

# Validation of CMS\_SUS\_16\_039

February 7, 2018

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We validated our codes for the CMS\_PAS\_SUS\_2016\_039 cutflow. In detail, we generated 100000 events using MadGraph-2.3.3 and performed the parton shower and hadronization with Pythia6.4 for each test point and CheckMATE-1.2.2 to do our analysis. In order to eliminate the effects of the various trigger efficiencies for leptons satisfying the offline selection, we slightly adjusted the cross section to make the events number of the first cutflow in our validation equal to that in the experiment.

## 1 Cutflow Validation of Signal Region Categories A and B

Signal region Process Point Generated events	SR A and SR B Production of $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ decaying to WZ $m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 200$ GeV; $m_{\tilde{\chi}_1^0} = 100$ GeV 100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
3 tight e, $\mu$ or $\tau_h$	482.20	-	482.20	-
4 <sup>th</sup> lepton veto	418.49	99.9%	481.853	99.9%
conversions and low-mass veto	463.71	96.3%	459.547	95.4%
b-jet veto	456.68	98.5%	454.896	99.0%
$p_T^{\text{miss}} > 50$ GeV	317.00	69.4%	290.691	63.9%
$M_T > 100$ GeV	111.97	35.3%	105.877	36.4%
$M_{ll} > 75$ GeV	103.49	92.4%	99.8032	94.3%

Table 1: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

Signal region Process Point Generated events	SR A and SR B Production of $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ for WZ decay model $m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 500$ GeV; $m_{\tilde{\chi}_1^0} = 150$ GeV 100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
3 tight e, $\mu$ or $\tau_h$	18.06	-	18.06	-
4 <sup>th</sup> lepton veto	18.03	99.8%	18.0379	99.9%
conversions and low-mass veto	17.79	98.6%	17.7421	98.4%
b-jet veto	17.47	98.2%	17.4449	98.3%
$p_T^{\text{miss}} > 50$ GeV	16.98	97.2%	16.9477	97.1%
$M_T > 100$ GeV	12.74	75.1%	12.8606	75.9%
$M_{ll} > 75$ GeV	11.71	91.9%	12.0333	93.6%

Table 2: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

## 2 Cutflow Validation of Signal Region Categories C-F

Signal region Process Point Generated events	SR C - F Production of $\tilde{\chi}_2^0 \tilde{\chi}_1^\pm$ for $\tau$ -dominated model $m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 250$ GeV; $m_{\tilde{\chi}_1^0} = 150$ GeV 100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
3 tight e, $\mu$ or $\tau_h$	189.05	-	189.05	-
4 <sup>th</sup> lepton veto	188.58	99.8%	187.541	99.2%
conversions and low-mass veto	168.19	89.2%	167.785	89.5%
b-jet veto	166.26	98.8%	163.944	97.7%
$p_T^{\text{miss}} > 50$ GeV	117.09	70.4%	102.984	62.8%
$M_{T2} < 100$ GeV	112.26	95.9%	99.4638	96.6%
$M_{ll} < 75$ GeV	93.07	82.9%	73.9462	74.3%

Table 3: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

Signal region Process Point Generated events	SR C - F Production of $\tilde{\chi}_2^0 \tilde{\chi}_1^\pm$ for $\tau$ -dominated model $m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 600$ GeV; $m_{\tilde{\chi}_1^0} = 1$ GeV 100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
3 tight e, $\mu$ or $\tau_h$	28.63	-	28.63	-
4 <sup>th</sup> lepton veto	28.62	100.0%	28.4019	99.2%
conversions and low-mass veto	28.31	98.9%	28.2785	99.6%
b-jet veto	27.78	98.2%	27.2798	96.5%
$p_T^{\text{miss}} > 50$ GeV	25.67	92.4%	25.2381	92.5%
$M_{T2} < 100$ GeV	15.74	61.3%	14.0706	55.8%
$M_{ll} < 75$ GeV	3.85	24.5%	3.58283	25.5%

Table 4: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

### 3 Cutflow Validation of Signal Region Category SS

Signal region	SS			
Process	Production of $\tilde{\chi}_2^0 \tilde{\chi}_1^\pm$ for flavor-democratic model			
Point	$m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 500$ GeV; $m_{\tilde{\chi}_1^0} = 350$ GeV			
Parameter	$x = 0.05$			
Generated events	100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
2 tight e, or $\mu$	214.24	-	214.241	-
same-sign	91.09	42.5%	102.151	47.7%
3 <sup>th</sup> lepton veto	75.82	83.2%	84.2001	82.4%
low-mass veto	73.61	97.1%	83.0763	98.7%
b-jet veto	71.27	96.8%	81.7004	98.3%
$p_T^{\text{miss}} > 60$ GeV	62.79	88.1%	71.7608	87.8%
0 or 1 ISR jet	54.85	87.3%	65.563	91.4%
$M_T < 100$ GeV	18.3	33.4%	17.0607	26.0%
$p_T^l > 100$ GeV	10.01	54.7%	8.30917	48.7%

Table 5: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

Signal region	SS			
Process	Production of $\tilde{\chi}_2^0 \tilde{\chi}_1^\pm$ for flavor-democratic model			
Point	$m_{\tilde{\chi}_2^0} = m_{\tilde{\chi}_1^\pm} = 500$ GeV; $m_{\tilde{\chi}_1^0} = 350$ GeV			
Parameter	$x = 0.5$			
Generated events	100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
2 tight e, or $\mu$	485.34	-	485.34	-
same-sign	128.59	26.5%	132.075	27.2%
3 <sup>th</sup> lepton veto	50.24	39.1%	43.9276	33.3%
low-mass veto	49.86	99.2%	43.2044	98.4%
b-jet veto	48.12	96.5%	42.3307	98.0%
$p_T^{\text{miss}} > 60$ GeV	38.92	80.9%	31.9386	75.5%
0 or 1 ISR jet	29.72	76.5%	26.3825	82.6%
$M_T < 100$ GeV	15.17	51.1%	12.8508	48.7%
$p_T^l > 100$ GeV	2.84	18.7%	2.31404	18.0%

Table 6: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

## 4 Cutflow Validation of Signal Region Categories G-K

Signal region	SR G-K			
Process	Production of $\tilde{\chi}_1^0\tilde{\chi}_1^0$ for $ZZ\tilde{G}\tilde{G}$ decay model			
Point	$m_{\tilde{\chi}_1^0} = 100$ GeV; $m_{\tilde{G}} = 1$ GeV			
Generated events	100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
4 tight e, $\mu$ or $\tau_h$	869.14	-	869.143	-
low-mass veto	868.60	99.9%	861.405	99.1%
b-jet veto	855.41	98.5%	853.359	99.1%
$p_T^{\text{miss}} > 100$ GeV	34.27	4.0%	39.7003	4.7%

Table 7: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .

Signal region	SR G-K			
Process	Production of $\tilde{\chi}_1^0\tilde{\chi}_1^0$ for $ZZ\tilde{G}\tilde{G}$ decay model			
Point	$m_{\tilde{\chi}_1^0} = 800$ GeV; $m_{\tilde{G}} = 1$ GeV			
Generated events	100,000			
Selection	CMS		CheckMATE	
	events	efficiency	events	efficiency
4 tight e, $\mu$ or $\tau_h$	0.36	-	0.36	-
low-mass veto	0.36	99.9%	0.359036	99.7%
b-jet veto	0.35	97.8%	0.351188	97.8%
$p_T^{\text{miss}} > 100$ GeV	0.34	96.7%	0.337121	96.0%

Table 8: Cutflow validation for cms\_sus\_16\_039. Shown are number of events passing each cut normalised to a luminosity of  $35.9 \text{ fb}^{-1}$ .