



Search for R-Parity violating Supersymmetry in multileptonic final states at $\sqrt{s} = 13$ TeV with ATLAS

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Bundesministerium
für Bildung
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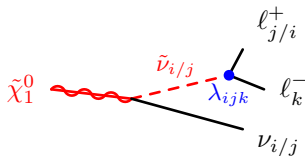
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$$P_R = (-1)^{3(B-L)+2S} = \begin{cases} 1 & \text{for SM particles} \\ -1 & \text{for SUSY particles} \end{cases}$$

- Supersymmetry belongs amongst the favoured BSM theories
- In a general SUSY theory interactions allowed violating R-parity

$$W \subset \lambda_{ijk} L_i L_j \bar{E}_k$$

⇒ Lightest SUSY particle $\tilde{\chi}_1^0$ is allowed to decay



⇒ multi leptonic final states

This talk: $c\tau(\tilde{\chi}_1^0) \lesssim 0.1 \text{ mm}$

k	ij = 12	ij = 13	ij = 23
1	$e e \nu_\mu$ $e \mu \nu_e$	$e e \nu_\tau$ $e \tau \nu_e$	$e \mu \nu_\tau$ $e \tau \nu_\mu$
2	$e \mu \nu_\mu$ $\mu \mu \nu_e$	$e \mu \nu_\tau$ $\mu \tau \nu_e$	$\mu \mu \nu_\tau$ $\mu \tau \nu_\mu$
3	$e \tau \nu_\mu$ $\mu \tau \nu_e$	$e \tau \nu_\tau$ $\tau \tau \nu_e$	$\mu \tau \nu_\tau$ $\tau \tau \nu_\mu$

- Consideration of electroweak production modes with $\tilde{Y} \rightarrow \tilde{\chi}_1^0 + Y$:

1. \tilde{W} -production:

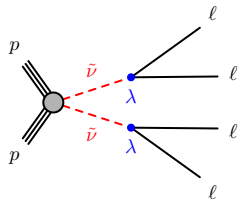
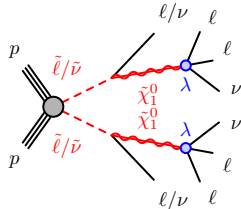
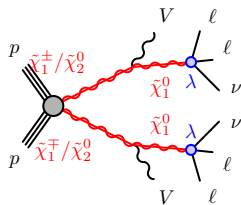
$$\tilde{\chi}_1^+ \tilde{\chi}_1^- / \tilde{\chi}_1^- \tilde{\chi}_2^0 / \tilde{\chi}_1^+ \tilde{\chi}_2^0$$

2. $\tilde{\ell}$ -production:

$$\tilde{\ell}_i^+ \tilde{\ell}_i^- / \tilde{\ell}_i^+ \tilde{\nu}_i / \tilde{\ell}_i^- \tilde{\nu}_i / \tilde{\nu}_i \tilde{\nu}_i$$

- Additional case: $\tilde{\nu} \tilde{\nu}$ with direct $\tilde{\nu} \rightarrow \ell \ell$ decays

⇒ Subsequent $\tilde{\chi}_1^0$ decay leads to final state with $N \geq 4$ leptons

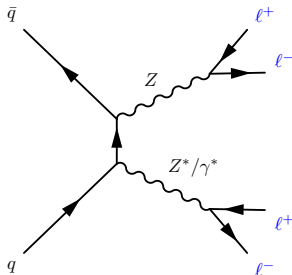
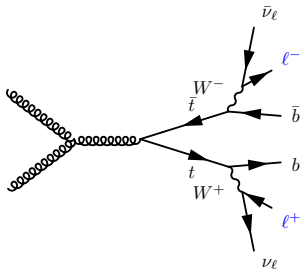


- **Irreducible** background processes:

$ZZ, t\bar{t} + X (X = Z, VV, t\bar{t}), VVV, \text{Higgs}$

- Estimation based on Monte-Carlo
- Strong rejection via Z-veto:

$$|m_{\text{SFOS}} - m_Z| > 10 \text{ GeV}$$

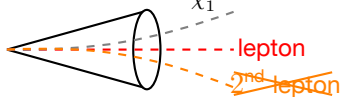


- **Reducible** backgrounds:

$t\bar{t}, Z+\text{jets}, WZ$

- Estimated in control data using the fake-factor method
c.f. Stefan Maschek

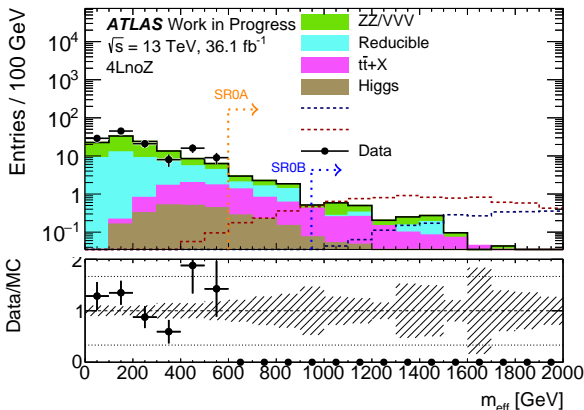
- Selection of events with $N_l \geq 4$, ($l = e/\mu/\tau$)
- Signal e/μ required to be isolated and originate from primary vertex
- Improved** e/μ -isolation criteria to enhance sensitivity to models with low $m_{\tilde{\chi}_1^0}$



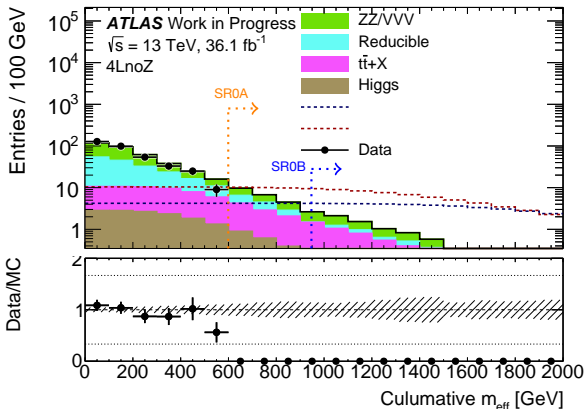
	p_T [GeV]	$ \eta $
e	≥ 7	≤ 2.47
μ	≥ 5	≤ 2.70
τ	≥ 20	≤ 2.50
j	≥ 20	≤ 2.80

Region	m_{eff} [GeV]	
VR0	< 600	<ul style="list-style-type: none"> Event classification based on τ-multiplicity
SR0A	> 600	<ul style="list-style-type: none"> This talk: τ not considered (τ covered by Andrea Matic)
SR0B	> 1100	<ul style="list-style-type: none"> Only events passing the Z-veto are considered Main discriminating variable effective mass:

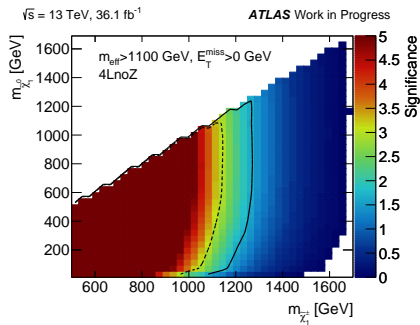
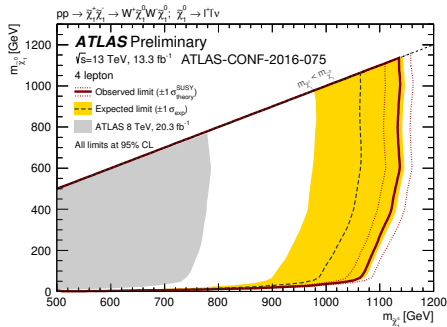
$$m_{\text{eff}} = E_T^{\text{miss}} + \sum_{\substack{\ell_j \\ p_T(i) > 40 \text{ GeV}}} p_T$$



- Signal located at high m_{eff}
- Good modelling observed of data within statistics
- In total 11 (1.5) background events expected in SR0A (SR0B)
 - Background in SR dominated by $t\bar{t}Z$ & ZZ production



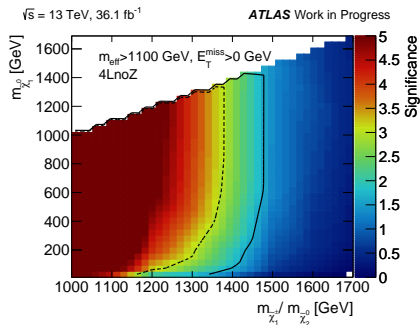
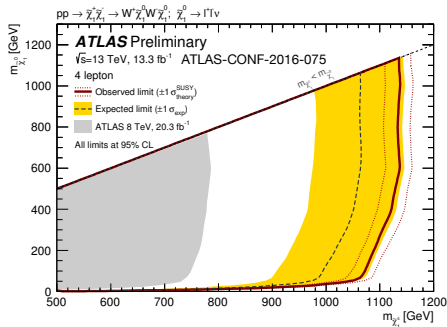
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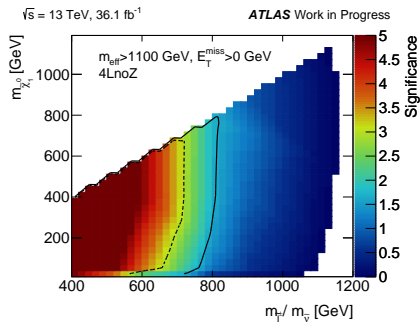
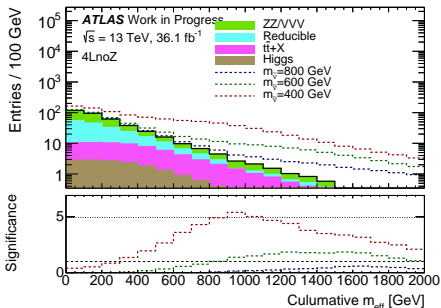
- Only $\tilde{\chi}_1^+ \tilde{\chi}_1^-$ production considered for ICHEP-2016 (13.8 fb $^{-1}$)
 $\Rightarrow \tilde{\chi}_1^\pm$ excluded at 95% C.L. for masses with $m \sim 1.14$ TeV

- Include $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ - production

\Rightarrow Exclusion sensitivity goes beyond $m_{\tilde{\chi}_1^\pm} / m_{\tilde{\chi}_2^0} \sim 1.4$ TeV



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- 3σ sensitivity to $\tilde{\ell}\tilde{\nu}$ production for $m_{\tilde{\ell}/\tilde{\nu}} \sim 600 \text{ GeV}$
- Model with $\tilde{\nu} \rightarrow \ell\ell$ is less sensitive due to lower expected m_{eff} and $\sigma_{\tilde{\nu}\tilde{\nu}}$

- Events with high lepton multiplicity are attractive for SUSY searches with R-parity violation (RPV)
- Low backgrounds
- High sensitivity to different production modes simultaneously
- Development of new models
 - Full \tilde{W} - model including $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ -production
 - $\tilde{\ell}\tilde{\nu}$ -model with all production modes
 - Direct RPV-decays of the produced particles studied for the first time

- Publication planned soon

BACKUP