Stealth and Compressed SUSY searches with ATLAS and CMS

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on behalf of the
ATLAS and CMS Collaborations

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compressed and Stealth SUSY

**compressed SUSY:**
\[ \Delta m(\text{next-to-LSP, LSP}) \text{ is close to 0 or to } m_{SM} \text{ (ex: } m_{\text{top}}) \]
- EWK-inos can exist in near-degenerate pairs or triplets
- Possible for squarks to have masses close to LSP or to \( m_{\text{quark}} \)

**Kinematics:**
- In the NLSP frame, decay products are at rest
- If NLSP is boosted, heavy LSP can inherit boost \( \rightarrow \) MET

**Stealth SUSY (cf. talk by M. Reece):**
A new sector with particles (\( S \) and \( \tilde{S} \)) of similar mass
- Almost no SUSY-breaking in “stealth” sector
- LSP (gravitino) is very light

**Kinematics:**
- All the boost is transferred to SM particles through the massive \( S \)
- Light LSP inherits no boost \( \rightarrow \) no MET

- **Note 1:** \( R \)-parity is conserved in all these models (all vertices have 2 red one black).
- **Note 2:** Small \( \Delta m \) can limit the decay phase-space, resulting in long-lived particles (not discussed in these slides)
Variety of signals

Signals:

Compressed electroweak SUSY
\[ \Delta m(\chi, \text{LSP}) \sim 0 \]

Compressed strong SUSY
\[ \Delta m(\tilde{q}, \text{LSP}) \sim 0 \text{ or } m_{\text{SM}} \]

Strong SUSY with compressed EWK decay
\[ \Delta m(\chi, \text{LSP}) \sim 0 \]

Strong SUSY with Stealth decay
\[ \Delta m(\tilde{S}, S) \sim 0 \]
Variety of signals and final states

Signals:
- Compressed electroweak SUSY
- Compressed strong SUSY
- Strong SUSY with compressed EWK decay
- Strong SUSY with Stealth decay

Final States:
- Soft lepton(s) + MET
- VBF jets + MET
- Mono-jet + MET (a.k.a. ISR)
- Jets + MET (+ b-tags)
- Ttbar-like (spin and $\sigma$)
- Photons (or leptons) + jets

8 TeV only

New 13 TeV results
State of the art at 8 TeV, 20 fb⁻¹

Natural example: compressed searches for stop

- Monojet
- soft lepton + MET
- ttbar spin corr. and σ
Compressed SUSY searches at 13 TeV

Early 13 TeV searches focus on strong-production
EWK searches require more data to be competitive with 8 TeV

Focus on recent searches with compressed signal regions

<table>
<thead>
<tr>
<th></th>
<th>ATLAS</th>
<th>CMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monojet</td>
<td>arXiv:1604.07773</td>
<td>CMS-PAS-EXO-16-013 (but no SUSY interpretations)</td>
</tr>
<tr>
<td>0 lep, b-tags, MET (sbottom)</td>
<td>ATLAS-CONF-2015-066</td>
<td>CMS-PAS-SUS-16-001</td>
</tr>
</tbody>
</table>

Good agreement observed between data and SM (all searches)
Interpret results using simplified SUSY models (SMS):
• $\varepsilon_{\text{SMS}} A_{\text{SMS}}$ to get cross-section limits as a function of mass
• $\sigma_{\text{SMS}}$ to convert cross-section limits to mass limits
1 lepton + jets + MET (ATLAS)

- 1 lepton: high $p_T$ (>35 GeV) or low $p_T$ (7/6–35 GeV (e/µ))
- 2 “compressed regions” using soft leptons
  - $N_j \geq 2$, $M_{E_T}$>540 GeV, $m_T$>100 GeV,
  - $N_j \geq 5$, $M_{E_T}$>375 GeV, $H_T$>1.1 TeV, jet aplanarity

Main backgrounds: ttbar, W+jets
  - Normalized in control regions, checked in validation regions

Large region probed by soft lepton

Even mass splitting ($\Delta m_1 = \Delta m_2$): small $\Delta m_2$ only near the diagonal
Inclusive: explore all phase space in $N_j$, $N_b$, $\text{MET}$, $m_T$
- 1 lepton: only low $p_T$ (5–20 GeV ($e/\mu$))
- $\text{MET} > 200$ GeV (trigger)
Main backgrounds: 1 lepton (tt, W), 2 lepton (tt)
  - Estimated in control regions with similar kinematics

Limit weakens near the diagonal (less $\text{MET}$) and at $m_{\text{LSP}} \sim 0$ (high $p_T$ leptons)

CMS Preliminary

As $m_{\text{LSP}} \sim 0$, leptons inherit the $\chi^\pm$ boost

**Figure:**
- CMS Preliminary data with expected predictions for $H_T > 200$ GeV, $E_{T,\text{miss}} > 200$ GeV, $1j$, $0b$ (0 fake), $M_T > 20$ GeV.
- Comparison between observed data and expected predictions.
- Diagram illustrating the mass limits for various scenarios with $m_{\chi^0}$ and $m_{\tilde{g}}$.

**Legend:**
- Data/SIM
- Events/bin
- Events
- $N(jets)$
- $m_{\tilde{g}}$ [GeV]
- $m_{\chi^0}$ [GeV]
- Observed upper limits on the cross section [fb]
- Expected upper limits on the cross section [fb]

**Notes:**
- Uneven mass splitting ($\Delta m_2 = 20$ GeV): small $\Delta m_2$ everywhere.
- As $m_{\text{LSP}} \sim 0$, leptons inherit the $\chi^\pm$ boost.
Inclusive: explore all phase space in $N_j$, $N_b$, $MET$, $m_T$

- 1 lepton: only low $p_T$ (5–20 GeV (e/$\mu$))
- $MET > 200$ GeV (trigger)

Main backgrounds: 1 lepton (tt, W), 2 lepton (tt)

- Estimated in control regions with similar kinematics

*Limit weakens near the diagonal (almost no momentum for visible decay products)*

**1 soft lepton + MET (CMS)**

![Graph showing 4-body phase space exclusion](image)

**CMS Preliminary**

- $2.3 \text{ fb}^{-1} (13 \text{ TeV})$

- $pp \rightarrow \tilde{t} \bar{t}, \tilde{l} \rightarrow b f' \tilde{\chi}^0_1$

- 4-body phase space NLO+NLL exclusion

- $95\% \text{ CL upper limit on cross section [pb]}$

**NEW**

Compressed stop decaying to 4 bodies
Both sbottom searches have compressed regions with similar selection

- 0 leptons, 2-3 jets, large MET (binned or >400 GeV)
- ISR jet (non b-tagged, 250-300 GeV), b-tags (1 or 2)

Main backgrounds: ttbar, W(lν) and Z(vv)+heavy-flavor,
- Estimated in control regions with leptons

*Limits are comparable: approach diagonal but cannot quite reach it*
- b-jets become too soft to be detected
Both sbottom searches have compressed regions with similar selection

- 0 leptons, 2-3 jets, large MET (binned or >400 GeV)
- ISR jet (non b-tagged, 250-300 GeV), b-tags (1 or 2)

Main backgrounds: ttbar, W(l\nu) and Z(vv)+heavy-flavor,

- Estimated in control regions with leptons

Limits are comparable: approach diagonal but cannot quite reach it

\(b\)-jets become too soft to be detected

CMS: Inclusive analysis (including 1j and ≥4) covers the space close to diagonal

ATLAS: diagonal covered by Monojet search (next)
High statistics, high precision

Inclusive final state: 0 lep., $p_{T1} > 250$ GeV, $N_{j(pT>30 \text{ GeV})} < 5$, $\Delta \phi(M_{ET}, j_{1234}) > 0.4$

- Backgrounds predicted from control regions: transfer factor systematics < 4%
- Tightest region (MET > 700 GeV): obs. = 185, pred. = 167 ± 20

Limit strongest at diagonal

- $\Delta m(NLSP, LSP) \sim 0$ —> Decay products at rest in NLSP frame —> All boost to heavy LSP’s
- For larger $\Delta m$, more rich kinematics, lower MET

Compressed stop decaying to charm+LSP

Identical limits for compressed sbottom to bottom+LSP
same-sign leptons

Rare SM process. Clean. Can trigger without MET

- gluinos are neutral: decays can have the same charge
- Both ATLAS and CMS searches at high lepton $p_T$

**CMS search: extend to softer kinematics**

- Low MET (>50 GeV), 2 jets, low lepton $p_T$ (10/10, 25/10 GeV)

**Study limit in different cases:**

- soft leptons recover efficiency in bulk region
- limit at diagonal weakens due to lower MET
Conclusions

Several complementary approaches can be used to probe compressed regions of SUSY phase space
- ISR jet, soft leptons, same-sign leptons shown
  - Also: VBF, precision measurements (top for stop), etc

Compressed signals can spread over many regions, acceptance in each is small
- Inclusive searches often reach best limits by maximizing acceptance
- Targeted searches/channels can win in specific topologies
  - Super-compressed (monojet), or lepton-rich SUSY (leptonic)
- Different channels are necessary to confirm/compare observations

Next steps: 2016/2017 dataset (100 fb⁻¹)
- Large improvements w.r.t. 8 TeV also for smaller cross-section signals
  - searches for compressed (and not) EWK production are picking up
- Stealth SUSY: no 13 TeV results yet
Backup
Inclusive 1 soft lepton + MET (CMS): backgrounds

1 lepton backgrounds
- W and Top(1L) with 1 soft lepton and a hard neutrino
- Control Region
  - reverse W decay kinematics (hard lep., low MET)
  - maintain similar event kinematics ($p_T(W)$)
- Uncertainties: W polarization, W/tt fraction, lep. eff.

2 lepton backgrounds
- Top(2L) with 1 soft lepton, 1 lost lepton, 2 neutrinos
  - 2 or 3 missing objects, producing an $m_T$ tail
- Control Region = SR + 1 extra lepton
- Uncertainties: lepton efficiency, acceptance

Fakes
- Small background (very tight ID/ISO requirement)
- Use MC for $m_T < 120$ GeV (negligible)
- Use Tight/Loose (“fake rate”) method > 120 GeV
2 searches: diphoton and dilepton

- sensitive to different models

Search variable: $S_T$

- $S_T = \Sigma (p_T^{jets} + p_T^{photons/leptons} + \text{MET})$
- $N(\text{jets}) \geq 4$: use lower jet multiplicities to predict $S_T$ shape in the signal region
- $S_T > 1200 \text{ GeV}$: normalize the $S_T$ shape at lower $S_T$ values

Results and limits from $\gamma\gamma$ search
Search for stop with \( m_{\text{stop}} \sim m_{\text{top}} \):

- increase in \( \sigma_{\text{tt}} \)
- reduced spin correlation between \( t \) and \( \bar{t} \)
  - in SM, spin correlation is
  \[
  A_{\text{helicity}} = \frac{N_{\text{like}} - N_{\text{unlike}}}{N_{\text{like}} + N_{\text{unlike}}} = 0.318 \pm 0.005
  \]
  - stop has spin = 0, so \( t \) and \( \bar{t} \) spins are uncorrelated (\( A=0 \))

Effect of assumptions on limits:
- varying \( m_{\text{LSP}} \): few%
- stop \( \rightarrow \) left-handed top: 10%
  (left/right depends on stop-neutralino mixing)
- don’t use \( \sigma_{\text{tt}} \): 30%
- don’t use \( \Delta\phi \): 30-40%
### 1 lepton + jets + MET (ATLAS)

<table>
<thead>
<tr>
<th>2-jet soft-lepton SR</th>
<th>5-jet soft-lepton SR</th>
<th>4-jet high-(x) SR</th>
<th>4-jet low-(x) SR</th>
<th>5-jet SR</th>
<th>6-jet SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N_{\text{lep}}(p_T^{\text{lep}} &gt; 7(6)\text{GeV}))</td>
<td>= 1</td>
<td>= 1</td>
<td>= 1</td>
<td>= 1</td>
<td>= 1</td>
</tr>
<tr>
<td>(p_T^{\text{lep}}) (GeV)</td>
<td>7(6)–35</td>
<td>7(6)–35</td>
<td>&gt; 35</td>
<td>&gt; 35</td>
<td>&gt; 35</td>
</tr>
<tr>
<td>(N_{\text{jet}})</td>
<td>≥ 2</td>
<td>≥ 5</td>
<td>≥ 4</td>
<td>≥ 4</td>
<td>≥ 5</td>
</tr>
<tr>
<td>(p_T^{\text{jet}}) (GeV)</td>
<td>&gt; 180, 30</td>
<td>&gt; 200, 200, 200, 30, 30</td>
<td>&gt; 325, 30, ..., 30</td>
<td>&gt; 325, 150, ..., 150</td>
<td>&gt; 225, 50, ..., 50</td>
</tr>
<tr>
<td>(E_T^{\text{miss}}) (GeV)</td>
<td>&gt; 530</td>
<td>&gt; 375</td>
<td>&gt; 200</td>
<td>&gt; 200</td>
<td>&gt; 250</td>
</tr>
<tr>
<td>(m_T) (GeV)</td>
<td>&gt; 100</td>
<td>-</td>
<td>&gt; 425</td>
<td>&gt; 125</td>
<td>&gt; 275</td>
</tr>
<tr>
<td>(E_T^{\text{miss}}/m_T)</td>
<td>&gt; 0.38</td>
<td>-</td>
<td>&gt; 0.3</td>
<td>-</td>
<td>&gt; 0.1</td>
</tr>
<tr>
<td>(H_T) (GeV)</td>
<td>-</td>
<td>&gt; 1100</td>
<td>&gt; 1800</td>
<td>&gt; 2000</td>
<td>&gt; 1800</td>
</tr>
<tr>
<td>Jet aplanarity</td>
<td>-</td>
<td>&gt; 0.02</td>
<td>-</td>
<td>&gt; 0.04</td>
<td>&gt; 0.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4-jet low (x)</th>
<th>4-jet high (x)</th>
<th>5-jet</th>
<th>6-jet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observed events</strong></td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Fitted background events</strong></td>
<td>1.3 ± 0.5</td>
<td>0.9 ± 0.5</td>
<td>1.3 ± 0.6</td>
</tr>
<tr>
<td><strong>(t\bar{t})</strong></td>
<td>0.40 ± 0.31</td>
<td>0.08 ± 0.07</td>
<td>0.40 ± 0.24</td>
</tr>
<tr>
<td><strong>(W+\text{jets})</strong></td>
<td>0.19 ± 0.12</td>
<td>0.8 ± 0.5</td>
<td>0.16 ± 0.12</td>
</tr>
<tr>
<td><strong>(Z+\text{jets})</strong></td>
<td>0.045 ± 0.023</td>
<td>0.028 ± 0.027</td>
<td>0.073 ± 0.035</td>
</tr>
<tr>
<td><strong>Single-top</strong></td>
<td>0.5 ± 0.5</td>
<td>0.04±0.10 (_{-0.04}^{+0.10})</td>
<td>0.21±0.22 (_{-0.21}^{+0.22})</td>
</tr>
<tr>
<td><strong>Diboson</strong></td>
<td>0.06±0.20 (_{-0.06}^{+0.20})</td>
<td>0.002±0.014 (_{-0.002}^{+0.014})</td>
<td>0.37 ± 0.23</td>
</tr>
<tr>
<td><strong>(t\bar{t}+\text{V})</strong></td>
<td>0.048 ± 0.021</td>
<td>0.024 ± 0.012</td>
<td>0.059 ± 0.029</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2-jet</th>
<th>5-jet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observed events</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Fitted background events</strong></td>
<td>3.6 ± 0.7</td>
</tr>
<tr>
<td><strong>(t\bar{t})</strong></td>
<td>0.64 ± 0.33</td>
</tr>
<tr>
<td><strong>(W+\text{jets})</strong></td>
<td>1.9 ± 0.5</td>
</tr>
<tr>
<td><strong>(Z+\text{jets})</strong></td>
<td>0.47 ± 0.12</td>
</tr>
<tr>
<td><strong>Single-top</strong></td>
<td>0.16 ± 0.14</td>
</tr>
<tr>
<td><strong>Diboson</strong></td>
<td>0.38 ± 0.16</td>
</tr>
<tr>
<td><strong>(t\bar{t}+\text{V})</strong></td>
<td>0.085 ± 0.028</td>
</tr>
</tbody>
</table>
ATLAS 1-lepton Control Regions

ATLAS 1-lepton + jets + $E_T^{\text{miss}}$
soft-lepton 2-jet

VR $m_T$

SR

CR

VR $E_T^{\text{miss}}$

ATLAS 1-lepton + jets + $E_T^{\text{miss}}$
soft-lepton 5-jet

SR
$p_T^{\text{jet},1} > 200$ GeV
$p_T^{\text{jet},2} > 200$ GeV
$p_T^{\text{jet},3} > 200$ GeV

VR $H_T$
$p_T^{\text{jet},1} > 150$ GeV
$p_T^{\text{jet},2} > 100$ GeV

CR
$p_T^{\text{jet},1} > 150$ GeV
$p_T^{\text{jet},2} > 100$ GeV

VR $E_T^{\text{miss}}$
$p_T^{\text{jet},1} > 150$ GeV
$p_T^{\text{jet},2} > 100$ GeV
sbottom (ATLAS)

<table>
<thead>
<tr>
<th>Variable</th>
<th>SRA</th>
<th>SRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event cleaning</td>
<td>Common to all SR</td>
<td></td>
</tr>
<tr>
<td>Lepton veto</td>
<td>No $e/\mu$ with $p_T &gt; 10$ GeV after overlap removal</td>
<td></td>
</tr>
<tr>
<td>$E_T^{\text{miss}}$</td>
<td>$&gt; 250$ GeV</td>
<td>$&gt; 400$ GeV</td>
</tr>
<tr>
<td>Leading jet $p_T(j_1)$</td>
<td>$&gt; 130$ GeV</td>
<td>$&gt; 300$ GeV</td>
</tr>
<tr>
<td>2nd jet $p_T(j_2)$</td>
<td>$&gt; 50$ GeV</td>
<td>$&gt; 50$ GeV</td>
</tr>
<tr>
<td>Fourth jet $p_T(j_4)$</td>
<td>vetoed if $&gt; 50$ GeV</td>
<td></td>
</tr>
<tr>
<td>$\Delta \phi_{\text{min}}$</td>
<td>$&gt; 0.4$</td>
<td>$&gt; 0.4$</td>
</tr>
<tr>
<td>$\Delta \phi(j_1, E_T^{\text{miss}})$</td>
<td>$&gt; 2.5$</td>
<td>$&gt; 2.5$</td>
</tr>
<tr>
<td>$b$-tagging</td>
<td>$j_1$ and $j_2$</td>
<td>$j_2$ and ($j_3$ or $j_4$)</td>
</tr>
<tr>
<td>$E_T^{\text{miss}}/m_{\text{eff}}$</td>
<td>$&gt; 0.25$</td>
<td>$&gt; 0.25$</td>
</tr>
<tr>
<td>$m_{\text{CT}}$</td>
<td>$&gt; 250, 350, 450$ GeV</td>
<td>-</td>
</tr>
<tr>
<td>$m_{bb}$</td>
<td>$&gt; 200$ GeV</td>
<td>-</td>
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### Signal region channels

<table>
<thead>
<tr>
<th></th>
<th>SRA250</th>
<th>SRA350</th>
<th>SRA450</th>
<th>SRB</th>
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</thead>
<tbody>
<tr>
<td>Observed events</td>
<td>22</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Fitted bkg events</td>
<td>$40 \pm 8$</td>
<td>$9.5 \pm 2.6$</td>
<td>$2.2 \pm 0.6$</td>
<td>$13.1 \pm 3.2$</td>
</tr>
<tr>
<td>Fitted $t\bar{t}$ events</td>
<td>$0.9 \pm 0.4$</td>
<td>$0.37 \pm 0.16$</td>
<td>$0.06 \pm 0.03$</td>
<td>$5.9 \pm 2.4$</td>
</tr>
<tr>
<td>Fitted single top events</td>
<td>$2.1 \pm 1.3$</td>
<td>$0.54 \pm 0.37$</td>
<td>$0.15 \pm 0.10$</td>
<td>$1.2 \pm 0.8$</td>
</tr>
<tr>
<td>Fitted $W+$jets events</td>
<td>$6.3 \pm 2.4$</td>
<td>$1.3 \pm 0.6$</td>
<td>$0.41 \pm 0.23$</td>
<td>$1.2 \pm 0.6$</td>
</tr>
<tr>
<td>Fitted $Z+$jets events</td>
<td>$30 \pm 7$</td>
<td>$7.1 \pm 2.4$</td>
<td>$1.5 \pm 0.5$</td>
<td>$3.3 \pm 1.4$</td>
</tr>
<tr>
<td><em>(Alt. method $Z+$jets events)</em></td>
<td>$(33 \pm 7)$</td>
<td>$(7.2 \pm 1.9)$</td>
<td>$(2.7 \pm 0.9)$</td>
<td></td>
</tr>
<tr>
<td>Fitted “Other” events</td>
<td>$0.7 \pm 0.6$</td>
<td>$0.1 \pm 0.1$</td>
<td>$0.02 \pm 0.02$</td>
<td>$1.4 \pm 0.4$</td>
</tr>
<tr>
<td>MC exp. SM events</td>
<td>27</td>
<td>6.5</td>
<td>1.5</td>
<td>13</td>
</tr>
<tr>
<td>MC exp. $t\bar{t}$ events</td>
<td>$1.1$</td>
<td>$0.45$</td>
<td>$0.07$</td>
<td>$6.6$</td>
</tr>
<tr>
<td>MC exp. single top events</td>
<td>$2.7$</td>
<td>$0.7$</td>
<td>$0.20$</td>
<td>$1.2$</td>
</tr>
<tr>
<td>MC exp. $W+$jets events</td>
<td>$4.7$</td>
<td>$1.0$</td>
<td>$0.31$</td>
<td>$1.2$</td>
</tr>
<tr>
<td>MC exp. $Z+$jets events</td>
<td>$18$</td>
<td>$4.2$</td>
<td>$0.9$</td>
<td>$2.7$</td>
</tr>
<tr>
<td>MC exp. “Other” events</td>
<td>$0.7$</td>
<td>$0.1$</td>
<td>$0.02$</td>
<td>$1.4$</td>
</tr>
</tbody>
</table>
sbottom (CMS)

<table>
<thead>
<tr>
<th>Selection</th>
<th>non-compressed</th>
<th>compressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N_{\text{jets}})</td>
<td>[2,3]</td>
<td>[2,3]</td>
</tr>
<tr>
<td>1st-jet (p_T)</td>
<td>(&gt; 100) GeV</td>
<td>(&gt; 250) GeV</td>
</tr>
<tr>
<td>2nd-jet (p_T)</td>
<td>(&gt; 75) GeV</td>
<td>(&gt; 60) GeV</td>
</tr>
<tr>
<td>Veto fourth jet</td>
<td>(p_T &gt; 50) GeV</td>
<td>(p_T &gt; 50) GeV</td>
</tr>
<tr>
<td>Lepton and isolated track veto</td>
<td>(p_T &gt; 10) GeV</td>
<td>(p_T &gt; 10) GeV</td>
</tr>
<tr>
<td>b jet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E_T^{\text{miss}})</td>
<td>(&gt; 250) GeV</td>
<td>(&gt; 250) GeV</td>
</tr>
<tr>
<td>(\Delta \phi(j_{123}, E_T^{\text{miss}}))</td>
<td>(&gt; 0.4)</td>
<td>(&gt; 0.4)</td>
</tr>
<tr>
<td>(\Delta \phi(j_1, E_T^{\text{miss}}))</td>
<td>(-)</td>
<td>(&lt; 2.3)</td>
</tr>
<tr>
<td>(\text{min} M_T(j, E_T^{\text{miss}}))</td>
<td>(&gt; 250) GeV</td>
<td>(&gt; 200) GeV</td>
</tr>
<tr>
<td>(H_T)</td>
<td>(&gt; 200) GeV</td>
<td></td>
</tr>
<tr>
<td>(m_{CT})</td>
<td>(&gt; 250) GeV</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Selection</th>
<th>T2bb ((m_{\tilde{g}}=325, m_{\tilde{t}}=275) GeV)</th>
<th>T2cc ((m_{\tilde{t}}=250, m_{\tilde{g}}=240) GeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preselection ((E_T^{\text{miss}} &gt; 200, p_T(j_1) &gt; 100) GeV)</td>
<td>1561</td>
<td>4985</td>
</tr>
<tr>
<td>(E_T^{\text{miss}} &gt; 250) GeV</td>
<td>1011</td>
<td>1046</td>
</tr>
<tr>
<td>(N_{\text{jets}} = [2,3], 4^{\text{th}}) jet veto</td>
<td>643.22</td>
<td>1936</td>
</tr>
<tr>
<td>1st-jet (p_T &gt; 250) GeV</td>
<td>409.25</td>
<td>1046</td>
</tr>
<tr>
<td>2nd-jet (p_T &gt; 60) GeV</td>
<td>311.77</td>
<td>753.65</td>
</tr>
<tr>
<td>lepton and isolated track veto</td>
<td>292.55</td>
<td>724.07</td>
</tr>
<tr>
<td>(\Delta \phi(j_{123}, E_T^{\text{miss}}) &gt; 0.4)</td>
<td>197.12</td>
<td>613.71</td>
</tr>
<tr>
<td>(\text{min} M_T(j, E_T^{\text{miss}}) &gt; 200) GeV</td>
<td>120.21</td>
<td>522.96</td>
</tr>
<tr>
<td>(\Delta \phi(j_1, E_T^{\text{miss}}) &gt; 2.3)</td>
<td>115.23</td>
<td>499.06</td>
</tr>
<tr>
<td>1st-jet isn’t b</td>
<td>95.17</td>
<td>418.31</td>
</tr>
<tr>
<td>(N_{b,-,tags} &gt;= 1)</td>
<td>47.71</td>
<td>396.63</td>
</tr>
<tr>
<td>(N_{b,-,tags} = 0)</td>
<td>47.46</td>
<td>21.88</td>
</tr>
</tbody>
</table>
Sbottom ATLAS vs CMS

- 0 leptons, $\text{MET}/(\text{HT+MET}) > 0.25$, $m_T(j_{1,2}, \text{MET}) > 200 \text{ GeV}$
- 2-3 jets (4th jet veto at 50 GeV), $\Delta\phi(\text{MET}, j_{123}) > 0.4$
- Compressed region:
  - ISR jet: not b-tagged, $p_T > 250$ (300) GeV, $\Delta\phi(\text{MET}, j_1) > 2.3$ (2.5), $p_T^{j_2} > 60$ (50) GeV
  - b-tags: 2 (including 4th jet if below 50 GeV), bin: [0,1,2]
  - MET: $>400 \text{ GeV}$, bin: [250, ..., 1000 GeV]
Acceptance at larger $\Delta m$ is sensitive to $p_T$ of jets used for…
- … the veto of 5th jet (Monojet analysis) or 4th jet (sbottom analysis)
- … the list of jets included in $\Delta \phi$(MET, jet) > 0.4 requirement

Graph showing normalized events vs. generator charm $p_T$ (GeV) for different mass differences. The graph includes data from CMS-PAS-SUS-13-009.