{D}=3)$: multijet, Σp_{τ} , N_{jets}^{u}	L=35 pb ⁻¹ (2010) [ATLAS-CONF-2011-068]	1.37 TeV Μ _D (δ=6)				
Ч	ADD BH ($M_{TH}/M_{D}=3$) : SS dimuon, $\dot{N}_{ch. part.}$	L=1.3 fb ⁻¹ (2011) [1111.0080]	1.25 TeV <i>M_D</i> (δ=6)				
	ADD BH (M_{TH}/M_D =3) : leptons + jets, Σp_{τ}	L=1.0 fb ⁻¹ (2011) [ATLAS-CONF-2011-147]	1.5 TeV M _D (δ=6)				
	Quantum black hole : dijet, $F_{y}(m_{ij})$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	4.11 TeV <i>M_D</i> (δ=6	i)			
	qqqq contact interaction $\hat{\chi}(m_{ij})$	L=4.8 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	7.8 TeV	Λ			
Ū	qqll CI : ee, $\mu\mu$ combined, \ddot{m}_{μ}	L=1.1-1.2 fb ⁻¹ (2011) [1112.4462]	10.2 T	ev Λ (constructiv	/e int.)		
	uutt CI : SS dilepton + jets + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [1202.5520]	1.7 TeV Λ		-		
	SSM Z' : m _{ee/uu}	L=4.9-5.0 fb ⁻¹ (2011) [ATLAS-CONF-2012-007]	2.21 TeV Z' mass				
2	SSM W': m _{Te/u}	L=1.0 fb ⁻¹ (2011) [1108.1316]	2.15 TeV W' mass				
ГQ	Scalar LQ pairs (β =1) : kin. vars. in eeji, evji	L=1.0 fb ⁻¹ (2011) [1112.4828]	660 Gev 1 st gen. LQ mass				
	Scalar LQ pairs ($\beta=1$) ; kin. vars. in uuii, uvii	L=1.0 fb ⁻¹ (2011) [Preliminary]	685 Gev 2 nd gen. LQ mass				
	4^{th} generation : Q $\overline{Q} \rightarrow WgWg$	L=1.0 fb ⁻¹ (2011) [1202.3389] 350 GeV	Q, mass				
arks	4^{th} generation : 4^{th} \overline{u}^{4} \rightarrow WbWb	L=1.0 fb ⁻¹ (2011) [1202.3076] 404 GeV	u, mass				
duś	4^{th} deneration : 4^{4} $\frac{4}{d}$ \rightarrow WtWt	L=1.0 fb ⁻¹ (2011) [Preliminary] 480 G	ev d, mass		ca		
Μ	New quark b' : b'b' \rightarrow Zb+X, m_	L=2.0 fb ⁻¹ (2011) [Preliminary] 400 GeV	b' mass		oti		
Ž	$TT \rightarrow tT + A A - 1-lep + iets + F$	L=1.0 fb ⁻¹ (2011) [1109.4725] 420 GeV	\sqrt{T} T mass (m(A) < 140 GeV)		X I		
ĥ	Excited quarks γ-jet resonance, m	L=2.1 fb ⁻¹ (2011) [1112.3580]	2.46 TeV 0* Mass		E C		
feri	Excited guarks : dijet resonance, $m_{\mu}^{y p t}$	/ =4.8 fb ⁻¹ (2011) [ATLAS-CONE-2012-038]	3.35 TeV 0* mass		AS		
зіt.	Excited electron : e_{γ} resonance, m	$I = 4.9 \text{ fb}^{-1}$ (2011) [ATLAS-CONE-2012-023]	20 TeV e [*] mass ($\Lambda = m(e^{2})$	*))	ac -L		
Ж	Excited muon : μ - γ resonance, $m^{e_{\gamma}}$	$l = 4.8 \text{ fb}^{-1}$ (2011) [ATLAS CONF-2012-023]	19 TeV μ^* mass ($\Lambda = m(\mu^*)$))	BAT		
	Techni-hadrons : dilepton. m	l = 11.12 (20.11) [ATLAS-CONF-2011-125] 470 G	$m_{\mu\nu} = 100 \text{ G}$	ieV)	iri,		
	Techni-hadrons : WZ resonance (vIII), m	/ -1 0 fb ⁻¹ (2011) [Preliminary] (123 f	$(m(p_1, m_1) + m_1, m(a)) = m(\pi) + m_1, m(a) = 10000$	= 1.1 m(0)	en c		
	Maior neutr (LRSM no mixing) · 2-len + iets	(-2.1 fh ⁻¹ (2011) [Preliminary]	$p_T = m_{W_T} (m_V) = m_{W_T} (m_V) = 2 T_V$	eV)	ES)		
<u>j</u>	W_{-} (LRSM_no mixing) : 2-lep + jets	l = 2.1 fb ⁻¹ (2011) [Preliminary]	$(m(N)_R) = 2 M$	(< 1.4 GeV)	t b		
)th	$H_{\mu}^{\pm\pm}$ (DY prod., BR($H^{\pm\pm} \rightarrow uu$)=1) ; SS dimuon. m	/ =1.6 fb ⁻¹ (2011) [1201 1091]	H ^{±±} mass		ou		
0	Color octet scalar : dijet resonance. m.	L=0.0 (2011) [1201.1001] 355 GeV		mass	Ú >		
	Vector-like quark · CC m	/-1.0.fb ⁻¹ (2011) [1112 5755]	$0 \text{ mass} (\text{coupling}_{K} - w/\text{m})$)	B		
	Vector-like quark : NC. m.	$L = 1.0 \text{ m}^{-1}$ (2011) [1112.5755]	α mass (coupling $\kappa_{qQ} = v/m_Q$,			
		10 ⁻¹	1	10	10		
	Mass scale [Te\/]						
*0	*Only a selection of the available mass limits on new states or of the head to be a state of the head to be available mass limits on new states or of the head to be available mass limits on new states or of the head to be available mass limits on						

5/7/12 *Only a selection of the available mass limits on new states or phankmastor wahmat U. Mississippi 43

ATLAS



	MSUGRA/CMSSM : 0-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033]	40 TeV $\tilde{q} = \tilde{g}$ mass		
Inclusive searches	MSUGRA/CMSSM : 1-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-041] 1.20	TeV $\tilde{q} = \tilde{g}$ mass $\int Ldt = (0.03 - 4.7)$ fb		
	MSUGRA/CMSSM : multijets + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-037] 850 GeV	\tilde{g} mass (large m_0) $s = 7 \text{ TeV}$		
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033] 1.3	18 TeV \widetilde{q} mass $(m(\widetilde{g}) < 2$ TeV, light $\widetilde{\chi}_1^0$ ATLAS		
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033] 940 GeV	\tilde{g} mass $(m(\tilde{q}) < 2 \text{ TeV}, \text{ light } \tilde{\chi}_1^0)$ Preliminary		
	Gluino med. $\widetilde{\chi}^{\pm}$ ($\widetilde{g} \rightarrow q \overline{q} \widetilde{\chi}^{\pm}$) : 1-lep + j's + $E_{T, miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-041] 900 GeV	\widetilde{g} mass $(m(\widetilde{\chi}_1^0) < 200 \text{ GeV}, m(\widetilde{\chi}^{\pm}) = \frac{1}{2}(m(\widetilde{\chi}^0) + m(\widetilde{g}))$		
	GMSB : 2-lep OS _{SF} + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [ATLAS-CONF-2011-156] 810 GeV	\tilde{g} mass (tan $\beta < 35$)		
	$GMSB: 1-\tau + j's + E_{\tau,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-005] 920 GeV	\tilde{g} mass (tan β > 20)		
	$GMSB: 2-\tau + j's + E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-002] 990 GeV	\widetilde{g} mass (tan β > 20)		
	$GGM: \gamma\gamma + E_{\tau,miss}$	L=1.1 fb ⁻¹ (2011) [1111.4116] 805 GeV	\tilde{g} mass ($m(\tilde{\chi}_1^0) > 50$ GeV)		
d generation	Gluino med. \tilde{b} ($\tilde{g} \rightarrow b \bar{b} \tilde{\chi}^0_{\downarrow}$) : 0-lep + b-j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-003] 900 GeV	\tilde{g} mass $(m(\tilde{\chi}_1^0) < 300 \text{ GeV})$		
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t\bar{t} \tilde{\chi}_{1}^{0}$) : 1-lep + b-j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-003] 710 GeV 👸 ľ	mass $(m(\tilde{\chi}_{1}^{0}) < 150 \text{ GeV})$		
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t\bar{t}\chi_{1}^{0}$) : 2-lep (SS) + j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-004] 650 GeV \widetilde{g} M	ass $(m(\tilde{\chi}_1^0) < 210 \text{ GeV})$		
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t \bar{t} \tilde{\chi}^{0}_{1}$) : multi-j's + $E_{T, miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-037] 830 GeV	\tilde{g} mass $(m(\tilde{\chi}_1^0) < 200 \text{ GeV})$		
Third	Direct \widetilde{bb} ($\widetilde{b}_1 \rightarrow b \widetilde{\chi}_1^0$) : 2 b-jets + $E_{T,\text{miss}}$	L=2.1 fb ⁻¹ (2011) [1112.3832] 390 GeV b mass (m	$p(\tilde{\chi}_1^0) < 60 \text{ GeV}$		
	Direct $\widetilde{t}\widetilde{t}$ (GMSB) : Z(\rightarrow II) + b-jet + $E_{T \text{ miss}}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-036] 310 GeV t mass (115 <	$< m(\tilde{\chi}_1^0) < 230 \text{ GeV})$		
G	Direct gaugino $(\tilde{\chi}^{\pm}_{1}\tilde{\chi}^{0}_{2} \rightarrow 3I \tilde{\chi}^{0}_{1})$: 2-lep SS + $E_{T,\text{miss}}$	L=1.0 fb ⁻¹ (2011) [1110.6189] 170 GeV $\widetilde{\chi}_1^{\pm}$ mass $((m(\widetilde{\chi}_1^0) < 40)$	$0 \text{ GeV}, \widetilde{\chi}_1^0, m(\widetilde{\chi}_1^{\pm}) = m(\widetilde{\chi}_2^0), m(\widetilde{l}, \widetilde{\nu}) = \frac{1}{2}(m(\widetilde{\chi}_1^0) + m(\widetilde{\chi}_2^0)))$		
Ω	Direct gaugino $(\widetilde{\chi}_{1}^{\pm}\widetilde{\chi}_{2}^{0} \rightarrow 3I \widetilde{\chi}_{1}^{0})$: 3-lep + $E_{T,\text{miss}}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-023] 250 GeV $\widetilde{\chi}_{1}^{\pm}$ mass $(m(\widetilde{\chi}_{1}^{0}))$	< 170 GeV, and as above)		
θ	AMSB : long-lived $\widetilde{\chi}_1^{\pm}$	L=4.7 fb ⁻¹ (2011) [CF-2012-034] $\widetilde{\chi}_{1}^{\pm}$ mass $(1 < \tau(\widetilde{\chi}_{1}^{\pm}) < 2 \text{ ns},$	90 GeV limit in [0.2,90] ns)		
rticl	Stable massive particles (SMP) : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 562 GeV g mas	SS		
d pa	SMP : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 294 GeV b mass			
live	SMP : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 309 GeV t mass			
-bu	SMP : R-hadrons (Pixel det. only)	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-022] 810 GeV	j mass		
ΓC	GMSB : stable $\tilde{\tau}$	L=37 pb $^{-1}$ (2010) [1106.4495] 136 GeV $\widetilde{ au}$ Mass			
	RPV : high-mass eμ	L=1.1 fb ⁻¹ (2011) [1109.3089] 1.32	2 TeV \tilde{v}_{τ} mass (λ'_{311} =0.10, λ_{312} =0.05)		
PV	Bilinear RPV : 1-lep + j's + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [1109.6606] 760 GeV q	$= \tilde{g} \text{ mass } (c\tau_{ISP} < 15 \text{ mm})$		
	MSUGRA/CMSSM - BC1 RPV : 4-lepton + E _{T,miss}	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-035]	1.77 TeV g mass		
	Hypercolour scalar gluons : 4 jets, $m_{ij} \approx m_{kl}$	L=34 pb ⁻¹ (2010) [1110.2693] 185 GeV sgluon mass (excl: n	n _{sq} < 100 GeV, <i>m</i> _{sg} ≈ 140 ± 3 GeV)		
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Mass scale [TeV]

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