Validation of the `MadAnalysis 5` implementation of CMS-SUS-16-033

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1 Setup

In this document, the `MadAnalysis 5` implementation of the all-hadronic search for SUSY particles at the LHC at $\sqrt{s} = 13$ TeV CMS-SUS-16-033 (see also arXiv:XXXXX.XXXX) is validated.

For this purpose, MC settings were provided by CMS to generate events with `MadGraph MG5_aMC`, showered with `Pythia 8`

Supersymmetric gluino production $pp \to \widetilde{g}\widetilde{g}$ is assumed with $\widetilde{g} \to b\bar{b}A$.

From the CMS-SUS-XPAG gitbub repository one can retrieve the cards used for `MadGraph MG5_aMC` event generation. The run card used in `MadGraph MG5_aMC` and proc card were retrieved from there. From the same repository the models can be retrieved.

This is needed for, for example, the fragmentation done with `Pythia 8`. For example, for `T1bbbb` this was used. The pythia settings are then retrieved from the CMS software github repository:

- Pythia8CUEP8M1Settings and
- Pythia8CommonSettings. Also:
- The genfragment file is used.

Models studied are shown in **??**.

The search, which originally has more than 172 bins, is also divided into aggregate search regions, as shown together with the search results in Table 1.

The `Pythia 6.4` settings were read from an external card and are given in Appendix A.

In `MadAnalysis 5`, to run `DelphesMA5tune` the CMS settings with an altered version of this `DelphesMA5tune` card, which can be found on the `MadAnalysis` Physics Analysis Database page, were used. The parameter changed in the `DelphesMA5tune` card was the b-tag parameter to obtain a b-tag efficiency of 70%, as shown in Appendix B. Cut flows and histograms of several observables are compared with those of CMS in the next sections.

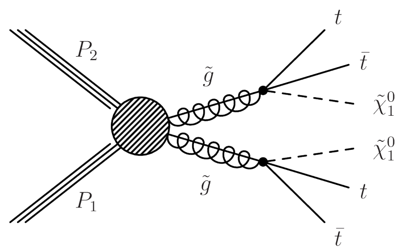

Figure 1: The `T1tttt` model. Versions with bottom and light quarks in the final state were also studied.

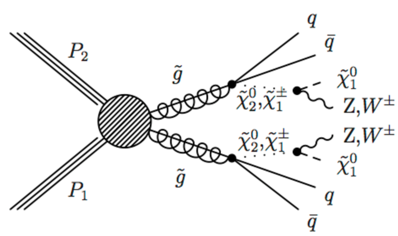

Figure 2: The `T5qqqqVV` model.

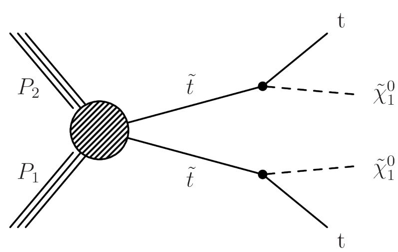

Figure 3: The `T2tt` model.

Table 1: Observed number of events and prefit background predictions in the aggregate search regions.

Region	N_{jet}	$N_{\text{b-jet}}$	H_{T} [GeV]	$H_{\mathrm{T}}^{\mathrm{miss}}$ [GeV]	Lost-e/μ	$\tau \to$ had	$Z \to \nu\bar{\nu}$	QCD	Total Pred.	Obs.
1	500+	500+	2+	0	1056^{+27+59}_{-27-56}	939^{+18+71}_{-18-72}	$6530^{+50+380}_{-49-380}$	90^{+2+35}_{-2-30}	$8615^{+68+400}_{-66-390}$	8792
2	750+	1500+	3+	0	$33.4^{+4.6+2.9}_{-4.5-2.8}$	$32.3^{+3.2+3.6}_{-3.1-3.6}$	374^{+12+46}_{-12-42}	$0.62^{+0.06+0.24}_{-0.05-0.22}$	441^{+15+46}_{-14-42}	413
3	500+	500+	5+	0	212^{+10+15}_{-9-14}	225^{+8+14}_{-8-15}	763^{+18+47}_{-16-45}	53^{+2+20}_{-2-18}	1254^{+25+55}_{-24-53}	1202
4	750+	1500+	5+	0	$5.3^{+1.4+0.7}_{-1.2-0.6}$	$6.3^{+1.2+0.6}_{-0.9-0.6}$	$55.8^{+4.8+7.6}_{-4.3-6.9}$	$0.30^{+0.05+0.12}_{-0.05-0.11}$	$67.7^{+5.5+7.6}_{-4.8-7.0}$	79
5	750+	1500+	9+	0	$0.00^{+0.44+0.00}_{-0.00-0.00}$	$0.00^{+0.46+0.00}_{-0.00-0.00}$	$0.00^{+0.64+0.00}_{-0.00-0.00}$	$0.01^{+0.02+0.00}_{-0.01-0.00}$	$0.0^{+1.1+0.0}_{-0.0-0.0}$	0
6	500+	500+	2+	2+	89^{+10+6}_{-8-5}	$91.1^{+5.6+5.4}_{-4.9-5.5}$	127^{+2+18}_{-2-18}	$15.4^{+0.6+9.6}_{-0.6-8.9}$	323^{+16+22}_{-13-21}	350
7	750+	750+	3+	1+	$59.0^{+7.1+3.9}_{-5.9-3.7}$	$53.8^{+4.5+3.5}_{-3.9-3.5}$	176^{+5+16}_{-4-15}	$4.4^{+0.3+1.7}_{-0.3-1.6}$	294^{+13+17}_{-11-16}	289
8	500+	500+	5+	3+	$11.8^{+3.5+0.9}_{-2.7-0.9}$	$14.9^{+2.5+1.5}_{-2.0-1.5}$	$11.6^{+0.6+4.9}_{-0.5-4.9}$	$6.6^{+0.5+7.3}_{-0.5-6.1}$	$44.8^{+6.1+9.0}_{-4.7-8.0}$	34
9	750+	1500+	5+	2+	$0.9^{+1.5+0.2}_{-0.6-0.2}$	$1.2^{+1.3+0.2}_{-0.6-0.2}$	$3.53^{+0.42+0.97}_{-0.29-0.96}$	$0.15^{+0.09+0.09}_{-0.07-0.08}$	$5.8^{+2.8+1.0}_{-1.1-1.0}$	10
10	750+	750+	9+	3+	$0.00^{+0.70+0.00}_{-0.00-0.00}$	$0.53^{+0.72+0.13}_{-0.31-0.13}$	$0.48^{+0.24+0.33}_{-0.16-0.32}$	$0.14^{+0.15+0.17}_{-0.13-0.01}$	$1.2^{+1.4+0.4}_{-0.4-0.3}$	3
11	300+	300+	7+	1+	329^{+12+21}_{-12-20}	381^{+10+22}_{-9-22}	194^{+8+38}_{-6-38}	69^{+1+29}_{-1-26}	973^{+23+57}_{-22-55}	896
12	750+	750+	5+	1+	$37.8^{+5.3+2.7}_{-4.5-2.5}$	$38.6^{+3.6+2.8}_{-3.1-2.8}$	$81.7^{+4.1+9.7}_{-3.6-9.6}$	$3.7^{+0.3+1.5}_{-0.3-1.3}$	162^{+10+11}_{-8-10}	151

2 Cut flow

This analysis is a multijet, missing transverse momentum and zero lepton analysis. The cut flows for the simplified model working points are given in Table 2, Table 3, and Table 4.

Table 2: Absolute cumulative efficiencies in % for each step of the event selection process for representative models of gluino pair production. The uncertainties are statistical. Uncertainties reported as 0.0 correspond to values less than 0.05%.

Selection		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to t\bar{t}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1500\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to b\bar{b}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1500\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to q\bar{q}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1400\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$	
N_{jet}	≥ 2	100.0	0.0	100.0	0.0	100.00	0.0
H_{T}	$> 300\,\mathrm{GeV}$	100.0	0.0	100.0	0.0	100.0	0.0
$H_{\mathrm{T}}^{\mathrm{miss}}$	$> 300\,\mathrm{GeV}$	76.7	0.3	80.3	0.4	80.0	0.3
N_{muon}	$= 0$	48.6	0.4	79.8	0.4	80.0	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{muon})}$	$= 0$	47.8	0.4	79.6	0.4	79.9	0.3
N_{electron}	$= 0$	30.7	0.3	79.2	0.4	79.5	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{electron})}$	$= 0$	29.7	0.3	78.7	0.4	79.1	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{hadron})}$	$= 0$	28.3	0.3	78.0	0.4	78.3	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_1}$	> 0.5	27.7	0.3	76.7	0.4	76.9	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_2}$	> 0.5	25.2	0.3	69.2	0.5	69.8	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_3}$	> 0.3	23.7	0.3	63.9	0.5	64.4	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_4}$	> 0.3	22.1	0.3	58.6	0.5	59.4	0.3
Event quality filter		21.8	0.3	57.7	0.5	58.7	0.3
Selection		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to t\bar{t}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1200\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 800\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to b\bar{b}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1000\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 900\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to q\bar{q}\ \widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1000\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 800\,\mathrm{GeV}$	
N_{jet}	≥ 2	100.0	0.0	92.5	0.1	99.6	0.0
H_{T}	$> 300\,\mathrm{GeV}$	99.0	0.0	38.6	0.1	81.3	0.1
$H_{\mathrm{T}}^{\mathrm{miss}}$	$> 300\,\mathrm{GeV}$	14.9	0.1	14.1	01	19.1	0.1
N_{muon}	$= 0$	9.6	0.1	13.9	0.1	19.1	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{muon})}$	$= 0$	9.2	0.1	13.6	0.1	19.1	0.1
N_{electron}	$= 0$	6.2	0.1	13.4	0.1	19.0	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{electron})}$	$= 0$	5.8	0.1	13.1	0.1	18.8	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{hadron})}$	$= 0$	5.3	0.1	12.8	0.1	18.4	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_1}$	> 0.5	5.3	0.1	12.8	0.1	18.4	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_2}$	> 0.5	4.5	0.1	11.4	0.1	16.9	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_3}$	> 0.3	4.0	0.1	10.4	0.1	15.8	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_4}$	> 0.3	3.6	0.1	9.6	0.1	14.8	0.1
Event quality filter		3.5	0.1	9.4	0.1	14.6	0.1

Table 3: Absolute cumulative efficiencies in % for each step of the event selection process for representative models of squark pair production. The uncertainties are statistical. Uncertainties reported as 0.0 correspond to values less than 0.05%.

Selection		$pp \to \widetilde{t}\,\bar{\widetilde{t}}\,, \widetilde{t} \to t\widetilde{\chi}_1^0$ $m_{\widetilde{t}} = 700\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 50\,\mathrm{GeV}$		$pp \to \widetilde{b}\,\bar{\widetilde{b}}\,, \widetilde{b} \to b\widetilde{\chi}_1^0$ $m_{\widetilde{b}} = 650\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 1\,\mathrm{GeV}$		$pp \to \widetilde{q}\,\bar{\widetilde{q}}\,, \widetilde{q} \to q\widetilde{\chi}_1^0$ $m_{\widetilde{q}} = 1000\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$	
N_{jet}	≥ 2	99.8	0.0	98.2	0.1	98.9	0.1
H_{T}	$> 300\,\mathrm{GeV}$	96.4	0.1	95.4	0.1	98.6	0.1
$H_{\mathrm{T}}^{\mathrm{miss}}$	$> 300\,\mathrm{GeV}$	57.8	0.3	59.8	0.2	80.0	0.3
N_{muon}	$= 0$	46.6	0.3	59.6	0.2	79.9	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{muon})}$	$= 0$	46.1	0.3	59.5	0.2	79.8	0.3
N_{electron}	$= 0$	37.4	0.3	59.2	0.2	79.6	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{electron})}$	$= 0$	36.9	0.3	59.0	0.2	79.3	0.3
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{hadron})}$	$= 0$	35.8	0.3	58.5	0.2	78.7	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_1}$	> 0.5	35.7	0.3	58.4	0.2	78.6	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_2}$	> 0.5	34.0	0.3	55.7	0.2	74.5	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_3}$	> 0.3	33.1	0.3	53.3	0.2	70.6	0.3
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_4}$	> 0.3	31.8	0.3	51.6	0.2	67.9	0.3
Event quality filter		31.4	0.3	50.8	0.3	67.1	0.3
Selection		$pp \to \widetilde{t}\,\bar{\widetilde{t}}\,, \widetilde{t} \to t\widetilde{\chi}_1^0$ $m_{\widetilde{t}} = 300\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 200\,\mathrm{GeV}$		$pp \to \widetilde{b}\,\bar{\widetilde{b}}\,, \widetilde{b} \to b\widetilde{\chi}_1^0$ $m_{\widetilde{b}} = 500\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 300\,\mathrm{GeV}$		$pp \to \widetilde{q}\,\bar{\widetilde{q}}\,, \widetilde{q} \to q\widetilde{\chi}_1^0$ $m_{\widetilde{q}} = 700\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 400\,\mathrm{GeV}$	
N_{jet}	≥ 2	86.9	0.0	96.0	0.1	98.0	0.0
H_{T}	$> 300\,\mathrm{GeV}$	23.3	0.0	68.0	0.1	91.3	0.1
$H_{\mathrm{T}}^{\mathrm{miss}}$	$> 300\,\mathrm{GeV}$	2.84	0.0	15.6	0.1	43.8	0.1
N_{muon}	$= 0$	2.16	0.0	15.6	0.1	43.8	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{muon})}$	$= 0$	2.10	0.0	15.5	0.1	43.7	0.1
N_{electron}	$= 0$	1.60	0.0	15.4	0.1	43.5	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{electron})}$	$= 0$	1.52	0.0	15.3	0.1	43.4	0.1
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{hadron})}$	$= 0$	1.41	0.0	15.2	0.1	43.0	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_1}$	> 0.5	1.40	0.0	15.1	0.1	42.9	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_2}$	> 0.5	1.03	0.0	14.1	0.1	41.1	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_3}$	> 0.3	0.85	0.0	13.5	0.1	39.6	0.1
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_4}$	> 0.3	0.73	0.0	13.1	0.1	38.4	0.1
Event quality filter		0.72	0.0	12.9	0.1	37.9	0.1

Table 4: Absolute cumulative efficiencies in % for additional representative models of gluino pair production. The uncertainties are statistical. Uncertainties reported as 0.0 correspond to values less than 0.05%.

Selection		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to t\bar{b}\ W^{*-}\widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1500\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to q\bar{q}\ V\widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1400\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 100\,\mathrm{GeV}$		$pp \to \widetilde{g}\widetilde{g}, \widetilde{g} \to t\bar{b}\ W^{*-}\widetilde{\chi}_1^0$ $m_{\widetilde{g}} = 1100\,\mathrm{GeV}$ $m_{\widetilde{\chi}_1^0} = 700\,\mathrm{GeV}$		$pp \to$
N_{jet}	≥ 2	100.0	0.0	100.0	0.0	100.0	0.0	
H_{T}	$> 300\,\mathrm{GeV}$	100.0	0.0	100.0	0.0	98.5	0.1	
$H_{\mathrm{T}}^{\mathrm{miss}}$	$> 300\,\mathrm{GeV}$	77.4	0.5	73.3	0.3	31.6	0.2	
N_{muon}	$= 0$	56.0	0.5	61.4	0.4	25.5	0.2	
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{muon})}$	$= 0$	53.0	0.5	61.1	0.4	24.7	0.2	
N_{electron}	$= 0$	39.7	0.5	50.0	0.4	19.9	0.2	
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{electron})}$	$= 0$	36.8	0.5	49.3	0.4	19.1	0.2	
$N_{\mathrm{isolated\ tracks}}^{(\mathrm{hadron})}$	$= 0$	34.8	0.5	47.7	0.4	18.4	0.2	
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_1}$	> 0.5	34.0	0.5	46.6	0.4	18.3	0.2	
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_2}$	> 0.5	30.4	0.5	42.2	0.4	17.1	0.2	
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_3}$	> 0.3	28.0	0.5	39.5	0.4	16.2	0.2	
$\Delta\phi_{H_{\mathrm{T}}^{\mathrm{miss}},j_4}$	> 0.3	25.9	0.5	37.1	0.4	15.1	0.2	
Event quality filter		25.7	0.5	36.6	0.4	15.0	0.2	

3 Distributions of observables

In Figure 4 some kinematic distributions are shown.

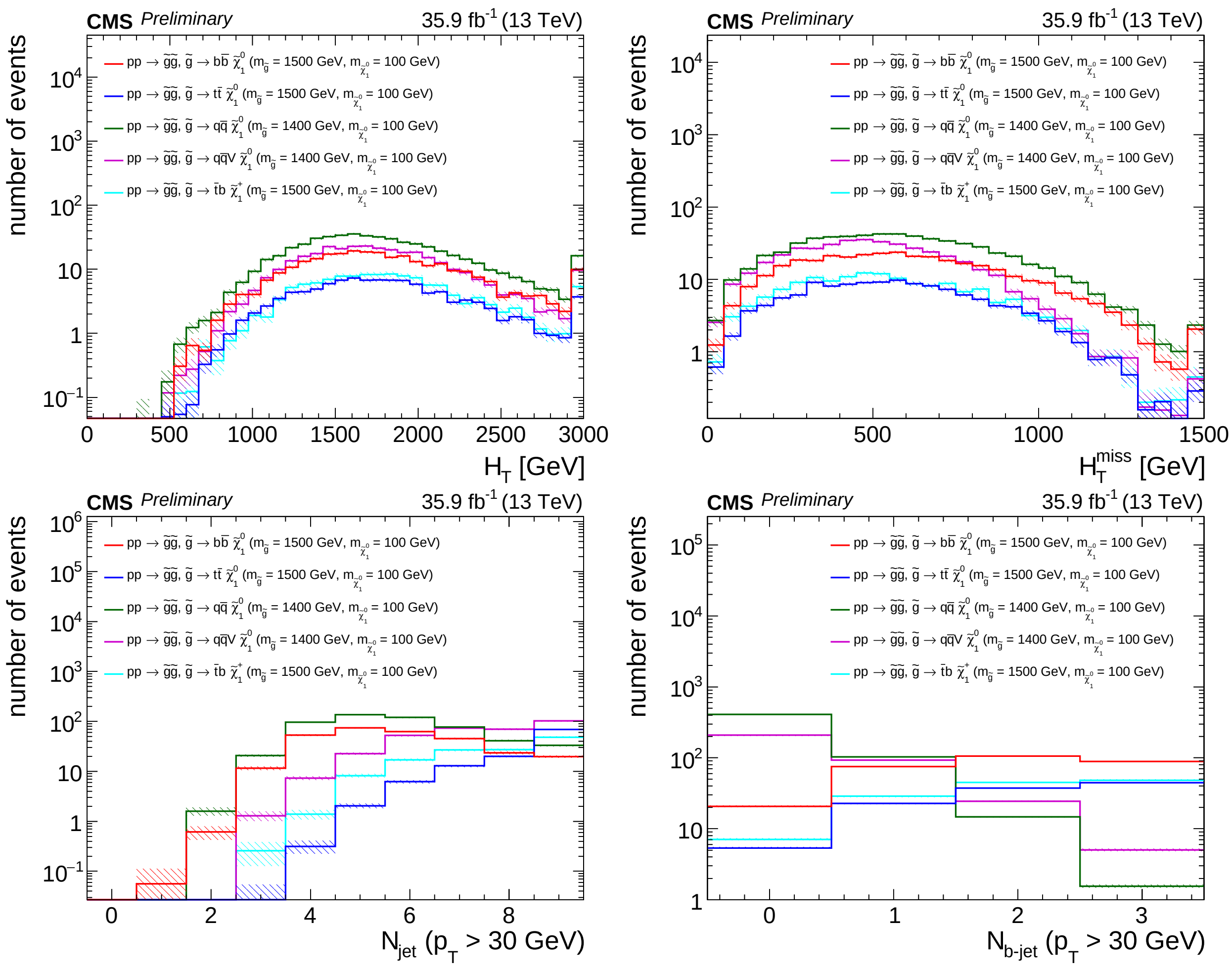

Figure 4: Distributions of (a) H_{T}, (b) $H_{\mathrm{T}}^{\mathrm{miss}}$, (c) the number of b-tagged jets, and (d) the number of jets from five representative gluino pair production signal models with $m_{\tilde{g}} \gg m_{\tilde{\chi}_1^0}$ after the baseline selection. Each plot ignores the baseline requirement (if any) for its respective variable. The last bin in each plot contains the overflow events. Only statistical uncertainties are shown.

Appendices

A Pythia 6.4 settings

The following settings in `Pythia 6.4` as used in `MadGraph 1.5.12` were read from an external card:

```
!... pythia_card.dat
!...Parton showering on or off
      MSTP(61)=1
      MSTP(71)=1

!...Fragmentation/hadronization on or off
      MSTJ(1)=1

!...Multiple interactions on or off
      MSTP(81)=1

!...Don't stop execution after 10 errors
      MSTU(21)=1

!...Set pdf to cteq6l1:
      MSTP(51)=10042 ! structure function chosen (external PDF CTEQ6L1)
      MSTP(52)=2 ! work with LHAPDF
      LHAPATH=/path/to/lhapdf/PDFSets

!...More settings:
      MSTJ(22)=2 ! Decay those unstable particles
      PARJ(71)=10 . ! for which ctau 10 mm
      MSTP(33)=0 ! no K factors in hard cross sections
      MSTP(2)=1 ! which order running alphaS
      PARP(82)=1.921 ! pt cutoff for multiparton interactions
      PARP(89)=1800. ! sqrts for which PARP82 is set
      PARP(90)=0.227 ! Multiple interactions: rescaling power
      MSTP(96)=6 ! CR (color reconnection parameters)
      PARP(77)=1.016 ! CR
      PARP(78)=0.538 ! CR
      PARP(80)=0.1 ! Prob. colored parton from BBR
      PARP(83)=0.356 ! Multiple interactions: matter distribution parameter
      PARP(84)=0.651 ! Multiple interactions: matter distribution parameter
      PARP(62)=1.025 ! ISR cutoff
      MSTP(91)=1 ! Gaussian primordial kT
      PARP(93)=10.0 ! primordial kT-max
      MSTP(81)=21 ! multiple parton interactions 1 is Pythia default
      MSTP(82)=4 ! Defines the multi-parton model
```

In the pythia program `pythia.f`, the following settings were used:

```
!... pythia.f
```

```
C... Model, process
        CALL PYGIVE( 'MSEL=0')
        CALL PYGIVE( 'MSUB(186)=1') ! gg->QQbarA (MSSM)
        CALL PYGIVE( 'KFPR(186,2)= 5') ! Q = b

C... Model params
            IMSS(4)= 2.      ! masses fixed by user',
            RMSS(5)= 30.    ! tan beta',
            RMSS(19)= 30. ! m_A',
            RMSS(1)= 100.   ! M1',
            RMSS(2)= 200.   ! M2',
            RMSS(3)= 800.   ! Mg',
            RMSS(4)= 200.   ! mu',
            RMSS(6)= 1000.   ! MS',
            RMSS(7)= 1000.   ! MS',
            RMSS(8)= 1000.   ! MS',
            RMSS(9)= 1000.   ! MS',
            RMSS(10)= 1000.   ! MS',
            RMSS(11)= 1000.   ! MS',
            RMSS(12)= 1000.   ! MS',
            RMSS(13)= 1000.   ! MS',
            RMSS(14)= 1000.   ! MS',
            RMSS(15)= 2000.   ! Ab',
            RMSS(16)= 2000.   ! At',
            RMSS(17)= 2000.   ! Atau',
            CALL PYGIVE( 'PMAS(36,1)=30.')   ! mA
C... Switch on decay of A -> mu+mu-:
            CALL PYGIVE( 'MDME(429,1)=1')   ! decay to mu+mu-',
C... Switch off all other decays:
            CALL PYGIVE( 'MDME(420,1)=0')   ! Higgs(H) decay into ddbar',
            CALL PYGIVE( 'MDME(421,1)=0')
            CALL PYGIVE( 'MDME(422,1)=0')
            CALL PYGIVE( 'MDME(423,1)=0')
            CALL PYGIVE( 'MDME(424,1)=0')
            CALL PYGIVE( 'MDME(425,1)=0')
            CALL PYGIVE( 'MDME(426,1)=0')
            CALL PYGIVE( 'MDME(427,1)=0')
            CALL PYGIVE( 'MDME(428,1)=0')
C... and these as well:
            CALL PYGIVE( 'MDME(430,1)=0')
            CALL PYGIVE( 'MDME(431,1)=0')
            ...
            CALL PYGIVE( 'MDME(502,1)=0')
```

The dots indicate the missing incrementing numbers from 432 up to and including 501.

B delphesMA5tune settings

In MadAnalysis 5, to run DelphesMA5tune the following settings were used:

```
ma5>set main.fastsim.package = delphesMA5tune
```

and

```
ma5>set main.fastsim.detector = cms
```

The DelphesMA5tune card used for this analysis can be found on the MadAnalysis Physics Analysis Database page. It was adjusted to have an appropriate b-tag efficiency:

```
###########
# b-tagging
###########

module BTagging BTagging {
  set PartonInputArray Delphes/partons
  set JetInputArray JetEnergyScale/jets

  set BitNumber 0

  set DeltaR 0.5

  set PartonPTMin 1.0

  set PartonEtaMax 2.5

  # default efficiency formula (misidentification rate)
  add EfficiencyFormula {0} {0.01}

  # efficiency formula for c-jets (misidentification rate)
  add EfficiencyFormula {4} {0.20}

  # working point 60%
  # obtained from CMS-SUS-13-013, Section 9
  # efficiency formula for b-jets
  add EfficiencyFormula {5} {
                                (pt < 120.) * ((1.55e-6)*pt^3 + (-4.26e-4)*pt^2 +
                                    (0.0391)*pt + (-0.496)) + \
                                (pt >= 120.) * ((-3.26e-4)*pt + 0.7681)
                              }

}
```