SEARCHES FOR SQUARKS AND GLUINOS IN SCENARIOS WITH R-PARITY VIOLATING SPARTICLE DECAYS, OR LONG-LIVED SPARTICLES WITH ATLAS

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ON BEHALF OF THE ATLAS COLLABORATION



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WHY NOT?

Often assume: Very massive squarks+gluinos R-Parity Conservation Trivial Sparticle Lifetimes



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But we have a huge number of exclusions and no SUSY discoveries

In the MSSM, tree-level terms that violate R-Parity

We often forbid them.

"SM conserves R at tree level, why shouldn't the MSSM?"

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$$W_{RPV} = \mu_i H_u L_i + \frac{1}{2} \lambda_{ijk} L_i L_j E_k + \lambda'_{ijk} L_i Q_j D_k + \frac{1}{2} \lambda''_{ijk} U_i D_j D_k$$

I Violating B Violating

Because of their coupling to Lepton superfields, these terms give rise to Missing E_T →RPC Searches often have sensitivity

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L Violating

B Violating

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But these couplings give SUSY particle decays to quarks... All hadronic signals at a QCD collider

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L Violating

B Violating

Run: 282712 Event: 474587238 2015-10-21 06:26:57 CEST



Very Common QCD Multijet Event



ATLAS

RPV Signal

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Very Common QCD Multijet Event



RPV Signal

Run: 282712 Event: 474587238 2015-10-21 06:26:57 CEST

Signal looks very similar to a huge, very hard-to-estimate background!



Very Common QCD Multijet Event

RPV MULTIJET SEARCH

- To kill QCD multi jet backgrounds, construct composite mass variable out of Large-R jets
- Scalar sum of masses
 - QCD: Small angle emissions
 - SUSY/BSM: Large angles → Event structure
- Regions w/ or w/o B-Tag for HF sensitivity









No significant deviation from SM. → Very strict limits on gluino mass despite the multijet background!



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RPV MULTIJET+1L SEARCH

- If top-quarks in final state, or L-violating RPV
 - Very low MET + Many Jets + [e or mu]
 - Regions looking for 12 jets ($p_T \ge 40 \text{ GeV}$)!
 - Or 10 jets ($p_T \ge 80 \text{ GeV}$)
- Backgrounds from ttbar estimated from jet multiplicity scaling parametrization
 - Stair-case/Berends Scaling + Poisson Term

$$N_{j+1}^{t\bar{t}+jets}/N_j^{t\bar{t}+jets} \equiv r^{t\bar{t}+jets}(j) = c_0^{t\bar{t}+jets} + c_1^{t\bar{t}+jets}/(j+c_2^{t\bar{t}+jets})$$

• B-jet multiplicity distribution fit in SR





No significant deviation from SM. → Very strict limits on gluino mass despite complicated signature!







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Unfortunately RPV gluinos are probably not hiding there... So that's depressing.

But what if another assumption has been wrong?

Unfortunately RPV gluinos are probably not hiding there... So that's depressing.

But what if another assumption has been wrong?

Many mechanisms for making long-lived sparticles!

Squark mass ~ 1 PeV, Gluino mass ~ TeV

→ Gluino hadronizes to "R-Hadron" and decays within inner tracking detectors



Macroscopic Lifetimes

Spectacular Displaced Signatures

DISPLACED VERTEX + MET SEARCH

- Missing E_T ≥ 250 GeV from neutralinos (or ISR for compressed spectra)
- Look for R-Hadron decay with Displaced Vertex:
 - Mass \geq 10 GeV && Track Multiplicity \geq 5
 - Roughly within pixel tracker volume
 - Dedicated tracking and vertexing algorithms
- No irreducible backgrounds. Purely instrumental.
 - High Mass Hadronic Interactions
 - Merged SM Vertices
 - Accidental High-Angle Track Crossing







- Expected BG: 0.02 ± 0.02 Events
- Observed: 0 Events
- In absence of an excess, able to set limits on gluino masses to up ~2.37 TeV!
 - The strictest limit on gluino mass of any search ever!

We are trying to ease reinterpretations for long-lived particle searches. **Parametrized efficiencies on HEPData**

We are making this a priority, so feedback from the theory community is very welcome! We want our information to be useful!



A D	TLAS SUSY Sear	rches*	- 95%	S CI	L Lo	ver Limits				ATLAS Preliminary $\sqrt{s} = 7, 8, 13$ TeV
	Model	e, μ, τ, γ	Jets 1	E_{T}^{miss}	$\int \mathcal{L} dt [fb]$	-1] Ma	ass limit	$\sqrt{s} = 7, 8$	TeV $\sqrt{s} = 13 \text{ TeV}$	Reference
Inclusive Searches	$ \begin{array}{l} \tilde{q}\tilde{q}, \tilde{q} \rightarrow q \tilde{k}_{1}^{0} \\ \tilde{q}\tilde{q}, \tilde{q} \rightarrow q \tilde{k}_{1}^{0} \\ \tilde{k}\tilde{s}, \tilde{s} \rightarrow q \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q \tilde{q}(\ell) \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q \tilde{q}(\ell) \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q \tilde{q}(\ell) \gamma \gamma \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q q \tilde{k}(\ell) \gamma \gamma \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q q \tilde{k}(\ell) \gamma \gamma \tilde{k}_{1}^{0} \\ \tilde{s}\tilde{s}, \tilde{s} \rightarrow q q \tilde{k}(\ell) \gamma \tilde{s}\tilde{s} \\ \tilde{s}\tilde{s} \rightarrow q \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \rightarrow q \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s}\tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s}\tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s}\tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s}\tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \tilde{s} \rightarrow q \tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \tilde{s} \rightarrow q \tilde{s} \\ \tilde{s} \rightarrow q \tilde{s} \\ \tilde{s} = \tilde{s} \tilde{s} \rightarrow q \tilde{s} \\$	$\begin{matrix} 0 \\ mono-jet \\ 0 \\ ee, \mu\mu \\ 3 e, \mu \\ 0 \\ 1-2 \tau + 0-1 \ell \\ 2 \gamma \\ \gamma \\ 0 \end{matrix}$	2-6 jets 1-3 jets 2-6 jets 2-6 jets 2 jets 4 jets 7-11 jets 0-2 jets 2 jets mono-jet	Yes Yes Yes Yes Yes Yes Yes Yes	36.1 36.1 36.1 14.7 36.1 36.1 3.2 36.1 36.1 20.3	φ φ k	710 GeV	1.57 TeV 2.02 TeV 2.01 TeV 1.7 TeV 1.87 TeV 1.87 TeV 2.0 TeV 2.15 Te 2.05 TeV	$\begin{split} m(\tilde{t}_{1}^{n}) <&200 \mbox{ GeV}, m(\tilde{t}_{1}^{n} \mbox{gen. }\tilde{q}) =& m(\tilde{z}_{1}^{n-1}\mbox{gen. }\tilde{q}) \\ m(\tilde{t}_{1}^{n}) -&200 \mbox{ GeV} \\ m(\tilde{t}_{1}^{n}) -&200 \mbox$	1712.02332 1711.03301 1712.02332 1611.05791 1706.02794 1807.05979 ATLAS-CONF-2017-080 ATLAS-CONF-2017-080 1502.01518
g med.	$\overline{g}\overline{g}, \overline{g} \rightarrow b\overline{b}\overline{\chi}_{1}^{0}$ $\overline{g}\overline{g}, \overline{g} \rightarrow t\overline{t}\overline{\chi}_{1}^{0}$	0 0-1 <i>e</i> ,μ	3 b 3 b	Yes Yes	36.1 36.1	200 200		1.92 TeV 1.97 TeV	$m(\bar{\chi}_1^0)$ <600 GeV $m(\bar{\chi}_1^0)$ <200 GeV	1711.01901 1711.01901
3 rd gen. squarks direct production	$ \begin{array}{l} \bar{b}_1 \bar{b}_1 + \bar{b}_1 \rightarrow b \tilde{\chi}_1^0 \\ \bar{b}_1 \bar{b}_1 + \bar{b}_1 \rightarrow b \tilde{\chi}_1^0 \\ \bar{h}_1 \bar{b}_1 + b \tilde{\chi}_1^0 \\ \bar{h}_1 \bar{h}_1 - h \phi \tilde{\chi}_1^0 \\ \bar{h}_1 \bar{h}_1 - h \phi \tilde{\chi}_1^0 \\ \bar{h}_1 \bar{h}_1 - h \phi \tilde{\chi}_1^0 \\ \bar{h}_1 \bar{h}_1 - h \tilde{\chi}_1^0 \\ \bar{h}_2 \bar{h}_1 - h \tilde{\chi}_1^0 \\ \bar{h}_2 \bar{h}_2 - h \tilde{\chi}_1 + h \end{array} $	0 2 e, μ (SS) 0-2 e, μ 0-2 e, μ 0 2 e, μ (Z) 3 e, μ (Z) 1-2 e, μ	2 b 1 b 1-2 b D-2 jets/1-2 b mono-jet 1 b 1 b 4 b	Yes Yes Yes Yes Yes Yes Yes Yes	36.1 36.1 1.7/13.3 20.3/36.1 36.1 20.3 36.1 36.1 36.1	\$\bar{b}_1\$	950 GeV 275-700 GeV 200-720 GeV 0.195-1.0 TeV 0-430 GeV 150-600 GeV 290-790 GeV 320-880 GeV		$\begin{split} m(\tilde{\xi}_1^0) &{\prec} 200 \; \text{GeV} \\ m(\tilde{\xi}_1^0) &{\sim} 200 \; \text{GeV}, \; m(\tilde{\xi}_1^0) &{=} m(\tilde{\xi}_1^0) {+} 100 \; \text{GeV} \\ m(\tilde{\xi}_1^0) &{=} 2m(\tilde{\xi}_1^0) {=} 55 \; \text{GeV} \\ m(\tilde{\xi}_1^0) &{=} m(\tilde{\xi}_1^0) {=} 5 \; \text{GeV} \\ m(\tilde{\xi}_1^0) &{=} 150 \; \text{GeV} \\ m(\tilde{\xi}_1^0) &{=} 160 \; \text{eV} \\ m(\tilde{\xi}_1^0) &{=} 0 \; \text{GeV} \end{split}$	1708.09266 1706.03731 1209.2102, ATLAS-CONF-2016-077 1506.08616, 1709.04183, 1711.11520 1711.03301 1403.5222 1706.03986 1706.03986
EW direct	$ \begin{split} \tilde{d}_{\perp k} \tilde{d}_{\perp k}, \tilde{\ell} \rightarrow \ell \tilde{\chi}_{1}^{0} \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{1}^{*}, \tilde{\chi}_{1}^{*} \rightarrow \tilde{\ell} \chi(\tilde{\nu}) \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{1}^{*}, \tilde{\chi}_{1}^{*} \rightarrow \tilde{\ell} \chi(\tilde{\nu}), \tilde{\chi}_{2}^{0} \rightarrow \tilde{\tau} \tau(\tilde{\nu}) \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{1}^{0} \tilde{\chi}_{1}^{*} \tilde{\chi}_{1}^{0} \rightarrow \tilde{\ell}_{1} \tilde{\ell}_{1}^{*} \ell(\tilde{\nu}), \ell \tilde{\nu}_{1}^{*} \ell(\tilde{\nu}) \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\ell}_{2}^{0} \tilde{\chi}_{1}^{*} \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\ell}_{1}^{0} \tilde{\chi}_{1}^{*}, h \rightarrow b \tilde{b} / W W / \tau \tau / \gamma \gamma \\ \tilde{\chi}_{1}^{*} \tilde{\chi}_{2}^{0} \rightarrow W \tilde{\ell}_{1}^{0} \tilde{\chi}_{1}^{*}, h \rightarrow b \tilde{b} / W W / \tau \tau / \gamma \gamma \\ \tilde{\chi}_{2}^{*} \tilde{\chi}_{1}^{*} \tilde{\chi}_{2}^{0} \rightarrow \tilde{\ell}_{4} \ell \\ GGM (wino NLSP) weak prod., \tilde{\chi}_{1}^{0} \rightarrow \gamma \\ GGM (bin NLSP) weak prod., \tilde{\chi}_{1}^{0} \rightarrow \gamma \\ \end{split}$	$\begin{array}{c} 2 \ e, \mu \\ 2 \ e, \mu \\ 2 \ \tau \\ 3 \ e, \mu \\ 2 - 3 \ e, \mu \\ e, \mu, \gamma \\ 4 \ e, \mu \\ \gamma \tilde{G} \ 1 \ e, \mu + \gamma \\ \gamma \tilde{G} \ 2 \ \gamma \end{array}$	0 0 0-2 jets 0-2 b 0 -	Yes Yes Yes Yes Yes Yes Yes Yes	36.1 36.1 36.1 36.1 20.3 20.3 20.3 36.1	$ \begin{array}{c} \vec{k} \\ \vec{k}_{1}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{1}^{+} \\ \vec{k}_{2}^{+} \\ \vec{k}_{$	90-500 GeV 750 GeV 1.13 Te 580 GeV 635 GeV 0 GeV 1.06 TeV	\mathbf{W} $\mathbf{m}(\tilde{\mathbf{r}}_{1}^{+})=\mathbf{r}$ $\mathbf{m}(\tilde{\mathbf{r}}_{2}^{0})=\mathbf{r}$	$\begin{split} m(\tilde{\xi}_{1}^{2}) &= 0 \\ m(\tilde{\xi}_{1}^{2}) &= 0, \\ m(\tilde$	ATLAS-CONF-2017-039 ATLAS-CONF-2017-039 1708.07875 ATLAS-CONF-2017-039 1501.07110 1405.5086 1507.05493 ATLAS-CONF-2017-080
Long-lived particles	$ \begin{array}{l} \label{eq:constraints} \begin{split} & \operatorname{Direct} \tilde{X}_1^+ \tilde{X}_1^- \ \operatorname{prod}, \ \operatorname{long-lived} \tilde{X}_1^+ \\ & \operatorname{Direct} \tilde{X}_1^+ \tilde{X}_1 \ \operatorname{prod}, \ \operatorname{long-lived} \tilde{X}_1^- \\ & \operatorname{Stable}, \ \operatorname{stoped} \tilde{g}, \ \mathrm{R-hadron} \\ & \operatorname{Stable} \tilde{g}, \ \mathrm{R-hadron} \\ & \operatorname{Metastable} \tilde{g}, \ \mathrm{R-hadron} \\ & Metastab$	Disapp. trk dE/dx trk 0 trk dE/dx trk displ. vtx 1-2 µ 2 y displ. ee/eµ/µ	1 jet - 1-5 jets - - - - - μ -	Yes Yes - Yes - Yes - Yes	36.1 18.4 27.9 3.2 3.2 32.8 19.1 20.3 20.3		460 GeV 495 GeV 850 GeV 537 GeV 440 GeV 1.0 TeV	1.58 TeV 1.57 TeV 2.37	$\begin{split} m(\tilde{\xi}_{1}^{2}) &= m(\tilde{\xi}_{1}^{2}) - m(\tilde{\xi}_{1}^{2}) - 160 \ \text{MeV}, \tau(\tilde{\xi}_{1}^{2}) = 0.2 \ \text{ns} \\ m(\tilde{\xi}_{1}^{2}) = 100 \ \text{GeV}, \tau(\tilde{\xi}_{1}^{2}) < 150 \ \text{meV}, \tau(\tilde{\xi}_{1}^{2}) < 150 \ \text{meV}, \tau(\tilde{\xi}_{1}^{2}) < 100 \ \text{s} \\ m(\tilde{\xi}_{1}^{2}) = 100 \ \text{GeV}, \tau > 10 \ \text{ns} \\ \tau(\tilde{\xi}_{1}^{2}) < 100 \ \text{GeV}, \tau > 10 \ \text{ns} \\ \tau(\tilde{\xi}_{1}^{2}) < \tau(\tilde{\xi}_{1}^{2}) < 100 \ \text{GeV} \\ \tau(\tilde{\xi}_{1}^{2}) < 3 \ \text{ns}, SPS8 \ \text{model} \\ \tau(\tau(\tilde{\xi}_{1}^{2}) < 240 \ \text{mn}, m(\tilde{\xi}_{1}^{2}) = 13 \ \text{eV} \end{split}$	1712.02118 1506.05332 1310.6584 1606.05129 1604.04520 1710.04901 1411.6795 1409.5542 1504.05182
RPV	$ \begin{array}{l} LFV pp \rightarrow \bar{\nu}_{\tau} + X, \bar{\nu}_{\tau} \rightarrow e\mu/e\tau/\mu\tau \\ Bilinear \ RPV \ CMSSM \\ \bar{\chi}_{1}^{*} \bar{\chi}_{1}^{*}, \bar{\chi}_{1}^{*} \rightarrow \mathcal{K}_{1}^{*} \partial_{\tau}^{*} \chi_{1}^{*} \rightarrow \mathcal{C}ee, e\mu\nu, \mu\mu\nu \\ \bar{\chi}_{1}^{*} \bar{\chi}_{1}^{*}, \bar{\chi}_{1}^{*} \rightarrow \mathcal{W}_{1}^{*} \bar{\chi}_{1}^{*} \rightarrow \tau\tau\nu, e\tau\nu, \\ \bar{g}\bar{g}, \bar{g} \rightarrow \tau q\bar{\chi}_{1}^{*}, \bar{\chi}_{1}^{*} \rightarrow qqq \\ \bar{g}\bar{g}, \bar{g} \rightarrow \tau \bar{t}_{1}, \bar{\chi}_{1}^{*} \rightarrow qqq \\ \bar{g}\bar{g}, \bar{g} \rightarrow \tau \bar{t}_{1}, \bar{t}_{1} \rightarrow bs \\ \bar{t}_{1}\bar{t}_{1}, \bar{t}_{1} \rightarrow b\ell \end{array}$	$e\mu, e\tau, \mu\tau$ 2 e, μ (SS) 4 e, μ 3 $e, \mu + \tau$ 0 4 1 e, μ 8 1 e, μ 8 0 2 e, μ		Yes Yes Yes Is - b - b - -	3.2 20.3 13.3 20.3 36.1 36.1 36.1 36.7 36.1		1.14 Tr 450 GeV 100-470 GeV 480-§10 GeV 0.4	1.9 TeV 1.45 TeV eV 1.875 TeV 2.1 TeV 1.65 TeV -1.45 TeV	$\begin{split} & \mathcal{X}_{111}^{*}=0.11, \mathcal{X}_{122}(_{133})_{233}=0.07 \\ & m(\bar{q})=m(\bar{q}), \ \sigma_{122}\mu<1 \\ & m(\bar{x}_{11}^{*})_{2}=00\text{GeV}, \ \mathcal{X}_{133}=0 \\ & m(\bar{x}_{11}^{*})_{2}=1027\text{GeV} \\ & m(\bar{x}_{11}^{*})_{2}=1027\text{GeV} \\ & m(\bar{x}_{11}^{*})_{2}=170, \ \mathcal{X}_{122}=0 \\ & m(\bar{x}_{11})_{2}=11\text{GeV}, \ \mathcal{X}_{122}=0 \\ & BR(\bar{t}_{1}-ber/\mu)\!\!>\!20\% \end{split}$	1607.08079 1404.2500 ATLAS-CONF-2016-075 1405.5086 SUSY-2016-22 1704.08493 1704.08493 1710.07171 1710.05544
Other	Scalar charm, $\bar{c} \rightarrow c \bar{\chi}_1^0$	0	2 c	Yes	20.3	ĉ	510 GeV		$m(\tilde{\chi}_{1}^{0})$ <200 GeV	1501.01325
	a selection of the available mas		new states		1) ⁻¹	1		IVeTI elcos aseM	

RPV gluino limits pushing up to 2 TeV range!

	LFV $pp \rightarrow \tilde{v}_{\tau} + X, \tilde{v}_{\tau} \rightarrow e\mu/e\tau/\mu\tau$	$e\mu,e au,\mu au$	-	-	3.2	$\tilde{\nu}_{ au}$
RPV	Bilinear RPV CMSSM	2 <i>e</i> , <i>µ</i> (SS)	0-3 <i>b</i>	Yes	20.3	ilde q, ilde g
	$\tilde{\chi}_1^+ \tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W \tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow eev, e\mu v, \mu \mu v$	$4 e, \mu$	-	Yes	13.3	$\tilde{\chi}_1^{\pm}$
	$\tilde{\chi}_1^+ \tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W \tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau \tau v_e, e \tau v_\tau$	$3 e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^{\pm}$
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qqq$	0 4-5	large-R je	ets -	36.1	ĝ
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\bar{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qqq$	1 e,µ 8-	0 jets/0-4	b -	36.1	ĝ
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}_1 t, \tilde{t}_1 \rightarrow bs$	1 <i>e</i> , µ 8-	0 jets/0-4	b -	36.1	ĝ
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow bs$	0 2	jets + 2 b	-	36.7	\tilde{t}_1
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\ell$	2 <i>e</i> , <i>µ</i>	2 <i>b</i>	-	36.1	\tilde{t}_1



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And LLP limits even higher to ~2.4 TeV!



There's more to this story from ATLAS. See talks by:

B Hooberman: SUSY searches with ATLAS

K Onogi: Reconstruction techniques in supersymmetry searches in the ATLAS experiment

J Reichert: Search for compressed SUSY scenarios with the ATLAS detector

F Ungaro: Searches for stops in scenarios with Rparity violating sparticle decays, or long-lived sparticles with ATLAS

Thanks for your attention!

Additional RPV Multijet Material

		$N_{\rm jet} \ (p_{\rm T} > 200 \ {\rm GeV})$	<i>b</i> -tag	<i>р</i> т,1	$ \Delta \eta_{12} $	$M_{ m J}^{\Sigma}$
CR	3jCR	= 3	-	-	-	-
	UDR1	= 2	-	> 400 GeV	-	-
UDK	UDR2	= 4	-	< 400 GeV	-	-
	4jVR	≥ 4	-	> 400 GeV	> 1.4	-
VD	5jVR	≥ 5	-	-	> 1.4	-
۷K	4jVRb	≥ 4	Yes	> 400 GeV	> 1.4	-
	5jVRb	≥ 5	Yes	-	> 1.4	-
	4jSR	≥ 4	-	> 400 GeV	< 1.4	> 1.0 TeV
SD	5jSR	≥ 5	-	-	< 1.4	> 0.8 TeV
SK	4jSRb	≥ 4	Yes	> 400 GeV	< 1.4	> 1.0 TeV
	5;CDh	≥ 5	Yes	-	< 1.4	> 0.8 TeV
	JJSKU	≥ 5	Yes	-	< 1.4	> 0.6 TeV





Additional RPV Multijet Material



SUSY 2017

ICHEP 2016



Additional RPV Multijet+1L Material



eV	
	eV

$\tilde{g} \to t\bar{t}\tilde{\chi}_1^0 \to t\bar{t}uds \ (m_{\tilde{g}} = 2000 \ GeV, m_{\tilde{\chi}_1^0} = 941 \ GeV)$	N_{raw}			$N_{\mathrm weighted}$			Total Eff.		
All Events	10000			10557.0			100.0 %		
Lepton trigger	5647		5713.4			54.1~%			
>= 1 baseline lepton	4360			4411.2			41.8 %		
>= 1 signal lepton	3535			3623.0			34.3~%		
$>= 5$ jets, $p_{\rm T} \ge 40 { m GeV}$		3535		3580.9			33.9~%		
		jet $p_{\rm T} \ge 40$	GeV	jet $p_{\rm T} \ge 60 { m ~GeV}$			jet $p_{\rm T} \ge 80 {\rm GeV}$		
	Nraw	$N_{weighted}$	Total Eff.	N_{raw}	$N_{weighted}$	Total Eff.	N_{raw}	$N_{weighted}$	Total Eff.
≥ 8 jets	3512	3556.6	33.7%	3397	3436.0	32.5%	3116	3152.8	29.9%
≥ 9 jets	3438	3483.8	33.0%	3128	3177.1	30.1%	2533	2568.1	24.3%
≥ 10 jets		3271.5	31.0%	2599	2654.9	25.1%	1757	1785.9	16.9%
≥ 11 jets		2852.3	27.0%						
≥ 12 jets		2266.8	21.5%						
≥ 8 jets, ≥ 3 b-tags	1907	2057.5	19.5%	1515	1675.8	15.9%	1164	1301.3	12.3%
≥ 9 jets, ≥ 3 b-tags	1886	2035.8	19.3%	1447	1605.6	15.2%	1012	1114.9	10.6%
≥ 10 jets, ≥ 3 b-tags		1936.3	18.3%	1249	1384.2	13.1%	759	830.1	7.9%
≥ 11 jets, ≥ 3 b-tags		1735.0	16.4%						
≥ 12 jets, ≥ 3 b-tags		1419.5	13.4%						

Additional RPV Multijet+1L Material

$$N_{j,b}^{t\bar{t}+jets} = N_j^{t\bar{t}+jets} \cdot f_{j,b},$$

$$f_{(j+1),b} = f_{j,b} \cdot x_0 + f_{j,(b-1)} \cdot x_1 + f_{j,(b-2)} \cdot x_2,$$

$$N_{j+1}^{t\bar{t}+jets} / N_j^{t\bar{t}+jets} \equiv r^{t\bar{t}+jets}(j) = c_0^{t\bar{t}+jets} + c_1^{t\bar{t}+jets} / (j + c_2^{t\bar{t}+jets}),$$





$(m_{\tilde{g}} \text{ [GeV]}, m_{\tilde{\chi}_1^0} \text{ [GeV]}, \tau \text{ [ns]})$	(1400, 100, 1)	(2000, 100, 1)	(2000, 1800, 1)	(1400, 100, 0.1)
Initial Events	827	32	32	827
Trigger-based data reduction	826	32	27	827
Event cleaning	826	32	27	827
Good Runs List	826	32	27	827
Primary vertex	826	32	27	827
NCB veto	823	32	26	824
$E_{\rm T}^{\rm miss}$ trigger	791	31	24	803
$E_{\rm T}^{\rm miss}$ filter	760	31	17	717
Offline $E_{\rm T}^{\rm miss}$	671	29	7	641
DV fiducial acceptance	620	28	6	625
DV fit quality	615	27	6	621
DV displacement	613	27	6	608
Material veto	493	22	5	544
Disabled module veto	480	22	5	541
DV track multiplicity	331	15	3	455
DV mass	305	14	2	442

- Hadronic interactions killed by data-driven material map
- Merging of low mass vertices uses other-event spatial correlations
- Random crossing of a track with a vertex from a crossing probability defined in low n-track regions

Additional DV+MET Exclusion Plots





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