Searches for $R$-Parity Violating Supersymmetry with Baryon Number Violation

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Introduction

• Generic MSSM violates leptons and baryon number
  - $W_{\Delta L=1} = \frac{1}{2} \lambda^{ijk} L_i L_j \bar{e}_k + \lambda'^{ijk} L_i Q_j \bar{d}_k + \mu''^i L_i H_u$
  - $W_{\Delta B=1} = \frac{1}{2} \lambda''^{ijk} \bar{u}_i \bar{d}_j \bar{d}_k$
• Forbid these by imposing $R$-Parity conservation
  - $R = (-1)^{3(B-L)+2s}$
• Sufficient to forbid either baryon or lepton number violation
• This talk presents searches for baryon number violating processes
  - All hadronic stop search: ATLAS-CONF-2015-026
• See Emma Torró’s talk for lepton number violating processes
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   Common features
   Jet counting
   Total jet mass

All hadronic stop search
   Search strategy
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Summary
Multi-jet search

- Two complimentary search strategies
  - **Jet counting** Exploits differences in the jet multiplicity
  - **Total jet mass** Exploits difference in shape of the jet mass distribution

\[ \tilde{g} \quad \tilde{g} \quad p \quad q \quad \lambda'' \quad q \quad q \quad q \quad p \quad \tilde{g} \quad \tilde{\chi}_1^0 \quad \lambda'' \quad q \quad q \quad q \quad q \quad p \quad q \quad q \quad q \]
Object definitions

- **Standard jets**
  - anti-$k_T$ $R = 0.4$
  - $p_T > 60$ GeV in all regions
- **Large-$R$ jets**
  - anti-$k_T$ $R = 1.0$
  - Trim subjets if $p_T^{i}/p_T^{jet} < 0.05$
  - Mass constructed from trimmed jets
  - Used in total jet mass analysis
- **$b$-tagging**: 70% efficient when applied
Jet counting

- Looking for excess of events with $\geq 6$, $\geq 7$ high $p_T$ jets
- Define 48 signal regions: optimal region selected for each model
  - $n_{\text{jet}} \geq 6, 7$
  - $p_T > 80 - 220$ GeV in steps of 20 GeV
  - $n_{b-\text{tagged}} \geq 0, 1, 2$
- SM multijet background extrapolated from control regions
  - $m_{\text{jet}} = n_{\text{jet}} - 2$ (depends on signal region)
  - $N_{\text{SR}} = \left( N_{\text{data}}^{\text{CR}} - N_{\text{MC}}^{\text{CR}, \text{other BG}} \right) \left( \frac{N_{\text{MC}}^{\text{SR}}}{N_{\text{MC}}^{\text{CR}}} \right) + N_{\text{MC}}^{\text{SR}, \text{other BG}}$

![Graph 1](atlas_graph1.png)

![Graph 2](atlas_graph2.png)
Jet counting results: 6-quark model

\[ \sigma(pp \rightarrow 6q) \rightarrow g\bar{g} \rightarrow (pp) \sigma \]

<table>
<thead>
<tr>
<th>( m_{h} ) [GeV]</th>
<th>( \sigma ) [pb]</th>
<th>Obs 95% CL Limit</th>
<th>Exp Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>1.0 \times 10^{-3}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>800</td>
<td>1.0 \times 10^{-2}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1000</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1200</td>
<td>1.0 \times 10^{-1}</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

\( \sqrt{s} = 8 \text{ TeV}, 20.3 \text{ fb}^{-1} \)

\[ \text{BR}(t)=0\%, \text{BR}(b)=0\%, \text{BR}(c)=0\% \]

\[ \text{BR}(t)=100\%, \text{BR}(b)=0\%, \text{BR}(c)=0\% \]

\[ \text{BR}(t)=100\%, \text{BR}(b)=100\%, \text{BR}(c)=0\% \]

\[ \text{ATLAS} \]
Jet counting results: 6-quark model

- Observed mass exclusion limits

**BR(c) = 0 %**

\[
\begin{array}{cccccc}
100 & 788 & 802 & 811 & 829 & 874 \\
75 & 763 & 773 & 802 & 816 & 872 \\
50 & 666 & 817 & 780 & 809 & 831 \\
25 & 680 & 681 & 759 & 810 & 863 \\
0 & 917 & 890 & 734 & 794 & 929 \\
\end{array}
\]

\[\text{pp} \rightarrow g\bar{g} \rightarrow 6q, \text{BR}(c)=0\%\]

All limits at 95% CL \( \sqrt{s} = 8 \text{ TeV}, 20.3 \text{ fb}^{-1} \)

**BR(c) = 50 %**

\[
\begin{array}{cccccc}
100 & 725 & 776 & 806 & 820 & 874 \\
50 & 675 & 743 & 788 & 810 & 822 \\
25 & 896 & 881 & 890 & 810 & 879 \\
0 & 896 & 881 & 890 & 810 & 879 \\
\end{array}
\]

\[\text{pp} \rightarrow g\bar{g} \rightarrow 6q, \text{BR}(c)=50\%\]

All limits at 95% CL \( \sqrt{s} = 8 \text{ TeV}, 20.3 \text{ fb}^{-1} \)
Jet counting results: 10-quark model

- Expected and observed mass exclusion limits

**Without $b$-tagging**

**With $b$-tagging**
Total jet mass

- **Total jet mass** = scalar sum of masses of four leading large-\(R\) jets
  - \(M_{\Sigma J} = \sum m_{\text{jet}}\)
- Also use \(|\Delta \eta|\) between leading two large-\(R\) jets to provide additional discrimination

| Region Name | \(n_{\text{jet}}\) \(\geq 4\) | \(|\Delta \eta|\) | \(p_T^3\) \(\geq 250\) | \(p_T^4\) \(\geq 100\) | \(M_{\Sigma J}\) \(\geq 100\) |
|-------------|-----------------|-------------|-----------------|-----------------|-----------------|
| 3jCR        | \(n_{\text{jet}} = 3\) | –           | –               | –               | –               |
| 4jCR        | \(n_{\text{jet}} \geq 4\) | \(\geq 1.40\) | \(> 100\)       | \(> 100\)       | –               |
| 4jVR        | \(n_{\text{jet}} \geq 4\) | 1.0–1.40    | \(> 100\)       | \(> 100\)       | –               |
| SR1         | \(n_{\text{jet}} \geq 4\) | \(< 0.7\)   | \(> 250\)       | \(> 100\)       | \(> 625\)       |
| SR100       | \(n_{\text{jet}} \geq 4\) | –           | \(> 250\)       | \(> 100\)       | \(> 350\) (binned) |
| SR250       | \(n_{\text{jet}} \geq 4\) | –           | \(> 250\)       | \(> 100\)       | \(> 350\) (binned) |
Background estimate

- Extract jet mass templates from 3-jet control region
  - Probability density function for mass of a given jet
  - Function of jet $p_T$ and $\eta$
- Use mass templates to construct data driven estimate
  - Apply jet mass template to each jet in event
  - Combine resulting masses to predict total jet mass for event
Total jet mass results: 10-quark model

- Expected and observed mass exclusion limits

\[ m_{\tilde{g}_{\chi_1}} \] results:

- Expected and observed mass exclusion limits

\[ m_{\tilde{g}_{\chi_1}} \] production:

\[ \tilde{g} \rightarrow q\bar{q}^0, \tilde{\chi}_1^0 \rightarrow q\bar{q} \]

All limits at 95% CL

\[ \sqrt{s} = 8 \text{ TeV}, 20.3 \text{ fb}^{-1} \]

\[ m_{\tilde{g}} \] limits:

- Expected limit (±1 \( \sigma_{\text{exp}} \))
- Observed limit (±1 \( \sigma_{\text{SUSY}} \))

Unevaluated due to UDD Radiation Uncertainties
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All hadronic stop search
  Search strategy
  Results

Summary
All hadronic stop search

- Targets direct production of light stops
  - $m_{\tilde{t}} = 100 - 400$ GeV
  - Region previously missed because of trigger requirement
- Search for resonant decay of stops
  - Each stop decays to two SM quarks
  - Fully hadronic final state
Strategy

- Difficult to target light stops at the LHC
  - Multijet trigger applies heavy prescale
  - Hard to distinguish 4-jet final state from QCD multijet background
- Using **boosted jets**, it is possible to work around these challenges
  - Cross sections are high for light stops. Able to cut hard on stop $p_T$
  - Recluster jets into two large-$R$ jets with substructure
- Require $b$-tagged jets
  - This restricts the search to 3rd generation couplings only
Selection

- Jets
  - anti-$k_T$ $R = 0.4$
  - $p_T > 20$ GeV
- “Large-$R$” jets
  - Recluster groomed jets using anti-$k_T$ $R = 1.5$
  - $p_T > 200$ GeV
  - $m > 20$ GeV
  - Require at least two large-$R$ jets
- Trigger
  - Leading $R = 0.4$ jet with $p_T > 175$ GeV
  - $H_T = \sum p_T > 650$ GeV
- $b$-tagging
  - Applied on $R = 0.4$ jets
  - 70% efficient working point
Signal region

- Number of \( b \)-tagged jets \( \geq 2 \)
- Mass asymmetry between leading and sub-leading large-\( R \) jets
  - Expect stops to have equal mass
  - No preference for QCD jets
  - \( \mathcal{A} = \left| \frac{m_1 - m_2}{m_1 + m_2} \right| < 0.1 \)
- Angle between the stop pair and the beam axis in center-of-mass frame
  - Distinguishes between centrally produced massive particles (stops) and high-mass forward-scattering event from QCD
  - \( |\cos \theta^*| < 0.3 \)
- Subjet \( p_T \) ratio
  - Applied to leading two large-\( R \) jets
  - \( \frac{\min[p_T(a), p_T(b)]}{\max[p_T(a), p_T(b)]} > 0.3 \)
**Signal region**

- **Number of** $b$-tagged jets $\geq 2$
- **Mass asymmetry** between leading and sub-leading large-$R$ jets
  - Expect stops to have equal mass
  - No preference for QCD jets
  - $\mathcal{A} = \left| \frac{m_1 - m_2}{m_1 + m_2} \right| < 0.1$
- **Angle between the stop pair and the beam axis** in center-of-mass frame
  - Distinguishes between centrally produced massive particles (stops) and high-mass forward-scattering event from QCD
  - $|\cos \theta^*| < 0.3$
- **Subjet $p_T$ ratio**
  - Applied to leading two large-$R$ jets
  - $\frac{\text{min}[p_T(a), p_T(b)]}{\text{max}[p_T(a), p_T(b)]} > 0.3$
Background estimation

- SM multijet background estimated from sideband regions
  - Assumes the $m_{\text{jet}}^{\text{avg}}$ distribution does not depend on the $b$-jet multiplicity
- $t\bar{t}$ estimate taken from Monte Carlo simulation
Results

- Search performed in regions of the average mass of the leading two large-$R$ jets: $m_{\text{avg}}^\text{jet} = \left( m_1^\text{jet} + m_2^\text{jet} \right) / 2$
- No observed excess
- Stops with mass between $100 \leq m_{\tilde{t}} \leq 310$ GeV were excluded
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**All hadronic stop search**
- Search strategy
- Results

**Summary**
Summary

- Presented ATLAS searches for RPV SUSY with baryon number violation.
- Lower mass limits on gluino production:
  - \( m_{\tilde{g}} > 917 \text{ GeV} \) when gluino decays to six light quarks.
  - \( m_{\tilde{g}} > 1 \text{ TeV} \) when gluino has cascade decay to ten quarks.
- Limits on stop decaying to all hadronic final state:
  - Exclude stops with mass \( 100 \leq m_{\tilde{t}} \leq 310 \text{ GeV} \).

![Graph showing limits on gluino and stop production](image-url)
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Multi-jet search</th>
<th>All hadronic stop search</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Backup
Jet counting results: 6-quark model

- **Expected mass exclusion limits**

**BR(c)=0 %**

| BR(t) [%] | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 0 |
|----------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| BR(b) [%] | 100 | 881| 896| 906| 917| 938| 75 | 857| 878| 894| 906| 925| 50 | 814| 849| 878| 897| 913| 25 | 794| 823| 862| 891| 907| 0  | 853| 832| 852| 898| 921|

ATLAS

**BR(c)=50 %**

| BR(t) [%] | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 | 5 | 0 |
|----------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| BR(b) [%] | 100 | 847| 876| 893| 907| 924| 75 | 814| 852| 878| 895| 913| 50 | 814| 852| 878| 895| 913| 25 | 814| 852| 878| 895| 913| 0  | 851| 834| 869| 899| 914|

ATLAS

All limits at 95% CL \( \sqrt{s} = 8 \) TeV, 20.3 fb\(^{-1} \)
Jet counting event yields: 6 quark model

<table>
<thead>
<tr>
<th>Sample $m_\tilde{g}$ [GeV]</th>
<th>Jet $p_T$ req. [GeV]</th>
<th># of jets</th>
<th># of $b$-tags</th>
<th>Signal (Acceptance)</th>
<th>Background</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>(BR(t), BR(b), BR(c))=(0%, 0%, 0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 120</td>
<td>7</td>
<td>0</td>
<td>600±230 (0.7%)</td>
<td>370±60</td>
<td>444</td>
<td></td>
</tr>
<tr>
<td>600 120</td>
<td>7</td>
<td>0</td>
<td>410±100 (1.5%)</td>
<td>370±60</td>
<td>444</td>
<td></td>
</tr>
<tr>
<td>800 180</td>
<td>7</td>
<td>0</td>
<td>13±4 (0.4%)</td>
<td>6.1±2.2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1000 180</td>
<td>7</td>
<td>0</td>
<td>6.8±2.3 (1.4%)</td>
<td>6.1±2.2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1200 180</td>
<td>7</td>
<td>0</td>
<td>2.7±0.5 (3.0%)</td>
<td>6.1±2.2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>(BR(t), BR(b), BR(c))=(0%, 100%, 0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 80</td>
<td>7</td>
<td>2</td>
<td>1900±400 (2.1%)</td>
<td>1670±190</td>
<td>1560</td>
<td></td>
</tr>
<tr>
<td>600 120</td>
<td>7</td>
<td>1</td>
<td>300±60 (1.1%)</td>
<td>138±26</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>800 120</td>
<td>7</td>
<td>1</td>
<td>131±25 (4.1%)</td>
<td>138±26</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>1000 180</td>
<td>7</td>
<td>1</td>
<td>4.4±1.0 (0.9%)</td>
<td>2.3±1.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1200 180</td>
<td>7</td>
<td>1</td>
<td>1.86±0.31 (2.1%)</td>
<td>2.3±1.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(BR(t), BR(b), BR(c))=(100%, 0%, 0%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 80</td>
<td>7</td>
<td>1</td>
<td>4600±800 (5.0%)</td>
<td>5900±700</td>
<td>5800</td>
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</tr>
<tr>
<td>600 100</td>
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<td>1</td>
<td>940±190 (3.5%)</td>
<td>940±140</td>
<td>936</td>
<td></td>
</tr>
<tr>
<td>800 120</td>
<td>7</td>
<td>1</td>
<td>108±18 (3.4%)</td>
<td>138±26</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>1000 120</td>
<td>7</td>
<td>1</td>
<td>42±6 (8.5%)</td>
<td>138±26</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>1200 180</td>
<td>7</td>
<td>1</td>
<td>1.3±0.4 (1.5%)</td>
<td>2.3±1.0</td>
<td>1</td>
<td></td>
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<tr>
<td>(BR(t), BR(b), BR(c))=(100%, 100%, 0%)</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>500 80</td>
<td>7</td>
<td>2</td>
<td>3600±600 (3.9%)</td>
<td>1670±190</td>
<td>1560</td>
<td></td>
</tr>
<tr>
<td>600 80</td>
<td>7</td>
<td>2</td>
<td>2300±400 (8.6%)</td>
<td>1670±190</td>
<td>1560</td>
<td></td>
</tr>
<tr>
<td>800 120</td>
<td>7</td>
<td>2</td>
<td>94±15 (3.0%)</td>
<td>38±17</td>
<td>56</td>
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</tr>
<tr>
<td>1000 120</td>
<td>7</td>
<td>2</td>
<td>37±6 (7.5%)</td>
<td>38±17</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>1200 140</td>
<td>7</td>
<td>2</td>
<td>5.5±1.0 (6.2%)</td>
<td>10±5</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>
Jet counting results event yields: 10 quark model

<table>
<thead>
<tr>
<th>Sample ( (m_{\tilde{g}}, m_{\chi_0^1}) )</th>
<th>Jet ( p_T ) req. [GeV]</th>
<th># jets</th>
<th># b-tagged jets</th>
<th>Signal (Acceptance)</th>
<th>Background</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>(400 GeV, 50 GeV)</td>
<td>80</td>
<td>7</td>
<td>2</td>
<td>1900±400 (0.5%)</td>
<td>1670±190</td>
<td>1558</td>
</tr>
<tr>
<td>(400 GeV, 300 GeV)</td>
<td>80</td>
<td>7</td>
<td>2</td>
<td>2500±600 (0.7%)</td>
<td>1670±290</td>
<td>1558</td>
</tr>
<tr>
<td>(600 GeV, 50 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>180±40 (0.7%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(600 GeV, 300 GeV)</td>
<td>80</td>
<td>7</td>
<td>2</td>
<td>2200±350 (8.3%)</td>
<td>1670±200</td>
<td>1558</td>
</tr>
<tr>
<td>(800 GeV, 50 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>95±16 (3.0%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(800 GeV, 300 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>172±28 (5.4%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(800 GeV, 600 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>150±23 (4.7%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(1000 GeV, 50 GeV)</td>
<td>220</td>
<td>6</td>
<td>1</td>
<td>7.0±1.3 (1.4%)</td>
<td>3.8±3.0</td>
<td>5</td>
</tr>
<tr>
<td>(1000 GeV, 300 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>67±8 (14%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(1000 GeV, 600 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>101±13 (20%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(1000 GeV, 900 GeV)</td>
<td>120</td>
<td>7</td>
<td>1</td>
<td>33±4 (6.7%)</td>
<td>138±26</td>
<td>178</td>
</tr>
<tr>
<td>(1200 GeV, 50 GeV)</td>
<td>220</td>
<td>6</td>
<td>1</td>
<td>3.8±0.7 (4.3%)</td>
<td>3.8±3.0</td>
<td>5</td>
</tr>
<tr>
<td>(1200 GeV, 300 GeV)</td>
<td>180</td>
<td>7</td>
<td>1</td>
<td>2.01±0.32 (2.3%)</td>
<td>2.3±1.0</td>
<td>1</td>
</tr>
<tr>
<td>(1200 GeV, 600 GeV)</td>
<td>140</td>
<td>7</td>
<td>1</td>
<td>18.9±2.3 (21%)</td>
<td>41±12</td>
<td>45</td>
</tr>
<tr>
<td>(1200 GeV, 900 GeV)</td>
<td>140</td>
<td>7</td>
<td>1</td>
<td>12.6±1.5 (14%)</td>
<td>41±12</td>
<td>45</td>
</tr>
</tbody>
</table>
Total jet mass results event yields

### SR1

**Summary yield table for SR1**

<table>
<thead>
<tr>
<th>$M_{\sum J}$ Bin</th>
<th>Expected SM</th>
<th>Obs.</th>
<th>$m_{\tilde{g}} = 600$ GeV $m_{\tilde{\chi}_1^0} = 50$ GeV</th>
<th>$m_{\tilde{g}} = 1$ TeV $m_{\tilde{\chi}_1^0} = 600$ GeV</th>
<th>$m_{\tilde{g}} = 1.4$ TeV $m_{\tilde{\chi}_1^0} = 900$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 625 GeV</td>
<td>160±9.7</td>
<td>176</td>
<td>70±4.2 ±25±30 (0.26%)</td>
<td>55±0.51 ±8.6 ±14 (11%)</td>
<td>6.3±0.07 ±0.46±2.5 (35%)</td>
</tr>
</tbody>
</table>

### SR100

**Summary yield table for SR100**

<table>
<thead>
<tr>
<th>$M_{\sum J}$ Bin</th>
<th>Expected SM</th>
<th>Obs.</th>
<th>$m_{\tilde{g}} = 600$ GeV $m_{\tilde{\chi}_1^0} = 50$ GeV</th>
<th>$m_{\tilde{g}} = 1$ TeV $m_{\tilde{\chi}_1^0} = 600$ GeV</th>
<th>$m_{\tilde{g}} = 1.4$ TeV $m_{\tilde{\chi}_1^0} = 900$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 - 400 GeV</td>
<td>4300±78</td>
<td>5034</td>
<td>200±7.2±22±35</td>
<td>5.8±0.17±1.3±1.5</td>
<td>0.19±0.01±0.04±0.07</td>
</tr>
<tr>
<td>400 - 450 GeV</td>
<td>2600±49</td>
<td>2474</td>
<td>200.±7.1±9.5±35</td>
<td>9.7±0.21±2.2±2.5</td>
<td>0.31±0.02±0.07±0.12</td>
</tr>
<tr>
<td>450 - 525 GeV</td>
<td>2100±42</td>
<td>1844</td>
<td>280.±8.4±13±49</td>
<td>26±0.35±4.3±6.7</td>
<td>0.88±0.03±0.14±0.34</td>
</tr>
<tr>
<td>525 - 725 GeV</td>
<td>960±25</td>
<td>1070</td>
<td>280.±8.4±57±49</td>
<td>77±0.60±3.2</td>
<td>3.6±0.05±0.36±1.4</td>
</tr>
<tr>
<td>&gt; 725 GeV</td>
<td>71±7.0</td>
<td>79</td>
<td>35.±2.9±18±6.0</td>
<td>35±0.40±9.9±9.0</td>
<td>4.8±0.06±0.61±1.9</td>
</tr>
</tbody>
</table>

### SR250

**Summary yield table for SR250**

<table>
<thead>
<tr>
<th>$M_{\sum J}$ Bin</th>
<th>Expected SM</th>
<th>Obs.</th>
<th>$m_{\tilde{g}} = 600$ GeV $m_{\tilde{\chi}_1^0} = 50$ GeV</th>
<th>$m_{\tilde{g}} = 1$ TeV $m_{\tilde{\chi}_1^0} = 600$ GeV</th>
<th>$m_{\tilde{g}} = 1.4$ TeV $m_{\tilde{\chi}_1^0} = 900$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 - 400 GeV</td>
<td>1400±35</td>
<td>1543</td>
<td>83±4.6 ±15±14</td>
<td>3.3±0.12±0.78±0.85</td>
<td>0.17±0.01 ±0.03±0.07</td>
</tr>
<tr>
<td>400 - 450 GeV</td>
<td>920±33</td>
<td>980</td>
<td>92±4.8 ±11±16</td>
<td>5.6±0.16 ±1.5±1.5</td>
<td>0.27±0.01 ±0.07±0.11</td>
</tr>
<tr>
<td>450 - 525 GeV</td>
<td>780±33</td>
<td>823</td>
<td>140±5.8 ±15±23</td>
<td>17±0.28 ±3.3±4.4</td>
<td>0.79±0.02 ±0.13±0.31</td>
</tr>
<tr>
<td>525 - 725 GeV</td>
<td>490±24</td>
<td>495</td>
<td>160±6.2 ±30±27</td>
<td>56±0.51 ±4.1±15</td>
<td>3.3±0.05 ±0.34±1.3</td>
</tr>
<tr>
<td>&gt; 725 GeV</td>
<td>37±5.5</td>
<td>42</td>
<td>22±2.3 ±9.1±3.9</td>
<td>27±0.36 ±7.4±7.0</td>
<td>4.4±0.06 ±0.56±1.7</td>
</tr>
</tbody>
</table>
## All hadronic stop search event yields

<table>
<thead>
<tr>
<th>$m_{\tilde{t}}$ [GeV]</th>
<th>Window [GeV]</th>
<th>$N_B^{\text{data-driven est.}}$</th>
<th>$N_{\tilde{t}\tilde{t}}^{\text{est.}}$</th>
<th>$N_B^{\text{tot. est.}}$</th>
<th>$N_{\text{data}}$</th>
<th>$N_S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>[95, 115]</td>
<td>405 ± 50</td>
<td>37 ± 29</td>
<td>442 ± 58</td>
<td>391</td>
<td>540 ± 130</td>
</tr>
<tr>
<td>125</td>
<td>[115, 135]</td>
<td>440 ± 46</td>
<td>64 ± 36</td>
<td>504 ± 59</td>
<td>484</td>
<td>510 ± 130</td>
</tr>
<tr>
<td>150</td>
<td>[135, 165]</td>
<td>604 ± 59</td>
<td>98 ± 50</td>
<td>702 ± 77</td>
<td>680</td>
<td>490 ± 140</td>
</tr>
<tr>
<td>175</td>
<td>[165, 190]</td>
<td>416 ± 46</td>
<td>62 ± 34</td>
<td>478 ± 58</td>
<td>503</td>
<td>379 ± 82</td>
</tr>
<tr>
<td>200</td>
<td>[185, 210]</td>
<td>351 ± 47</td>
<td>15 ± 11</td>
<td>366 ± 48</td>
<td>363</td>
<td>285 ± 61</td>
</tr>
<tr>
<td>225</td>
<td>[210, 235]</td>
<td>236 ± 38</td>
<td>2.5 ± 2.5</td>
<td>238 ± 38</td>
<td>270</td>
<td>170 ± 30</td>
</tr>
<tr>
<td>250</td>
<td>[235, 265]</td>
<td>162 ± 30</td>
<td>1.1 ± 1.1</td>
<td>163 ± 30</td>
<td>169</td>
<td>124 ± 28</td>
</tr>
<tr>
<td>275</td>
<td>[260, 295]</td>
<td>94 ± 21</td>
<td>0.78 ± 0.78</td>
<td>95 ± 21</td>
<td>79</td>
<td>70 ± 19</td>
</tr>
<tr>
<td>300</td>
<td>[280, 315]</td>
<td>63 ± 17</td>
<td>0.75 ± 0.70</td>
<td>64 ± 17</td>
<td>54</td>
<td>46 ± 10</td>
</tr>
<tr>
<td>325</td>
<td>[305, 350]</td>
<td>39 ± 13</td>
<td>0.59 ± 0.40</td>
<td>39 ± 13</td>
<td>47</td>
<td>28.7 ± 6.9</td>
</tr>
<tr>
<td>350</td>
<td>[325, 370]</td>
<td>23.9 ± 9.6</td>
<td>0.16 ± 0.096</td>
<td>24.0 ± 9.6</td>
<td>38</td>
<td>19.3 ± 4.2</td>
</tr>
<tr>
<td>375</td>
<td>[345, 395]</td>
<td>16.2 ± 8.0</td>
<td>0.076 ± 0.072</td>
<td>16.3 ± 8.0</td>
<td>21</td>
<td>12.6 ± 3.0</td>
</tr>
<tr>
<td>400</td>
<td>[375, 420]</td>
<td>8.8 ± 5.6</td>
<td>0.071 ± 0.071</td>
<td>8.9 ± 5.6</td>
<td>6</td>
<td>7.8 ± 1.8</td>
</tr>
</tbody>
</table>