# cms_1303_2985 Validation

Hadronic $\alpha_T$ and $b-$jet multiplicity, [1]
Energy: 8 TeV
Luminosity: 11.7 fb$^{-1}$
Validation notes:

- No cut flow is provided by CMS, validation is performed with signal region distributions and parameter scans, see Figures 1 to 7.
  - The Monte-Carlo generator was Pythia 6.427 [2].
  - Cross-sections calculated with NLL-Fast 2.1 [3, 4, 5, 6, 7].
- The SM background distributions have been taken from the CMS note.
- The $H_T$ distributions (Figure 1 - Figure 4) are only given as logarithmic plots in the original study with no numerical values. Thus it is difficult to give a quantitative number for the agreement of CheckMATE.
- The ATLAS $b$-tagging has been used for the dependence of efficiency as a function of $p_T$ and $\eta$ but has been normalised to the values used in this study by CMS. The CMS study states that the b-tagging efficiency lies between 60% and 70% and we thus take a 65% average as a naive estimate.
- Jumps in limit in CheckMATE parameter scans are due to the single signal region limit setting procedure used (see **??**).
- Detailed trigger efficiencies as a function of $H_T$, $\alpha_T$ and number of jets are taken directly from Table 2 of the corresponding experimental paper [1].
- In Figure 5 left, we see a difference in the exclusion for lighter squark masses and a heavier neutralino mass. We believe that this difference may be due to the precise parton shower settings given in Pythia 6.4 [2] that can radically change limits when SUSY spectra become compressed [8, 9]. CMS purely relies on the parton shower for these limits but does not document the precise settings used. In addition we recommend that a matching procedure [10, 11] is used for compressed spectra to give accurate results.
- In Figure 5 right, we see a difference in the exclusion for sbottom masses and light neutralinos which can be explained by examining the difference in the exclusion procedure of CMS and CheckMATE. In this analysis CMS performs a fit over all signal regions to set an exclusion whereas CheckMATE does a bin-by-bin exclusion as explained in **??**. The signal region used to set the exclusion in CheckMATE has 2 or 3 jets, of which 2 jets are b-tagged and in addition the $H_T$ variable used has 575-675 GeV. In this signal region the expected background was 3 events but CMS actually saw 5 events resulting in an over-fluctuation that substantially reduces the exclusion. For example, if the $H_T$ bin 475-575 GeV that contains no over-fluctuation had been used, the exclusion of the sbottom mass would have been $\sim$ 625 GeV which is well within the 1-$\sigma$ band given by CMS.

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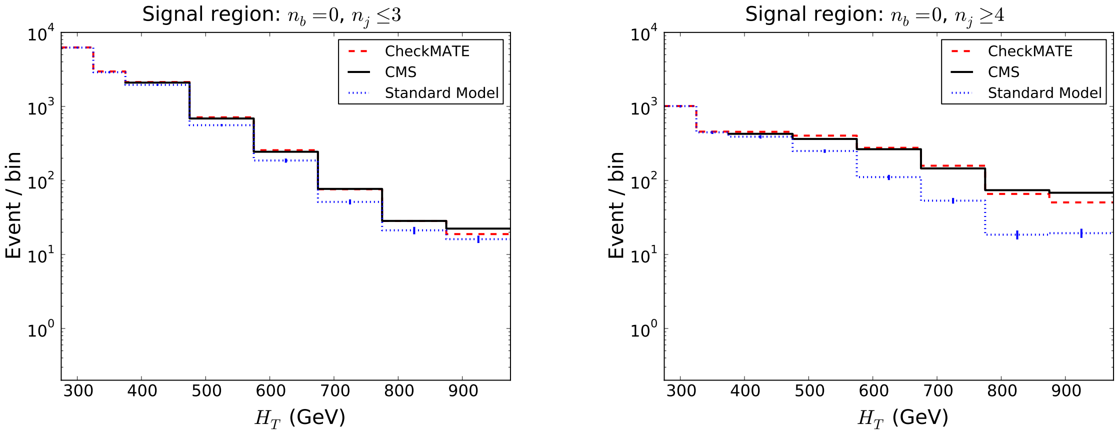

Figure 1: Distributions in $H_T$ for different signal models in in cms_1303_2985. Left: $pp \to \tilde{q}\tilde{q}, \tilde{q} \to q\tilde{\chi}_1^0$, ($m_{\tilde{q}} = 600$ GeV, $m_{\tilde{\chi}_1^0} = 250$ GeV). Right: $pp \to \tilde{g}\tilde{g}, \tilde{g} \to q\bar{q}\tilde{\chi}_1^0$, ($m_{\tilde{g}} = 700$ GeV, $m_{\tilde{\chi}_1^0} = 300$ GeV)

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- Figure 6 and Figure 7 show discrepancies at different points in the exclusion curves while being in good agreement for other ares. All the differences are again due to the bin-by-bin fluctuations resulting from our limit setting procedure.

# cms_1303_2985 Validation

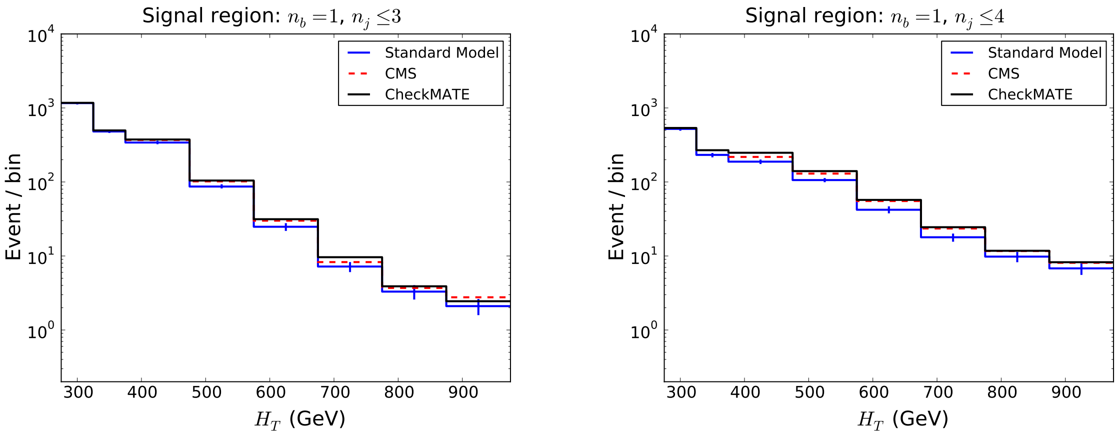

Figure 2: Distributions in $H_T$ for different signal models in in cms_1303_2985. Left: $pp \to \tilde{b}\tilde{b}, \tilde{b} \to b\tilde{\chi}_1^0$, ($m_{\tilde{b}} = 500$ GeV, $m_{\tilde{\chi}_1^0} = 150$ GeV). Right: $pp \to \tilde{t}\tilde{t}, \tilde{t} \to t\tilde{\chi}_1^0$, ($m_{\tilde{t}} = 400$ GeV, $m_{\tilde{\chi}_1^0} = 0$ GeV)

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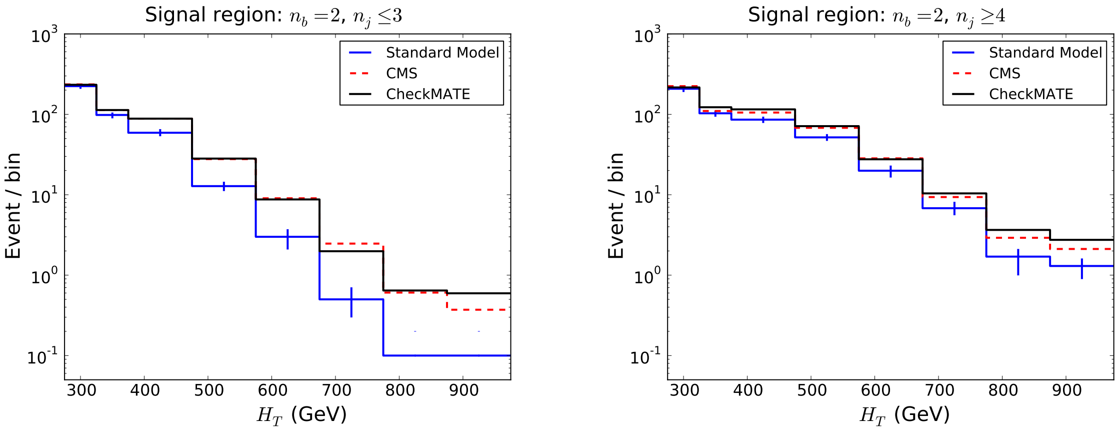

Figure 3: Distributions in $H_T$ for different signal models in in cms_1303_2985. Left: $pp \to \tilde{b}\tilde{b}, \tilde{b} \to b\tilde{\chi}_1^0$, ($m_{\tilde{b}} = 500$ GeV, $m_{\tilde{\chi}_1^0} = 150$ GeV). Right: $pp \to \tilde{t}\tilde{t}, \tilde{t} \to t\tilde{\chi}_1^0$, ($m_{\tilde{t}} = 400$ GeV, $m_{\tilde{\chi}_1^0} = 0$ GeV)

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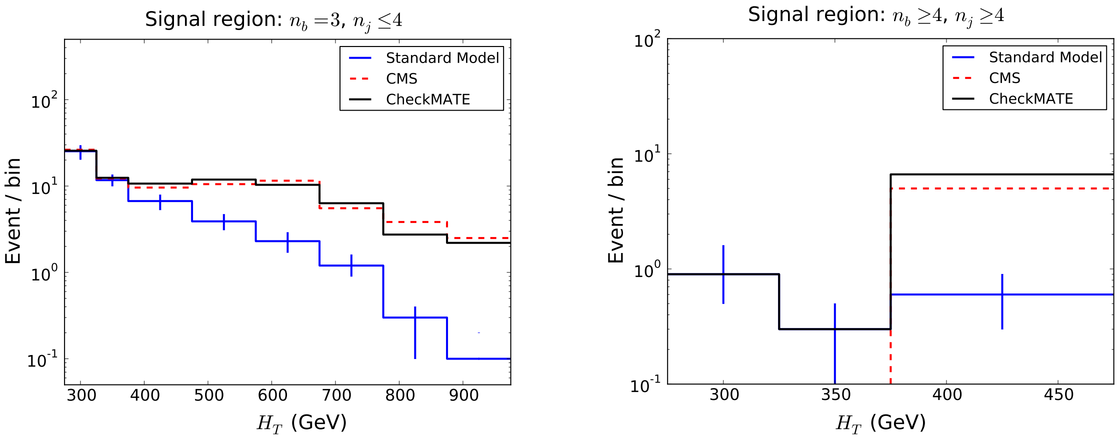

Figure 4: Distributions in $H_T$ for different signal models in in cms_1303_2985. Left: $pp \to \tilde{g}\tilde{g}, \tilde{g} \to b\bar{b}\tilde{\chi}_1^0$, ($m_{\tilde{g}} = 900$ GeV, $m_{\tilde{\chi}_1^0} = 500$ GeV). Right: $pp \to \tilde{g}\tilde{g}, \tilde{g} \to t\bar{t}\tilde{\chi}_1^0$, ($m_{\tilde{g}} = 850$ GeV, $m_{\tilde{\chi}_1^0} = 250$ GeV)

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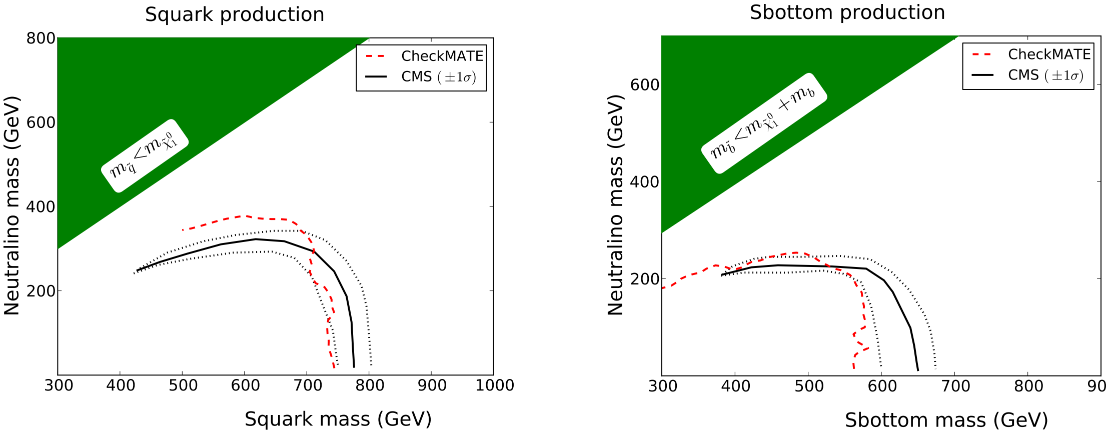

Figure 5: Exclusion curve for a simplified model with only first and second generation squark production (left) and only bottom squark production (right) in cms_1303_2985.

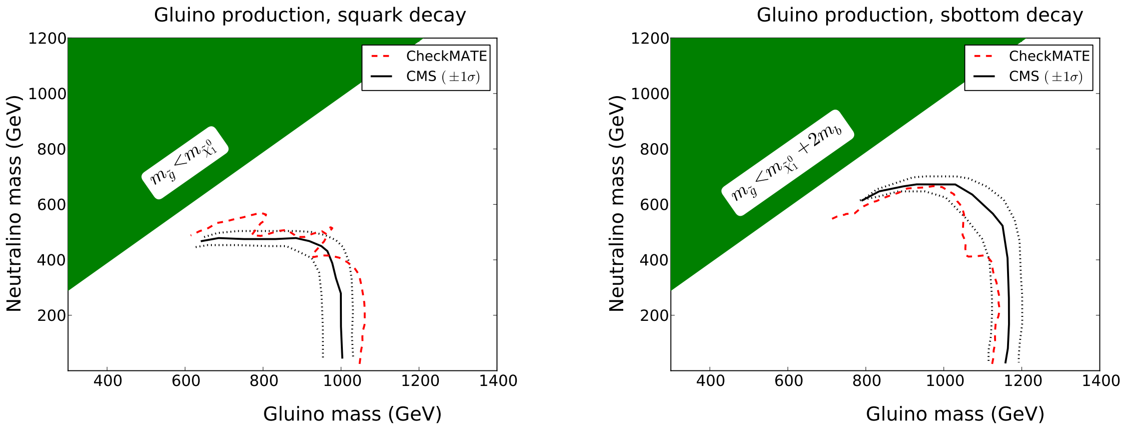

Figure 6: Exclusion curve for a simplified model with gluino production followed by decay into a $q\bar{q}\tilde{\chi}_1^0$ final state (left) or $b\bar{b}\tilde{\chi}_1^0$ final state (right) in cms_1303_2985.

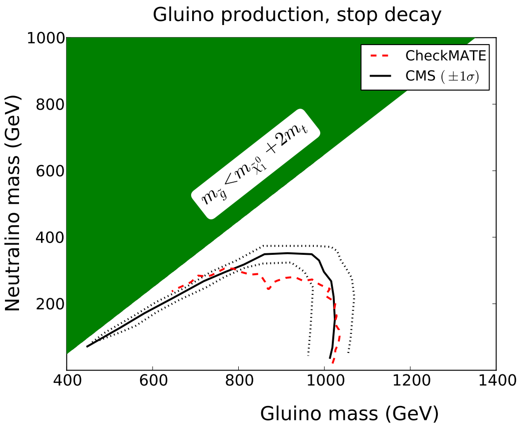

Figure 7: Exclusion curve for a simplified model with gluino production followed by decay into a $t\bar{t}\tilde{\chi}_1^0$ final state in cms_1303_2985.

# References

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