Searches for supersymmetry in resonance production, R-parity violating signatures and events with long-lived particles with the ATLAS detector

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19th International Symposium on Particles, Strings, and Cosmology (PASCOS 2013)

Outline

- * R-Parity Violating (RPV) SUSY searches:
 - * Four or more leptons
 - * Two same-sign leptons and jets
 - * Heavy narrow resonance searches decaying to $e \mu$, $e \tau$ or $\mu \tau$
 - * Multi-jet resonances searches:
 - * Pair-produced of massive particles decaying to multijets
- * Long-Lived Particle searches:
 - * Non-pointing photons in diphoton ET^{miss} final state
 - Muons and multitrack displaced vertex final states
 - * Charginos based on a disappearing tracks signature
 - * Heavy long-lived sleptons
 - Stopped gluinos R-Hadrons

R-Parity Violating (RPV) SUSY Searches

- * Many SUSY models assume R-parity conservation (RPC), where $R = (-1)^{2S + 3B + L}$,
 - * Lepton and baryon number violation forbidden
 - * Stable lightest SUSY particle (LSP) -> dark matter candidate
- * There is no experimental evidence forbidding a RPV potential for which either the lepton or baryon number is conserved

$$L_{RPV} = \lambda_{ijk} L_i L_j \overline{E_k} + \lambda'_{ijk} L_i Q_j \overline{D_k} + \kappa_i L_i H_2 + \lambda''_{ijk} U_i \overline{U}_j \overline{D_k}$$

lepton number violating

baryon number violating

- * The stability of the proton forbids simultaneous lepton and baryon number violation
- * We search for both multi-leptonic and multi-jet final states

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Four or more leptons search, RPV, 20.7 fb⁻¹

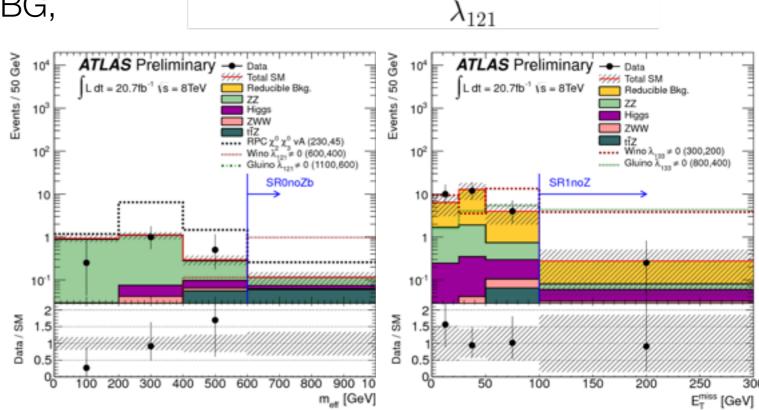
ATLAS-CONF-2013-036

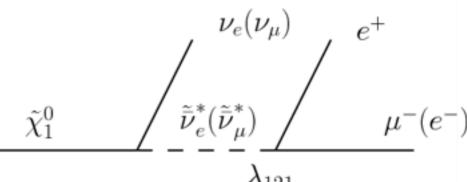
- High lepton multiplicity can be indicative of lepton violating SUSY
- After event selection there is a high signal to background (BG) ratio (low SM BG, mainly WZ and ZZ)
- **Event Selection Criteria**
 - Inclusive single and double electron and muon triggers
 - \geq 4 leptons ($p_T^{min} > 10 \text{ GeV}$), \geq 1(2) above the trigger p_T^{min}
 - Z Candidate veto
 - 2 Signal regions

- Irreducible BGs (4 real leptons)
are estimated from MC

- Reducible BGs (>1 fake lepton) are estimated from DATA

SR	$N_{(e,\mu)}$	$N(\tau)$	E_{miss}^{T} or $m_{eff}[GeV]$
SR0noZ _b	≥ 4	= 0	> 75 or > 600
SR1noZ	= 3	$\geqslant 1$	> 100 or > 400

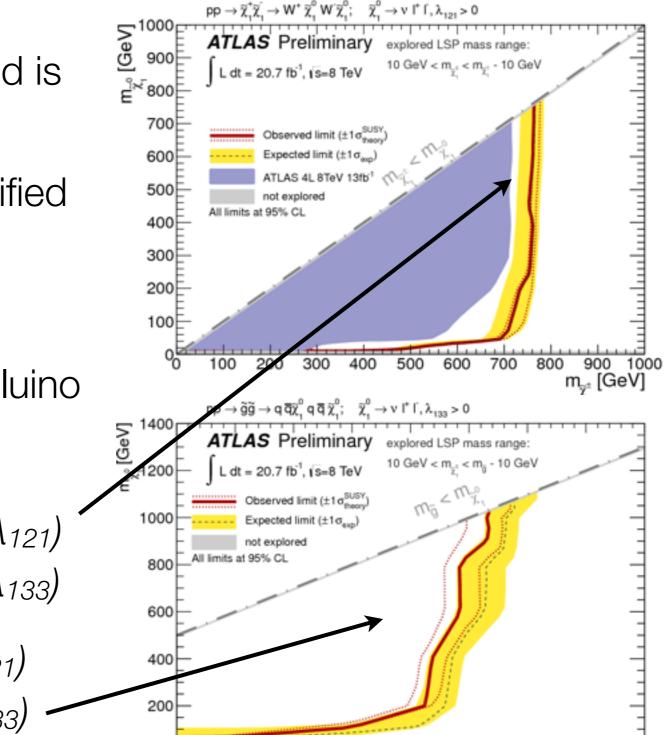




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Four or more leptons search, RPV, 20.7 fb⁻¹

- No excess over SM background is observed
- * Results are interpreted in simplified SUSY models with \geq 1 NLSP
 - LSP: Bino-like neutralino
 NLSP: Wino charginos, lefthanded sleptons, sneutrinos, gluino
- * Exclusion Limits:
 - * Chargino excl: ~ 750 GeV (λ₁₂₁)
 ~ 400 GeV (λ₁₃₃)
 - * Gluino excl: ~ 1400 GeV (λ₁₂₁)
 ~ 1000 GeV (λ₁₃₃)



800

700

900

1000

1100

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1200

m_a [GeV]

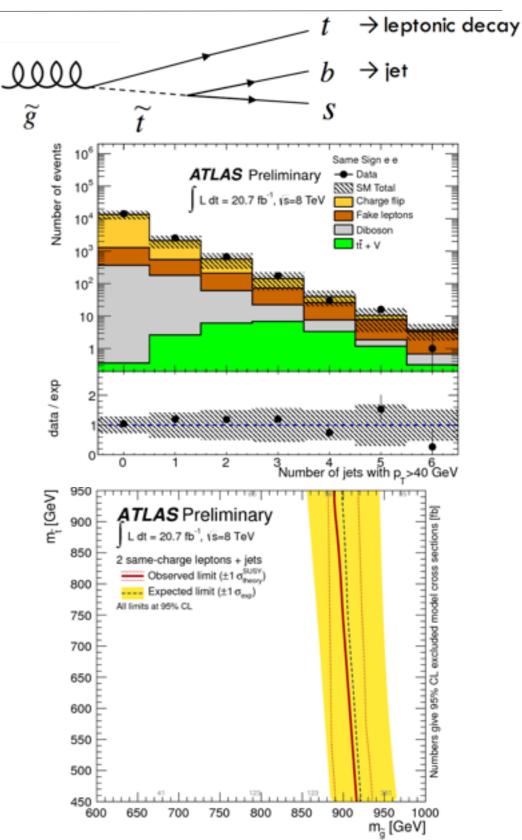
1300

ATLAS-CONF-2013-007

Two same-sign leptons and jets, RPV, 20.7 fb⁻¹

- * Same-sign leptons events are rare in SM
 → low background scenario
- * RPV scenario:
 - gluino pair production,
 gluino decays to *tt* pair
 - * assume only one RPV and baryon number violating term, $\lambda''_{323} = 1$ therefore $t \rightarrow b s$
 - Same-sign lepton combinations come from the leptonic decay of the top quark
- * Signal region:
 - * 2 same sign light leptons (e/ μ),
 - * \geq 3 b-jets, \geq 5 jets
 - * $E_T^{miss} < 150 \text{ GeV} \text{ or } m_T < 100 \text{ GeV}$

 $m_{\tilde{g}} \lesssim 860 \; GeV$ excluded for stop mass up to 1 TeV



Phys. Lett. B 723 (2013) 15-32

Heavy resonances decaying to: eµ, et, µt, 4.6 fb^{-1}

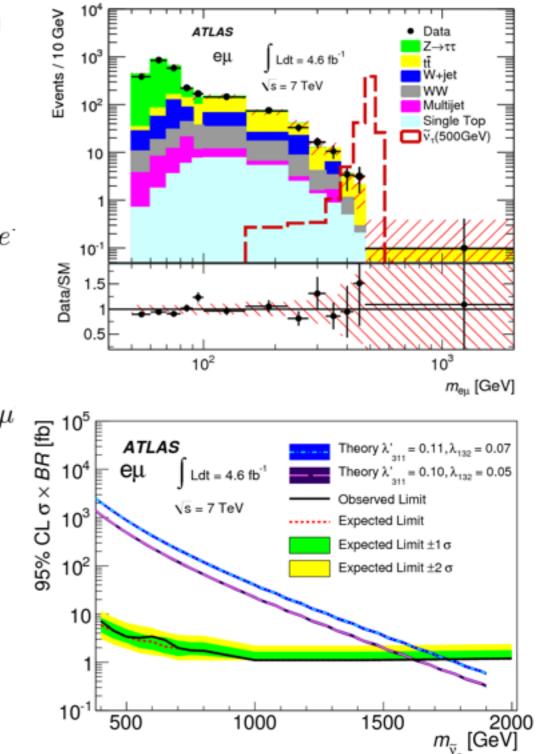
 λ'_{311}

 $\tilde{\nu}_{\tau}$

- Search for heavy particles decaying to di-lepton events with different flavour leptons and opposite sign
 - * Results interpreted for $v_{\tilde{\tau}}$ decays
- * Selection ($e \mu$ channel):
 - * Single lepton trigger
 - * *p*_T(*e*,μ) > 25 GeV
 - * Q(e) * Q(μ) < 0 , $\Delta \phi$ > 2.7
 - Search m_{II} spectrum for resonance

Limits: For a sneutrino mass of *500 (2000) GeV*, the production cross section times branching ratio:

e μ channel:	3.2	(1.4) fb
e τ channel:	42.0	(17.0) fb
$\mu \tau$ channel:	40.0	(18.0) fb



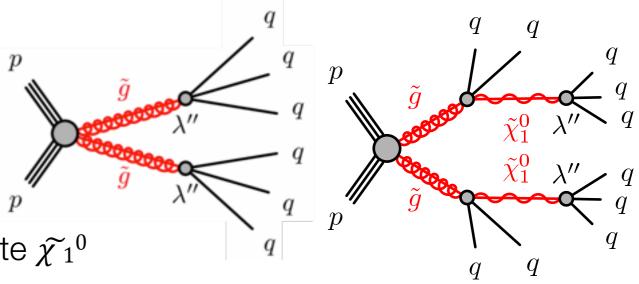
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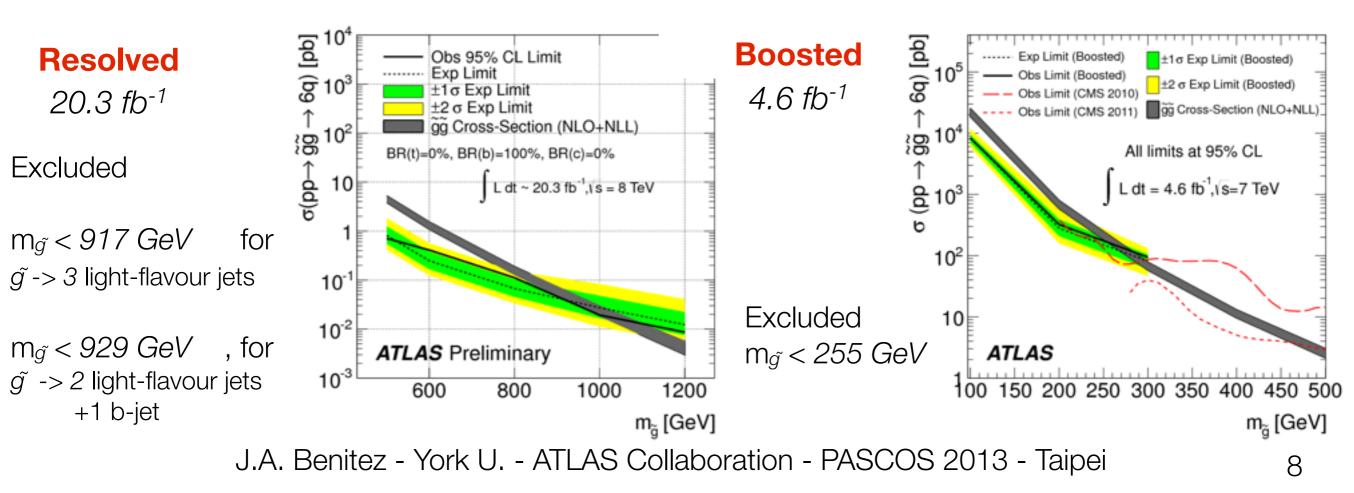
ATLAS-CONF-2013-091 JHEP12(2012)086

Pair-produced massive particles decaying to multi-jets

- RPV scenario: gluino decays into three quarks
- Two orthogonal search channels:
 - * High \tilde{g} mass: resolve all 6 jets (Resolved) p10 jets final state, intermediate $\tilde{\chi}_1^0$

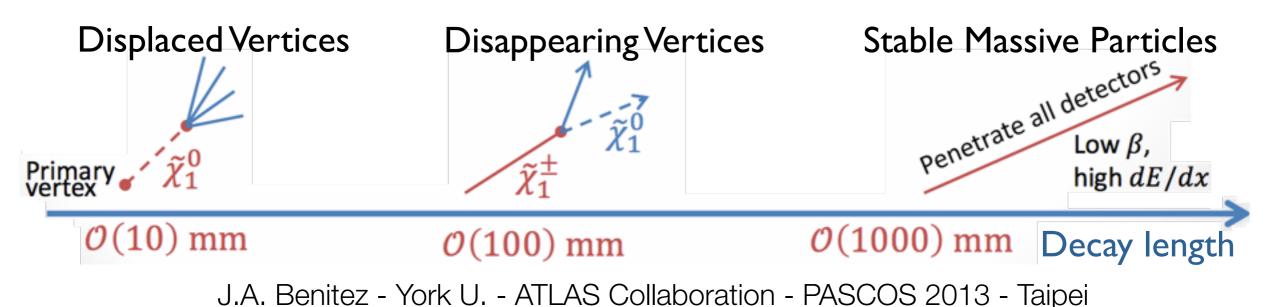


- * Low \tilde{g} mass: jets are boosted and difficult to resolve
 - reconstruct 2 large jet with substructure (Boosted)



Long-Lived Particles

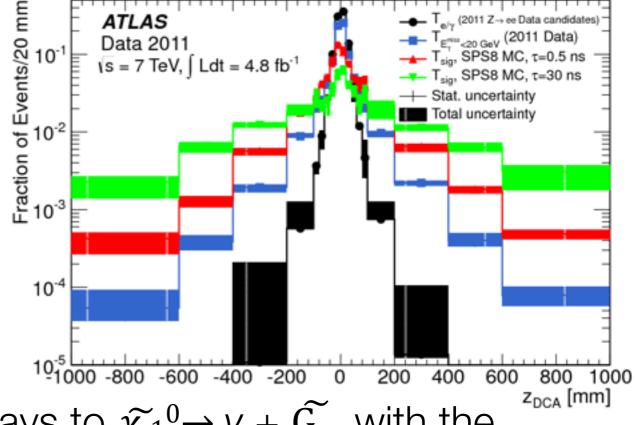
- * RPV scenarios:
 - * Lifetime proportional to λ^{-2} , $\lambda^{\prime-2}$, $\lambda^{\prime-2}$
 - * if λ is small, LSP can have a long lifetime
- * RPC scenarios:
 - * Slow NLSP decay to LSP due to mass degeneracy, weak coupling or virtual heavy mediator particles
 - * Chargino in Anomaly-Mediated SUSY Breaking (AMSB) model
 - * R-hadron in Split SUSY model
 - * stau in Gauge-Mediated SUSY Breaking (GMSB) model



Non-pointing photons in diphoton Etmiss final state, 4.8 fb-1

- Results are presented in the context of SPS8, for a minimal GMSB model
- * SUSY production is dominated by electroweak pair production of gauginos, and, in particular: $\tilde{\chi}_2^0 \tilde{\chi}_1^{\pm}$ and $\tilde{\chi}_1^+ \tilde{\chi}_1^-$

photon's degree of non-pointing

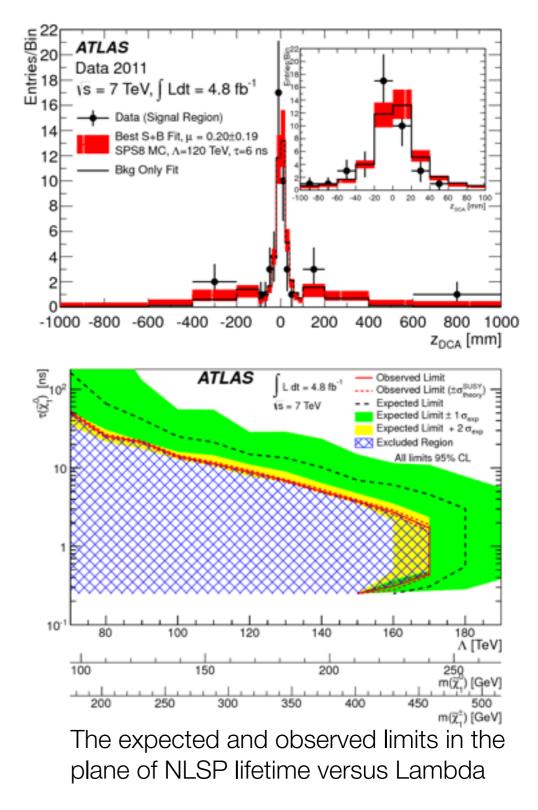


- * NLSP: $\chi _1^0$ it is long-lived and decays to $\chi _1^0 \rightarrow \gamma + \tilde{G}$, with the photon being produced after a finite delay and with a flight direction that does not point back to the primary vertex
- * The search is performed by fitting the shape of the z_{DCA} ($z_{DCA} = z_{\gamma} z_{PV}$) for the diphoton events with $E_T^{miss} > 75$ GeV (Signal Region) to a combination of templates

Non-pointing photons in diphoton Etmiss final state, 4.8 fb-1

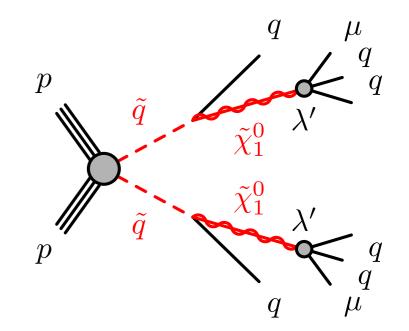
- Analysis: Select tight-loose diphoton events, tag with the tight photon and probe timing and pointing with the loose photon
- * Background estimation:
 - * Control region $E_T^{miss} < 20$ GeV, obtain jet background shape
 - * From data $Z \rightarrow ee$ Obtain prompt e/γ background shape

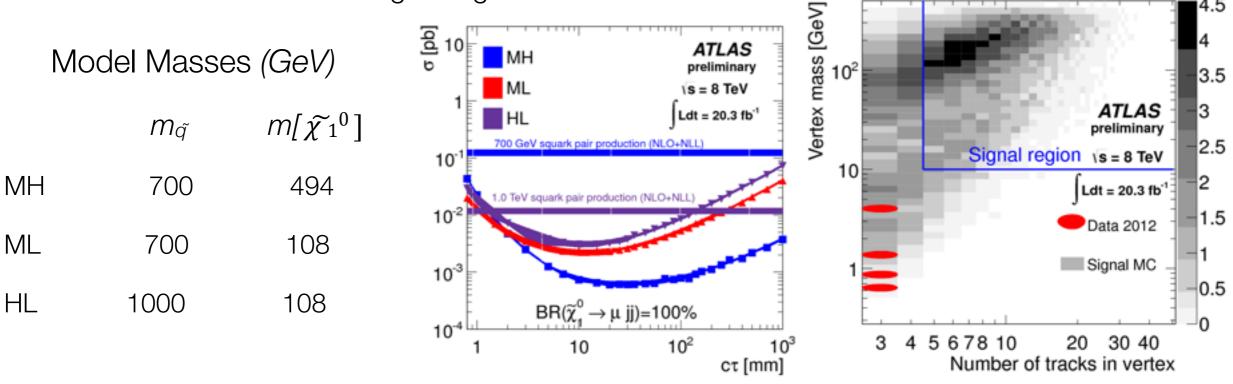
No significant evidence of non-pointing photons is observed.
 For A > 70 GeV (160 TeV), NLSP lifetimes between 0.25 ns and 50.7 ns (2.7 ns) are excluded at 95% C.L.



Muons and multitrack displaced vertex final states, 20.3 fb⁻¹

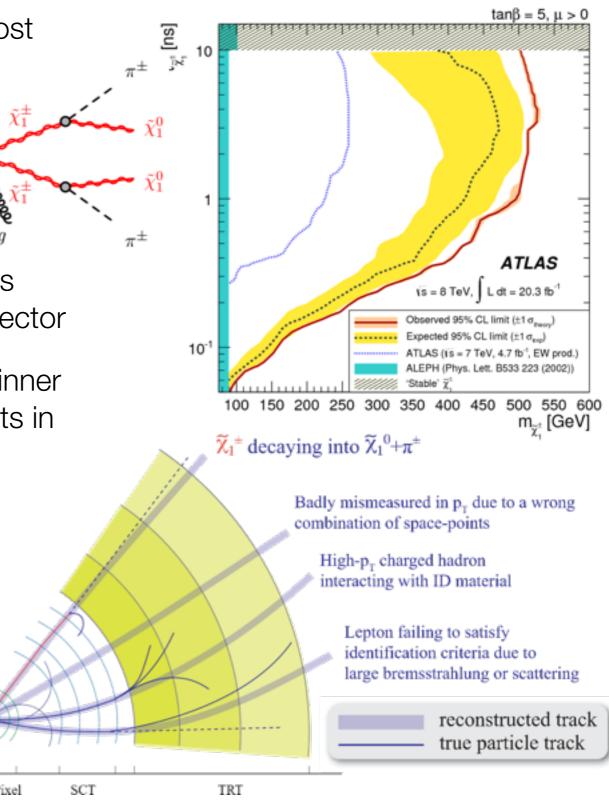
- * RPV scenario: search for a heavy particles that decay at a radial distance between *4mm* and *180mm* from the interaction point. The particle decay produces multi-track (≥ 5) displaced vertex, and an associated muon with high p_T
- The LSP decays via a weak RPV coupling to produce two quarks and a muon
- Vertices from regions of the detector with high density material are vetoed to reduce the background from hadronic interactions.
- * The expected background is very low (0.02+/-0.02 events).
- No events are observed in the signal region





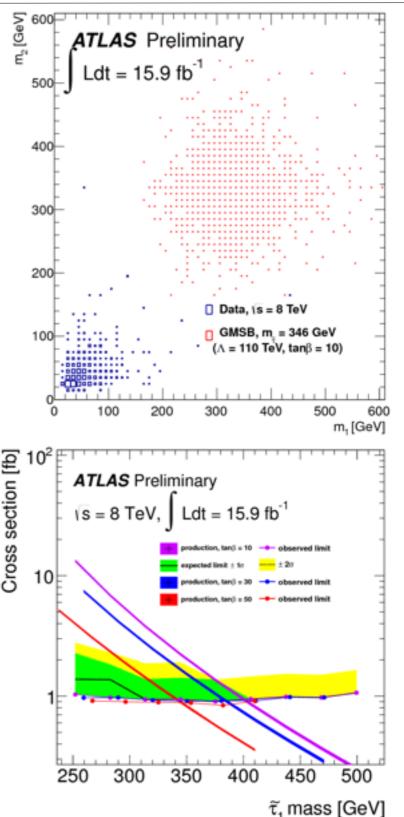
Direct chargino search - disappearing-tracks signatures, 20.3 fb⁻¹

- * In AMSB models, the lightest chargino $(\tilde{\chi}_1^{\pm})$ is almost mass degenerate with the lightest neutralino $\tilde{\chi}_1^0$ $\Delta m_{\tilde{\chi}_1} \sim 160 \text{ MeV}$ and $\tilde{\chi}_1^{\pm}$ life time O(0.1 ns) p_{χ_1}
- * $\widetilde{\chi_1}^{\pm}$ decays to $\widetilde{\chi_1}^0$ + low momentum π^{\pm}
- When decaying in the ATLAS detector,
 the chargino decays are expected to be observed as
 "disappearing tracks" inside the ATLAS tracking detector
- * **Strategy**: Look for well reconstructed tracks in the inner tracker (silicon detectors), but with low number of hits in the outer tracker.
- * The background is determined by a fit to the p_T spectrum of the disappearing tracks.
- No excess over SM background is observed
- * A new limit excluding charginos $m_{\tilde{\chi}1} < 270 \text{ GeV}$ at 95 % C.L. for $\Delta m_{\tilde{\chi}1} = 160 \text{ MeV}$ and $\tilde{\chi_1}^{\pm}$ life time 0.2 ns in AMSB models.



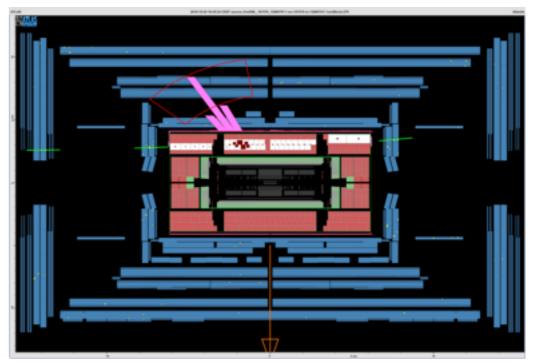
Search for long-lived sleptons, 16 fb⁻¹

- Interpretation of the results are given in the GMSB model with the stau (τ₁) being the NLSP. τ₁ decays outside the detector
- Long-lived τ₁ appear in the detector as if they are heavy muons
- * The $\tilde{\tau}_1$ mass is estimated using $m = p / (\gamma \beta)$
- * β is estimated using the time of flight (calorimeter and muon system). $\beta \gamma$ is estimated from the Silicon tracking detector
- * Small background, mainly composed of missmeasured solution that the background solution is the background of the background solution of the background solution is the background solution of the background so
- * signal regions: 1 tight candidate or 2 loose candidates
- * Results matched SM expectations, limits: $\tilde{\tau}_1$ mass = 402 - 347 GeV, for tan $\beta = 5 - 50$

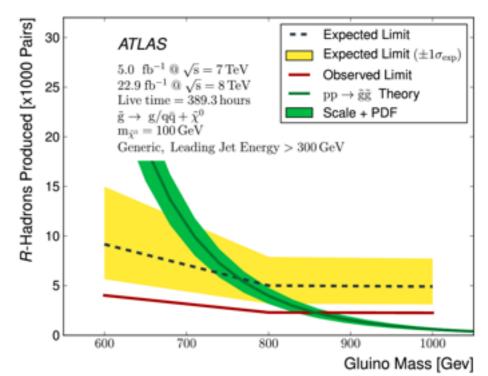


Stopped gluino R-hadron search 5.0 fb-1 @7 TeV 22.9 fb-1 @8 TeV

- Search for long-lived stopped g R-hadrons, beyond the time between bunches. (decay is associated with later bunch)
- * Selection:
 - Trigger on empty bunch crossings with calorimeter activity.
 - Leading jet: $|\eta| < 1.2$, $E_{jet} > 100$, 300 GeV
 - Muon activity veto
- Main backgrounds: Cosmic rays and beam halo
- * Data is consistent with the background
- * Limits: $m_{\tilde{g}} < 832 \text{ GeV}$ excluded, for $1 \ \mu \text{s} < \tau_{\tilde{g}} < 1000$ $m_{\tilde{g}} > 600 \text{GeV}$ excluded, for lifetimes of up to 2 years!
- * Also exclude long-lived stops and sbottoms (limits in backup slides)



This event passed all the selection criteria except for the muon segment veto



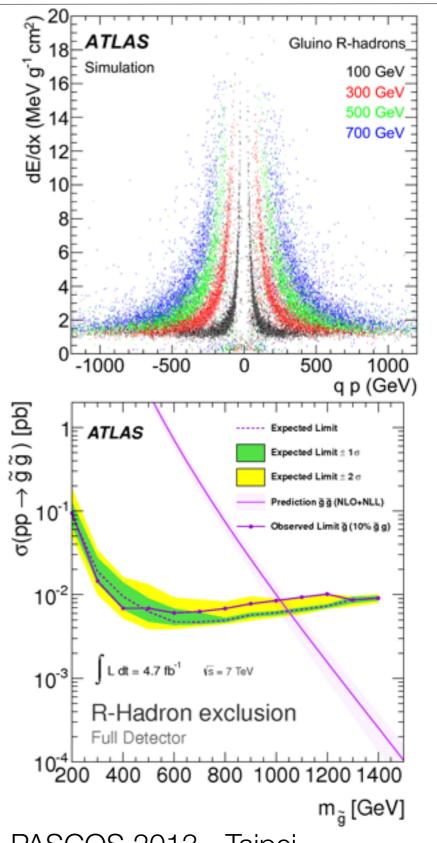
Outlook

- * The ATLAS collaboration has covered a comprehensive range of analysis for RPV, resonances and long-lived searches
- * These type of analyses require different strategies compared to other more conventional searches
- No excess over the SM background has been observed no evidence of SUSY so far
- * Limits in SUSY parameter space continues to expand

Backup Slides

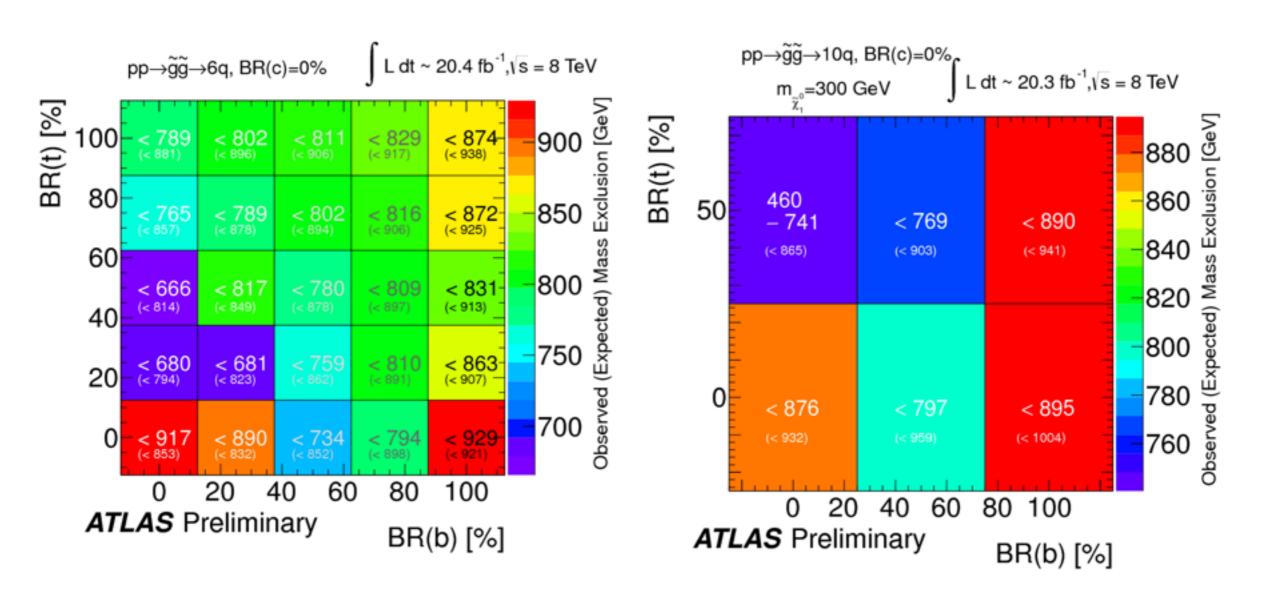
Search for long-lived RHadrons, 4.7 fb⁻¹

- R-hadrons are composites of a gluino or squark with SM partons
- R-Hadron charge can change during flight, and have a high energy loss
- Results are interpreted with the R-hadrons being stable throughout the ATLAS detector
- Strategy: three different R-hadron searches: "full detector", "MS-agnostic" and "ID-only"
- No indication of signal over expected backgrounds
- * R-hadrons are excluded for masses up-to 985 GeV, in "full detector" search



ATLAS-CONF-2013-091 JHEP12(2012)086

Pair produced massive particles decaying multi-jets

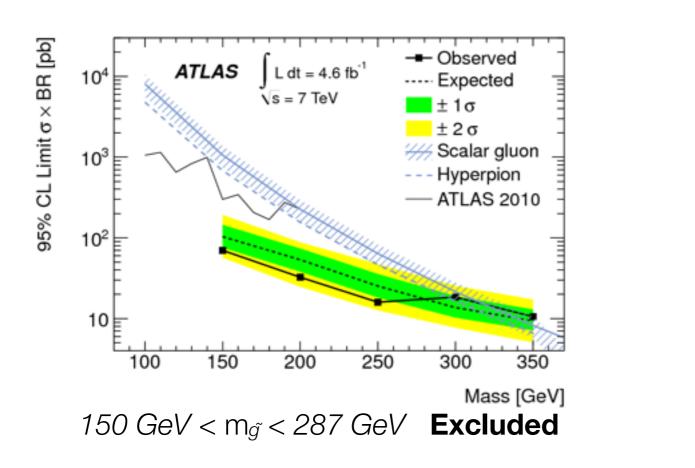


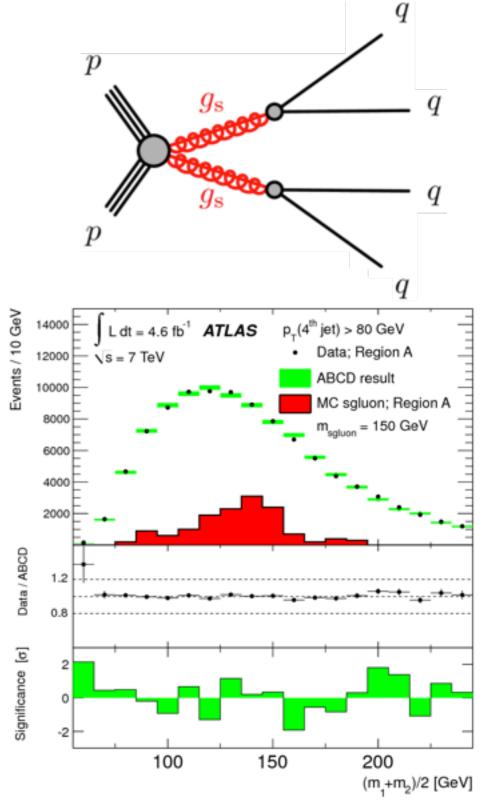
Resolved 20.3 fb⁻¹

Pair produced massive coloured scalar to four jet, 4.6 fb-1

- Models with massive scalars gluons (sgluons)
 gluon decays to 2-jet
- * Candidates are reconstructed based on jets with $\Delta R < 1$ and similar mass

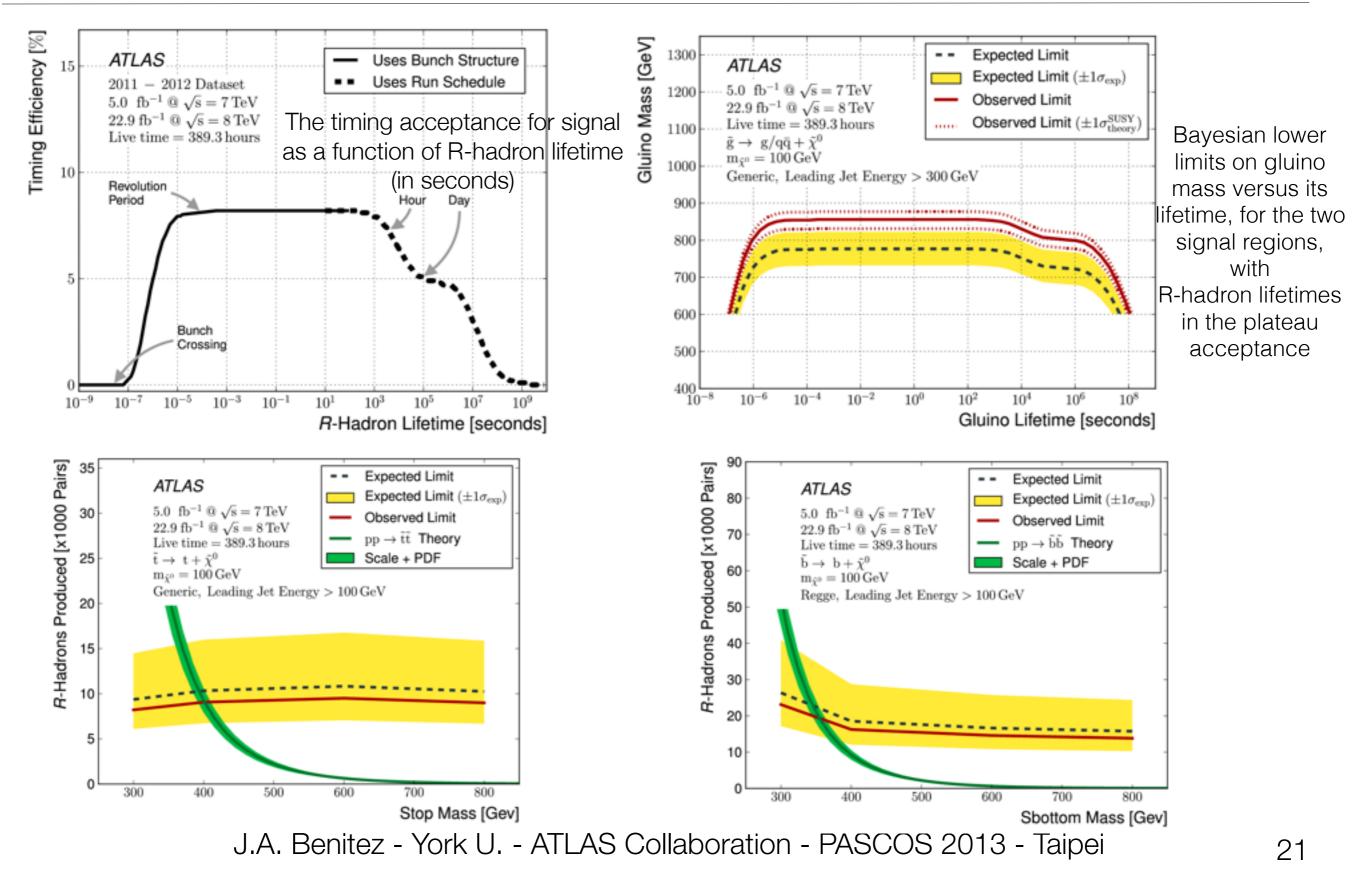
Signal region: $|m_1 - m_2|/(m_1 + m_2) < 0.15$ and $|\cos \theta^*| < 0.5$





arXiv:1310.6584

Stopped gluino R-hadron search 5.0 fb-1 @7 TeV 22.9 fb-1 @8 TeV



SUSY Searches

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: SUSY 2013

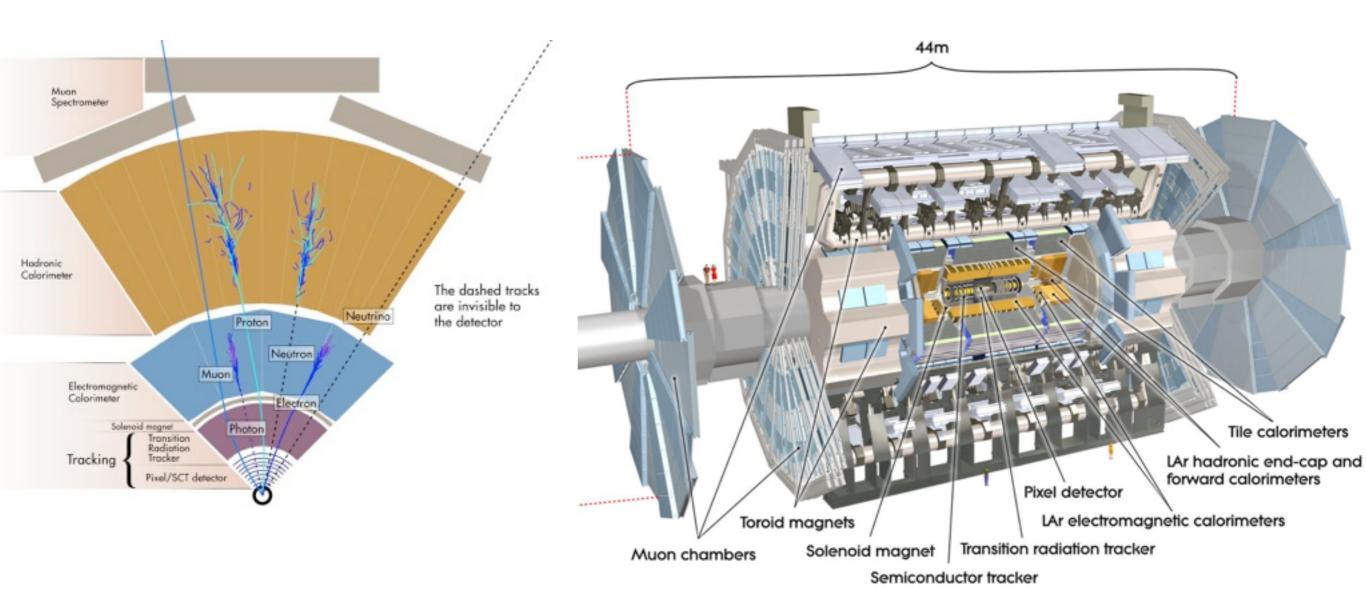
	Model	e, μ, τ, γ	Jets	$\mathbf{E}_{\mathrm{T}}^{\mathrm{miss}}$	∫£dt[ft	-1] Mass limit		Reference
Inclusive Searches	$\begin{array}{l} \text{MSUGRA/CMSSM} \\ \text{MSUGRA/CMSSM} \\ \text{MSUGRA/CMSSM} \\ \tilde{q}\tilde{q}, \tilde{q} \rightarrow q \tilde{\tilde{\chi}}_{1}^{0} \\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow q \tilde{q} \tilde{\tilde{\chi}}_{1}^{0} \\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow q q \tilde{\tilde{\chi}}_{1}^{0} \\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow q q \tilde{\tilde{\chi}}_{1}^{0} \rightarrow q q W^{\pm} \tilde{\tilde{\chi}}_{1}^{0} \\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow q q (\ell/(\nu/\nu)) \tilde{\tilde{\chi}}_{1}^{0} \\ \text{GMSB} (\tilde{\ell} \text{ NLSP}) \\ \text{GMSB} (\tilde{\ell} \text{ NLSP}) \\ \text{GGM (bino NLSP)} \\ \text{GGM (wino NLSP)} \\ \text{GGM (higgsino-bino NLSP)} \\ \text{GGM (higgsino NLSP)} \\ \text{GGM (higgsino NLSP)} \\ \text{Gravitino LSP} \\ \end{array}$	$\begin{array}{c} 0 \\ 1 \ e, \mu \\ 0 \\ 0 \\ 1 \ e, \mu \\ 2 \ e, \mu \\ 2 \ e, \mu \\ 1 \cdot 2 \ \tau \\ 2 \ \gamma \\ 1 \ e, \mu + \gamma \\ \gamma \\ 2 \ e, \mu \left(Z \right) \\ 0 \end{array}$	2-6 jets 3-6 jets 7-10 jets 2-6 jets 2-6 jets 3-6 jets 0-3 jets 0-2 jets - 1 b 0-3 jets mono-jet	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	20.3 20.3 20.3 20.3 20.3 20.3 20.3 20.3	G. Š 1.7 Š 1.2 TeV Š 1.2 TeV Š 1.1 TeV Š 1.1 TeV Š 1.3 TeV Š 1.3 TeV Š 1.3 TeV Š 1.3 TeV Š 1.12 TeV Š 1.12 TeV Š 1.24 TeV Š 1.4 TeV Š 1.07 TeV Š 619 GeV Š 690 GeV Š 690 GeV Š 690 GeV	any m(\tilde{q}) any m(\tilde{q}) m(\tilde{k}_1^0)=0 GeV m(\tilde{k}_1^0)=0 GeV m(\tilde{k}_1^0)=0 GeV tan \tilde{q} <200 GeV, m(\tilde{k}^+)=0.5(m(\tilde{k}_1^0)+m(\tilde{g})) m(\tilde{k}_1^0)=0 GeV tan \tilde{q} <215 tan \tilde{q} >18 m(\tilde{k}_1^0)>50 GeV m(\tilde{k}_1^0)>50 GeV m(\tilde{k}_1^0)>200 GeV m(\tilde{H})>200 GeV m(\tilde{g})>10 ⁻⁴ eV	ATLAS-CONF-2013-047 ATLAS-CONF-2013-062 1308.1841 ATLAS-CONF-2013-047 ATLAS-CONF-2013-047 ATLAS-CONF-2013-047 ATLAS-CONF-2013-062 ATLAS-CONF-2013-069 1208.4688 ATLAS-CONF-2013-026 1209.0753 ATLAS-CONF-2012-144 1211.1167 ATLAS-CONF-2012-152 ATLAS-CONF-2012-147
3 rd gen. Ë med.	$\tilde{g} \rightarrow b \bar{b} \tilde{\chi}_{1}^{0}$ $\tilde{g} \rightarrow t \bar{t} \tilde{\chi}_{1}^{0}$ $\tilde{g} \rightarrow t \bar{t} \tilde{\chi}_{1}^{0}$ $\tilde{g} \rightarrow b \bar{t} \tilde{\chi}_{1}^{+}$	0 0 0-1 e,μ 0-1 e,μ	3 b 7-10 jets 3 b 3 b	Yes Yes Yes Yes	20.1 20.3 20.1 20.1	8 1.2 TeV 8 1.1 TeV 8 1.34 TeV 8 1.3 TeV	m(k ² ₁)<600 GeV m(k ² ₁) <350 GeV m(k ² ₁)<400 GeV m(k ² ₁)<300 GeV	ATLAS-CONF-2013-061 1308.1841 ATLAS-CONF-2013-061 ATLAS-CONF-2013-061
3rd gen. squarks direct production	$ \begin{array}{l} \tilde{b}_1 \tilde{b}_1, \tilde{b}_1 \rightarrow b \tilde{\tilde{t}}_1^0 \\ \tilde{b}_1 \tilde{b}_1, \tilde{b}_1 \rightarrow t \tilde{\tilde{t}}_1^{\pm} \\ \tilde{t}_1 \tilde{t}_1 (\text{light}), \tilde{t}_1 \rightarrow b \tilde{\tilde{t}}_1^{\pm} \\ \tilde{t}_1 \tilde{t}_1 (\text{light}), \tilde{t}_1 \rightarrow b \tilde{\tilde{t}}_1^{\pm} \\ \tilde{t}_1 \tilde{t}_1 (\text{light}), \tilde{t}_1 \rightarrow b \tilde{\tilde{t}}_1^{\pm} \\ \tilde{t}_1 \tilde{t}_1 (\text{medium}), \tilde{t}_1 \rightarrow t \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_1 (\text{medium}), \tilde{t}_1 \rightarrow t \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_1 (\text{heavy}), \tilde{t}_1 \rightarrow t \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_1 (\text{heavy}), \tilde{t}_1 \rightarrow t \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_1 (\text{heavy}), \tilde{t}_1 \rightarrow t \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow c \tilde{\tilde{t}}_1^0 \\ \tilde{t}_1 \tilde{t}_2, \tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z \end{array} $	0 2 e, µ (SS) 1-2 e, µ 2 e, µ 0 1 e, µ 0 2 e, µ (Z) 3 e, µ (Z)	2 b 0-3 b 1-2 b 0-2 jets 2 jets 2 b 1 b 2 b 1 ono-jet/c-1 1 b 1 b	Yes Yes Yes Yes Yes Yes Yes tag Yes Yes Yes	20.1 20.7 4.7 20.3 20.3 20.1 20.7 20.5 20.3 20.7 20.7	b1 100-620 GeV b1 275-430 GeV t1 275-430 GeV t1 110-167 GeV t1 130-220 GeV t1 130-220 GeV t1 130-220 GeV t1 225-525 GeV t1 200-610 GeV t1 320-660 GeV t1 90-200 GeV t1 500 GeV t1 201-650 GeV	$\begin{array}{l} m(\tilde{k}_{1}^{0}) < 90 \ \text{GeV} \\ m(\tilde{k}_{1}^{0}) = 2 \ m(\tilde{k}_{1}^{0}) \\ m(\tilde{k}_{1}^{0}) = 55 \ \text{GeV} \\ m(\tilde{k}_{1}^{0}) = m(\tilde{t}_{1}) - m(\mathcal{W}) - 50 \ \text{GeV}, \ m(\tilde{t}_{1}) < < m(\tilde{t}_{1}^{0}) \\ m(\tilde{t}_{1}^{0}) = 0 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) < 200 \ \text{GeV}, \ m(\tilde{t}_{1}^{0}) - m(\tilde{t}_{1}^{0}) = 5 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) = 0 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) = 0 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) = 0 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) = 150 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) > 150 \ \text{GeV} \\ m(\tilde{t}_{1}^{0}) = m(\tilde{t}_{1}^{0}) + 180 \ \text{GeV} \end{array}$	1308.2631 ATLAS-CONF-2013-007 1208.4305, 1209.2102 ATLAS-CONF-2013-048 ATLAS-CONF-2013-048 1308.2631 ATLAS-CONF-2013-037 ATLAS-CONF-2013-024 ATLAS-CONF-2013-024 ATLAS-CONF-2013-025 ATLAS-CONF-2013-025
EW direct	$\begin{array}{l} \tilde{\ell}_{L,R} \tilde{\ell}_{L,R}, \tilde{\ell} \rightarrow \ell \tilde{\chi}_{1}^{0} \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow \tilde{\ell} \nu (\ell \tilde{\nu}) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{+} \rightarrow \tilde{\tau} \nu (\tau \tilde{\nu}) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{2}^{0} \rightarrow \tilde{\ell}_{L} \nu \tilde{\ell}_{L} \ell (\tilde{\nu} \nu), \ell \tilde{\nu} \tilde{\ell}_{L} \ell (\tilde{\nu} \nu) \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\chi}_{1}^{0} Z \tilde{\chi}_{1}^{0} \\ \tilde{\chi}_{1}^{+} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\chi}_{1}^{0} h \tilde{\chi}_{1}^{0} \end{array}$	2 e, µ 2 e, µ 2 r 3 e, µ 3 e, µ 1 e, µ	0 - 0 2 b	Yes Yes Yes Yes Yes Yes	20.3 20.3 20.7 20.7 20.7 20.7 20.3	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{l} m(\widetilde{k}_{1}^{0}) = 0 \; GeV \\ m(\widetilde{k}_{1}^{0}) = 0 \; GeV, \; m(\widetilde{\ell}, \widetilde{\nu}) = 0.5(m(\widetilde{k}_{1}^{+}) + m(\widetilde{k}_{1}^{0})) \\ m(\widetilde{k}_{1}^{0}) = 0 \; GeV, \; m(\widetilde{\ell}, \widetilde{\nu}) = 0.5(m(\widetilde{k}_{1}^{+}) + m(\widetilde{k}_{1}^{0})) \\ \widetilde{\ell}_{1}^{+}) = m(\widetilde{k}_{2}^{0}), \; m(\widetilde{k}_{1}^{0}) = 0, \; m(\widetilde{\ell}, \widetilde{\nu}) = 0.5(m(\widetilde{k}_{1}^{+}) + m(\widetilde{k}_{1}^{0})) \\ m(\widetilde{k}_{1}^{+}) = m(\widetilde{k}_{2}^{0}), \; m(\widetilde{k}_{1}^{0}) = 0, \; sleptons \; decoupled \\ m(\widetilde{k}_{1}^{+}) = m(\widetilde{k}_{2}^{0}), \; m(\widetilde{k}_{1}^{0}) = 0, \; sleptons \; decoupled \end{array}$	ATLAS-CONF-2013-049 ATLAS-CONF-2013-049 ATLAS-CONF-2013-028 ATLAS-CONF-2013-035 ATLAS-CONF-2013-035 ATLAS-CONF-2013-035
Long-lived particles	Direct $\tilde{\chi}_1^+ \tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^+$ Stable, stopped \tilde{g} R-hadron GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(GMSB, \tilde{\chi}_1^0 \rightarrow \gamma \tilde{G}, long-lived \tilde{\chi}_1^0$ $\tilde{q}\tilde{q}, \tilde{\chi}_1^0 \rightarrow qq\mu$ (RPV)	0	1 jet 1-5 jets - -	Yes Yes Yes	20.3 22.9 15.9 4.7 20.3	x̂1 270 GeV 832 GeV 8 832 GeV 832 GeV x̂1 230 GeV 1.0 TeV	$\begin{array}{l} m(\tilde{k}_1^{*})\text{-}m(\tilde{k}_1^{0}) \!=\! 160 \; \text{MeV}, \; r(\tilde{k}_1^{*}) \!=\! 0.2 \; \text{ns} \\ m(\tilde{k}_1^{0}) \!=\! 100 \; \text{GeV}, \; 10 \; \mu \text{s} \! <\! r(\tilde{g}) \!<\! 1000 \; \text{s} \\ 10 \!<\! \tan\!\beta \!<\! 50 \\ 0.4 \!<\! r(\tilde{k}_1^{0}) \!<\! 2 \; \text{ns} \\ 1.5 \; \!<\! cr \!<\! 156 \; \text{mm}, \; \text{BR}(\mu) \!=\! 1, \; m(\tilde{k}_1^{0}) \!=\! 108 \; \text{GeV} \end{array}$	ATLAS-CONF-2013-069 ATLAS-CONF-2013-057 ATLAS-CONF-2013-058 1304.6310 ATLAS-CONF-2013-092
NdB	$ \begin{array}{l} LFV \ pp \! \rightarrow \! \tilde{v}_{\tau} + X, \ \tilde{v}_{\tau} \! \rightarrow \! e \! + \! \mu \\ LFV \ pp \! \rightarrow \! \tilde{v}_{\tau} + X, \ \tilde{v}_{\tau} \! \rightarrow \! e(\!\mu) \! + \! \tau \\ Bilinear \ RPV \ CMSSM \\ \tilde{x}_{1}^{+} \tilde{x}_{1}^{-}, \ \tilde{x}_{1}^{+} \! \rightarrow \! W \widetilde{x}_{1}^{0}, \ \tilde{x}_{1}^{0} \! \rightarrow \! ee \! \tilde{v}_{\mu}, e \! \mu \! \mu \\ \tilde{x}_{1}^{+} \tilde{x}_{1}^{-}, \ \tilde{x}_{1}^{+} \! \rightarrow \! W \widetilde{x}_{1}^{0}, \ \tilde{x}_{1}^{0} \! \rightarrow \! \tau \tau \bar{v}_{e}, e \! \tau \! \tau \! \tilde{v}_{e} \! \\ \tilde{g} \! \rightarrow \! q \! q \! q \\ \tilde{g} \! \rightarrow \! \tilde{t}_{1} t, \ \tilde{t}_{1} \! \rightarrow \! bs \end{array} $	$\begin{array}{c} 2 \ e, \mu \\ 1 \ e, \mu + \tau \\ 1 \ e, \mu \\ \phi_e \\ \phi_r \\ 3 \ e, \mu + \tau \\ 0 \\ 2 \ e, \mu (SS) \end{array}$	- 7 jets - - 6-7 jets 0-3 b	- Yes Yes - Yes	4.6 4.7 20.7 20.7 20.3 20.7	\bar{v}_r 1.61 TeV \bar{v}_r 1.1 TeV \bar{u}_i 1.2 TeV $\bar{\chi}_1^a$ 760 GeV $\bar{\chi}_1^a$ 350 GeV \bar{g} 916 GeV \bar{g} 880 GeV		1212.1272 1212.1272 ATLAS-CONF-2012-140 ATLAS-CONF-2013-036 ATLAS-CONF-2013-036 ATLAS-CONF-2013-091 ATLAS-CONF-2013-007
Other	Scalar gluon pair, sgluon $\rightarrow q\bar{q}$ Scalar gluon pair, sgluon $\rightarrow t\bar{t}$ WIMP interaction (D5, Dirac χ)	0 2 e, µ (SS) 0	4 jets 1 b mono-jet		4.6 14.3 10.5	sgluon 100-287 GeV sgluon 800 GeV M* scale 704 GeV	incl. limit from 1110.2693 m(χ)⊲80 GeV, limit of⊲687 GeV for D8	1210.4826 ATLAS-CONF-2013-051 ATLAS-CONF-2012-147
		√s = 8 TeV partial data		8 TeV data		10 ⁻¹ 1	Mass scale [TeV]	

ATLAS Preliminary

 $\int \mathcal{L} dt = (4.6 - 22.9) \text{ fb}^{-1}$ $\sqrt{s} = 7, 8 \text{ TeV}$

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

ATLAS DETECTOR



LHC

