Run-2 Supersymmetry searches in ATLAS

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On behalf of the ATLAS Collaboration

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Outline

• Overview of Run-1 and Run-2 SUSY searches

• Common analysis procedures
  – Selection of physics objects (jets, b-jets, leptons)
  – Event-selection variables
  – Background estimation & validation methods

• Results and interpretations for 7 analyses:
  1. 2-6 jets ATLAS-CONF-2015-062
  2. 7-10 jets ATLAS-CONF-2015-077
  3. 1 lepton ATLAS-CONF-2015-076
  4. 2 same-sign or 3 leptons ATLAS-CONF-2015-078
  5. 3 or more b-jets ATLAS-CONF-2015-067
  7. $Z \rightarrow \ell\ell$ ATLAS-CONF-2015-082
### Run-1 (7-8 TeV) SUSY results

**ATLAS SUSY Searches** - 95% CL Lower Limits

**Status:** July 2015

**Models**

<table>
<thead>
<tr>
<th>Model</th>
<th>$\tilde{e}+\tilde{\mu}, \tilde{\tau}, \tilde{\gamma}$ Jets</th>
<th>$E_T^{miss}$</th>
<th>$\ell\ell$ $d$ $N_{jets}$ ($h^{-1}$)</th>
<th>Mass limit</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSUGRA/CMSSM</td>
<td>0-3 e, $\mu$/$1-2 \tau$ 2-10 jets/3 b</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.8$ TeV</td>
</tr>
<tr>
<td>GGM (bino NLSP)</td>
<td>2 $\gamma$</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.33$ TeV</td>
</tr>
<tr>
<td>GGM (higgsino-bino NLSP)</td>
<td>$\gamma$</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.3$ TeV</td>
</tr>
<tr>
<td>Gravitino LSP</td>
<td>0 mono-jet</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.25$ TeV</td>
</tr>
<tr>
<td>Inclusive Searches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th gen. med.</td>
<td>0 e, $\tilde{\mu}$</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.25$ TeV</td>
</tr>
<tr>
<td>3rd gen. squarks direct production</td>
<td>0 e, $\tilde{\mu}$</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.3$ TeV</td>
</tr>
<tr>
<td>EW direct</td>
<td>0 e, $\tilde{\mu}$</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$0.3$ TeV</td>
</tr>
<tr>
<td>Long-lived particles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disapp. trk</td>
<td>1 jet</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$270$ GeV</td>
</tr>
<tr>
<td>Stable b R-hadron</td>
<td>0-1 jets</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.2$ TeV</td>
</tr>
<tr>
<td>GMSB, stable $\tau, \tilde{\tau}, \tilde{\tau}$</td>
<td>0 jets</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$435$ GeV</td>
</tr>
<tr>
<td>RPV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFV $\nu\rightarrow\nu$</td>
<td>0 jets</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.7$ TeV</td>
</tr>
<tr>
<td>Bilinear RPV CMSSS</td>
<td>0-3 jets</td>
<td>Yes</td>
<td>20.3</td>
<td>$\tilde{q}$</td>
<td>$1.35$ TeV</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

**Mass scale [TeV]**

<table>
<thead>
<tr>
<th>$\tilde{e}$</th>
<th>$\tilde{e}$</th>
<th>$\tilde{e}$</th>
<th>$\tilde{e}$</th>
<th>$\tilde{e}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>490 GeV</td>
<td>100-308 GeV</td>
<td>4-1.0 TeV</td>
<td>1.0-1.0 TeV</td>
<td>1.0-1.0 TeV</td>
</tr>
</tbody>
</table>

**ATLAS Preliminary**

$\sqrt{s} = 7, 8$ TeV
Run 2 (13 TeV) SUSY analyses…

- ATLAS collected 3.87 fb\(^{-1}\), after quality cuts: 3.2 ± 0.2 fb\(^{-1}\)
- Much smaller than our 8 TeV Run-1 sample: ~20 fb\(^{-1}\)
- But cross sections for strongly produced heavy particles increase significantly in going from 8 TeV to 13 TeV:
  - \(\sim \times 15\) for \(\sigma(\tilde{q}\tilde{q})\) with \(m_{\tilde{q}} = 1\) TeV
  - \(\sim \times 35\) for \(\sigma(\tilde{g}\tilde{g})\) with \(m_{\tilde{g}} = 1.5\) TeV

→ Run-2 SUSY searches focus on gluino and squark production

- 7 analyses using a variety of signatures with 44 signal regions:
  - Missing transverse energy (MET, \(E_T^{miss}\))
  - Jets
  - Leptons: 0, 1, 2 (Z), 2 same sign or 3
  - b-jets: 0, 1, 2, or 3+
… cover a range of SUSY scenarios
Physics object selection

• **Jets:**
  – Reconstructed from calorimeter energy clusters using the anti-$k_T$ algorithm with radius parameter $R = 0.4$
  – Jets are reclustered with $R = 1$ to search for boosted top quarks
  – Corrected for avg. energy deposition from pile-up (= multiple $pp$ collisions, averaging 14 in 2015)
  – Jet energy scale calibrated with detector response from MC and 8 TeV data
  – Event rejected if contains jet identified as due to noise or non-collision

• **b-jets:**
  – Tagged by multivariate algorithm using the impact parameters of tracks in the jet, and the presence and flight paths of displaced vertices from b/c hadrons

• **Electrons:**
  – Matching EM calorimeter clusters to inner-detector tracks & TRT threshold

• **Muons:**
  – Matching tracks in the muon spectrometer and inner detector
Event selection inputs

• **Physics-object overlap removal:**
  - If 2 objects (e, μ, jet, or b-jet) are nearby, indicating mis-identification, one of them is discarded according to an optimized algorithm

• **Missing transverse energy:**
  - \( \vec{p}_T^{\text{miss}} = - \left[ \sum_{\text{physics objects}} \vec{p}_T + \sum_{\text{other PV tracks}} \vec{p}_T \right] \)
  - \( \text{MET} \equiv E_T^{\text{miss}} = |\vec{p}_T^{\text{miss}}| \)

• **Scalar \( p_T \) sum**

• **Effective mass:**
  - \( m_{\text{eff}} = \sum_{\text{physics objects}} p_T + E_T^{\text{miss}} \)
Common analysis procedures

- Define signal regions (SRs)
  - Based on \( N_{\text{leptons}}, N_{\text{jets}}, N_{b-\text{jets}} \) with \( p_T \) cuts, \( H_T \), MET, \( m_{\text{eff}} \), etc.
  - Targeting different regions in SUSY parameter space

- Estimate background for each SR in control regions (CRs)
  - Usually using Monte Carlo distributions to relate CR yields to SR yields
  - Background estimate from CRs validated using validation regions (VRs)
  - Smaller backgrounds often obtained from MC

- If no excess, set limits using the CLs prescription, accounting for systematic uncertainties:
  - Finite MC statistics
  - Theory, e.g., models used for background shapes
  - Jet energy scale and resolution
  - Lepton / b-jet ID efficiencies and purities
1/7. Search using 2-6 jets no leptons
Analysis overview

- 7 SRs with 2-6 jets & different cuts
  - Targeting different models
- Veto leptons with $p_T > 10$ GeV
- 4 CRs for each SR, to obtain background from
  - Multi-jet
  - $Z \rightarrow \nu \bar{\nu}$ + jets
  - $W \rightarrow \ell \bar{\nu}$ + jets
  - $t\bar{t}$, single-$t$
- Background from MC
  - Di-boson

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Signal Region</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2jl</td>
</tr>
<tr>
<td>$E_T^{miss}$ [GeV] &gt;</td>
<td></td>
</tr>
<tr>
<td>$p_T(j_1)$ [GeV] &gt;</td>
<td>200</td>
</tr>
<tr>
<td>$p_T(j_2)$ [GeV] &gt;</td>
<td>200</td>
</tr>
<tr>
<td>$p_T(j_3)$ [GeV] &gt;</td>
<td></td>
</tr>
<tr>
<td>$p_T(j_4)$ [GeV] &gt;</td>
<td></td>
</tr>
<tr>
<td>$p_T(j_5)$ [GeV] &gt;</td>
<td></td>
</tr>
<tr>
<td>$p_T(j_6)$ [GeV] &gt;</td>
<td></td>
</tr>
<tr>
<td>$\Delta\phi(jet_{1,2,3}, E_T^{miss})_{min}$ &gt;</td>
<td>0.8</td>
</tr>
<tr>
<td>$\Delta\phi(jet_{4,5,6}, E_T^{miss})_{min}$ &gt;</td>
<td></td>
</tr>
<tr>
<td>$E_T^{miss} / \sqrt{H_T}$ [GeV$^{1/2}$] &gt;</td>
<td>15</td>
</tr>
<tr>
<td>Aplanarity &gt;</td>
<td></td>
</tr>
<tr>
<td>$E_T^{miss} / m_{eff}(N_j)$ &gt;</td>
<td></td>
</tr>
<tr>
<td>$m_{eff}$(incl.) [GeV] &gt;</td>
<td>1200</td>
</tr>
</tbody>
</table>

Leptons: none with $p_T > 10$ GeV
$m_{\text{eff}}$ in signal regions
Results

Expected and observed event count in each SR:
2/7. Search using
7-10 jets
no leptons
Analysis overview

- 6 SRs with 7-8 $p_T > 80$ GeV jets, incl. 0-2 $b$-jets
- 9 SRs with 8-10 $p_T > 50$ GeV jets, incl. 0-2 $b$-jets
- No leptons with $p_T > 10$ GeV

- $t\bar{t}$, V+jets background obtained from CRs containing a lepton with $p_T > 20$ GeV

- Multijet background from CRs with 1 jet less.
- Utilize near invariance of $E_T^{miss}/\sqrt{H_T}$ wrt. $N_{jets}$ when MET originates from calorimeter mismeasurement
  - Checked in VRs

(a) $n_{s0} = 7$, using a template with $n_{s0} = 6$. 
$E_T^{\text{miss}} / \sqrt{H_T}$ in some SRs

- **SR:** \(\frac{E_T^{\text{miss}}}{\sqrt{H_T}} > 4 \sqrt{\text{GeV}}\)

- **Distribution normalization:** \(\frac{E_T^{\text{miss}}}{\sqrt{H_T}} < 1.5 \sqrt{\text{GeV}}\)

(a) \(n_{50} \geq 10\).

(b) \(n_{50} \geq 10\) and \(n_{b\text{-jet}} \geq 2\).

(c) \(n_{50} \geq 8\).

(d) \(n_{50} \geq 8\) and \(n_{b\text{-jet}} \geq 2\).
## Results

Expected and observed event count in each SR:

<table>
<thead>
<tr>
<th>Signal region</th>
<th>Fitted background</th>
<th>Obs events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multijet</td>
<td>Leptonic</td>
</tr>
<tr>
<td>8j50</td>
<td>109.3 ± 6.8</td>
<td>79 ± 25</td>
</tr>
<tr>
<td>8j50–1b</td>
<td>76.7 ± 2.6</td>
<td>61 ± 21</td>
</tr>
<tr>
<td>8j50–2b</td>
<td>33.8 ± 2.1</td>
<td>33 ± 13</td>
</tr>
<tr>
<td>9j50</td>
<td>16.8 ± 1.2</td>
<td>12.8 ± 5.4</td>
</tr>
<tr>
<td>9j50–1b</td>
<td>13.5 ± 1.9</td>
<td>10.2 ± 4.9</td>
</tr>
<tr>
<td>9j50–2b</td>
<td>6.4 ± 1.6</td>
<td>5.8 ± 3.3</td>
</tr>
<tr>
<td>10j50</td>
<td>2.61 ± 0.60</td>
<td>1.99 ± 0.62</td>
</tr>
<tr>
<td>10j50–1b</td>
<td>2.42 ± 0.62</td>
<td>1.44 ± 0.49</td>
</tr>
<tr>
<td>10j50–2b</td>
<td>1.40 ± 0.87</td>
<td>0.83 ± 0.37</td>
</tr>
<tr>
<td>7j80</td>
<td>40.0 ± 5.1</td>
<td>30 ± 12</td>
</tr>
<tr>
<td>7j80–1b</td>
<td>29.1 ± 3.2</td>
<td>20.8 ± 10</td>
</tr>
<tr>
<td>7j80–2b</td>
<td>11.5 ± 1.6</td>
<td>11.0 ± 4.9</td>
</tr>
<tr>
<td>8j80</td>
<td>4.5 ± 1.9</td>
<td>4.9 ± 2.1</td>
</tr>
<tr>
<td>8j80–1b</td>
<td>3.9 ± 1.5</td>
<td>3.8 ± 2.1</td>
</tr>
<tr>
<td>8j80–2b</td>
<td>1.72 ± 0.92</td>
<td>2.3 ± 1.1</td>
</tr>
</tbody>
</table>
3/7. Search using 1-lepton
Analysis overview

- **4 hard-ℓ SRs:**
  - $p_T > 35$ GeV lepton
  - No additional leptons with $p_T > 10$ GeV
  - 4-6 jets

- **2 soft-ℓ SRs:**
  - $p_T > 7 (6)$ GeV for $e(\mu)$ and $p_T < 35$ GeV
  - No additional $e(\mu)$ with $p_T > 7 (6)$ GeV
  - 2 or 5 jets

- **Dominant background:** $W +$ jets and $t\bar{t}$.
  - Suppressed with cuts on transverse mass
    $$m_T = \sqrt{2p_T^\ell E_T^{\text{miss}} (1 - \cos[\Delta\phi(\ell, p_T^{\text{miss}})])}$$
  - Estimated from CRs, e.g., for soft-ℓ 2-jets:

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A. Soffer, ATLAS SUSY Run-2, Valparaiso
Some SR distributions
Results

Expected and observed event count in each SR:
4/7. Search with same-sign dileptons or 3 leptons
Analysis overview

Background estimation:

- **Wrong lepton charge:**
  - \( Z/\gamma^* \to e^+e^- \) sample
- **Fake leptons or leptons from heavy-flavor-decay:**
  - “Matrix method” with loose lepton selection criteria
- **\( t\bar{t}V, t\bar{t}h \):**
  - From MC with VRs

<table>
<thead>
<tr>
<th>Signal region</th>
<th>( N_{\text{signal}}^{\text{lept}} )</th>
<th>( N_{b\text{jets}}^{20} )</th>
<th>( N_{\text{jets}}^{50} )</th>
<th>( E_T^{\text{miss}} ) [GeV]</th>
<th>( m_{\text{eff}} ) [GeV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR0b3j</td>
<td>( \geq 3 )</td>
<td>=0</td>
<td>( \geq 3 )</td>
<td>&gt;200</td>
<td>&gt;550</td>
</tr>
<tr>
<td>SR0b5j</td>
<td>( \geq 2 ) SS</td>
<td>=0</td>
<td>( \geq 5 )</td>
<td>&gt;125</td>
<td>&gt;650</td>
</tr>
<tr>
<td>SR1b</td>
<td>( \geq 2 ) SS</td>
<td>( \geq 1 )</td>
<td>( \geq 4 )</td>
<td>&gt;150</td>
<td>&gt;550</td>
</tr>
<tr>
<td>SR3b</td>
<td>( \geq 2 ) SS</td>
<td>( \geq 3 )</td>
<td>-</td>
<td>&gt;125</td>
<td>&gt;650</td>
</tr>
</tbody>
</table>
MET distributions in SRs

(a) ATLAS Preliminary
$\sqrt{s}=13\text{ TeV}, 3.2\text{ fb}^{-1}$
SR0b3j before $E_{T}^{\text{miss}}$ cut
- Data
- SUSY $\tilde{g}\to q\tilde{q}_{1}^{0}$
- Multi-Boson
- Rare
- Fake Leptons
- Charge-Flip

$m_{\tilde{g}}=1.2\text{ TeV}, m_{\chi_{1}}=500\text{ GeV}$

(b) ATLAS Preliminary
$\sqrt{s}=13\text{ TeV}, 3.2\text{ fb}^{-1}$
SR0b5j before $E_{T}^{\text{miss}}$ cut
- Data
- SM Total
- Charge-Flip
- Multi-Boson
- Top + V
- Rare
- Fake Leptons
- $\tilde{g}\to q\tilde{q}_{1}^{0}$

$m_{\tilde{g}}=1.1\text{ TeV}, m_{\chi_{1}}=100\text{ GeV}$

(c) ATLAS Preliminary
$\sqrt{s}=13\text{ TeV}, 3.2\text{ fb}^{-1}$
SR1b before $E_{T}^{\text{miss}}$ cut
- Data
- SUSY $\tilde{b}_{1}\to tW_{1}^{0}$
- Charge-Flip
- Multi-Boson
- Rare
- Fake Leptons
- Top + V

$m_{\tilde{b}_{1}}=600\text{ GeV}, m_{\chi_{1}}=50\text{ GeV}$

(d) ATLAS Preliminary
$\sqrt{s}=13\text{ TeV}, 3.2\text{ fb}^{-1}$
SR3b before $E_{T}^{\text{miss}}$ cut
- Data
- SUSY $\tilde{t}\to t\chi_{1}^{0}$
- Charge-Flip
- Multi-Boson
- Rare
- Fake Leptons
- $\tilde{t}\to t\chi_{1}^{0}$

$m_{\tilde{t}}=1.2\text{ TeV}, m_{\chi_{1}}=0.7\text{ TeV}$
## Results

<table>
<thead>
<tr>
<th></th>
<th>SR0b3j</th>
<th>SR0b5j</th>
<th>SR1b</th>
<th>SR3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed events</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Total bkg events</td>
<td>2.4 ± 0.7</td>
<td>0.98 ± 0.32</td>
<td>4.3 ± 1.0</td>
<td>0.78 ± 0.24</td>
</tr>
<tr>
<td>$p(s = 0)$</td>
<td>0.33</td>
<td>0.06</td>
<td>0.12</td>
<td>0.36</td>
</tr>
<tr>
<td>Fake/non-prompt leptons</td>
<td>&lt; 0.2</td>
<td>0.04 ± 0.17</td>
<td>0.8 ± 0.8</td>
<td>0.12 ± 0.16</td>
</tr>
<tr>
<td>Charge flip</td>
<td></td>
<td>0.02 ± 0.04</td>
<td>0.60 ± 0.12</td>
<td>0.19 ± 0.06</td>
</tr>
<tr>
<td>$t\bar{t}W$, $t\bar{t}Z$</td>
<td>0.13 ± 0.06</td>
<td>0.11 ± 0.06</td>
<td>2.0 ± 0.7</td>
<td>0.21 ± 0.09</td>
</tr>
<tr>
<td>$WZ$</td>
<td>1.5 ± 0.5</td>
<td>0.61 ± 0.25</td>
<td>0.17 ± 0.09</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>$W^\pm W^\pm jj$</td>
<td></td>
<td>0.11 ± 0.05</td>
<td>0.03 ± 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>$ZZ$</td>
<td>0.6 ± 0.4</td>
<td></td>
<td>&lt; 0.14</td>
<td>&lt; 0.03</td>
</tr>
<tr>
<td>Triboson</td>
<td>0.09 ± 0.05</td>
<td>0.02 ± 0.01</td>
<td>0.02 ± 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Rare</td>
<td>0.05 ± 0.04</td>
<td>0.05 ± 0.04</td>
<td>0.7 ± 0.4</td>
<td>0.26 ± 0.14</td>
</tr>
</tbody>
</table>

![Diagram](a) $\tilde{g} \rightarrow q\bar{q}ll\tilde{\chi}^0_1$ scenario, SR0b3j

![Diagram](b) $\tilde{g} \rightarrow q\bar{q}WZ\tilde{\chi}^0_1$ scenario, SR0b5j

![Diagram](c) $\tilde{b}_1 \rightarrow t\tilde{\chi}^-_1$ scenario, SR1b

![Diagram](d) $\tilde{g} \rightarrow t\bar{t}\tilde{\chi}^0_1$ scenario, SR3b
5/7. Search with at least 3 $b$-jets
Analysis overview

8 SRs:
• $\geq 3$ $b$-jets
• 0 or 1 lepton
• 0 or $\geq 1$ top ($R = 1$ jet)

Background Estimation:
• $t\bar{t}$
  • From CR for each SR
• $t\bar{t}V$, $t\bar{t}h$, single-$t$, 4$t$, V+jets
  • From MC

• MET distributions in some SRs:
Results

Results of background-only fit in VRs
6/7. Search for sbottom pair
**Analysis overview**

4 SRs:
- 3 "SRA" target pair production
- SRB target pair production with ISR jet

**Background:**
- $t\bar{t}$ and $V +$ heavy flavor
  - Studied with CRs containing leptons

---

### Main discriminator: contraverse mass,

$$m_{CT}^2(v_1, v_2) = [E_T(v_1) + E_T(v_2)]^2 - [p_T(v_1) - p_T(v_2)]^2$$

Can be used to measure $m_{\tilde{b}}$
Results
7/7. Search with

\[ Z \rightarrow \ell^+ \ell^- \]
Analysis overview

Target $Z$ production

<table>
<thead>
<tr>
<th>$E_T^{\text{miss}}$ [GeV]</th>
<th>$H_T$ [GeV]</th>
<th>$n_{\text{jets}}$</th>
<th>$m_{TT}$ [GeV]</th>
<th>SF/DF</th>
<th>$\Delta\phi(\text{jet}_{12}, P_T^{\text{miss}})$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 225</td>
<td>&gt; 600</td>
<td>$\geq 2$</td>
<td>$81 &lt; m_{ee} &lt; 101$</td>
<td>SF</td>
<td>$&gt; 0.4$</td>
</tr>
</tbody>
</table>

Run-1 $3\sigma$ excess:

Dominant backgrounds:

- $t\bar{t}, WW, Wt$:
  - Using CR with different-flavor leptons ($e\mu$)
- $Z/\gamma^* + \text{jets}$:
  - Using CR with $\gamma + \text{jets}$
## Results

<table>
<thead>
<tr>
<th></th>
<th>SRZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed events</td>
<td>21</td>
</tr>
<tr>
<td>Total expected background events</td>
<td>10.3 ± 2.3</td>
</tr>
<tr>
<td>Flavour symmetric ($t\bar{t}$, $Wt$, $WW$ and $Z \rightarrow \tau\tau$) events</td>
<td>5.1 ± 2.0</td>
</tr>
<tr>
<td>$WZ/ZZ$ events</td>
<td>2.9 ± 0.8</td>
</tr>
<tr>
<td>$Z/\gamma^*$ + jets events</td>
<td>1.9 ± 0.8</td>
</tr>
<tr>
<td>Rare top events</td>
<td>0.4 ± 0.1</td>
</tr>
<tr>
<td>$p$-value</td>
<td>0.013</td>
</tr>
<tr>
<td>Significance</td>
<td>2.2</td>
</tr>
<tr>
<td>Observed (Expected) $S^{95}$</td>
<td>20.0 (10.2±4.4)</td>
</tr>
</tbody>
</table>

### ATLAS Preliminary Data 2015

- $\sqrt{s} = 13$ TeV, 3.2 fb$^{-1}$
- SRZ $e\mu+\mu\mu$

![Graph showing events vs. $m_{ll}$](attachment:image.png)

A. Soffer, ATLAS SUSY Run-2, Valparaiso
Conclusions

• ATLAS doing very well in Run-2 (3.2 ± 0.2 fb⁻¹)
• Completed 7 analyses to search for SUSY signatures
  – Focusing on strong production – improvement wrt. Run-1
  – No excess signal found
  – Mass limits almost always tighter than those of Run-1
• Working hard on many more SUSY searches with Run-2 data