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1. Validation

Two simplified models of $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ and $\tilde{\chi}_1^{+}\tilde{\chi}_1^{-}$ production are considered in this validation. In both models, the lightest neutralino is the LSP and purely bino, the stau and tau sneutrino are assumed to be mass-degenerate, and the $\tilde{\tau}_1$ is assumed to be purely $\tilde{\tau}_L$. The mass of the $\tilde{\tau}_L$ state is set to be halfway between the masses of the $\tilde{\chi}_1^{\pm}$ and $\tilde{\chi}_1^0$. In the model characterised by $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ production, the $\tilde{\chi}_1^{\pm}$ and $\tilde{\chi}_2^0$ are assumed to be pure wino and mass-degenerate. In the model where only $\tilde{\chi}_1^{+}\tilde{\chi}_1^{-}$ production is considered, the $\tilde{\chi}_1^{\pm}$ is pure wino. Charginos and next-to-lightest neutralinos decay into the lightest neutralino via an intermediate on-shell stau or tau sneutrino, $\tilde{\chi}_1^{\pm} \to \tilde{\tau}\nu_\tau(\tilde{\nu}_\tau\tau) \to \tau\nu_\tau(\nu_\tau\tau)\tilde{\chi}_1^0$, $\tilde{\chi}_2^0 \to \tilde{\tau}\tau \to \tau\tau\tilde{\chi}_1^0$, and $\tilde{\chi}_2^0 \to \tilde{\nu}_\tau\nu_\tau \to \nu_\tau\nu_\tau\tilde{\chi}_1^0$.

We generate the point used in Table1 by the following process with MadGraph5 and Pythia6. In the proc_card.dat, we set the following information:

import model mssm –modelname;

generate p p > x1+ n2, (x1+ > sl3+ vt, sl3+ > tau+ n1), (n2 > sl3− tau+, sl3− > tau− n1)

add process p p > x1+ n2, (x1+ > sl3+ vt, sl3+ > tau+ n1), (n2 > vt sv3 , sv3 > vt n1) add process p p > x1+ n2, (x1+ > tau+ sv3, sv3 > vt n1), (n2 > sl3- tau+, sl3- > tau- n1) add process p p > x1+ n2, (x1+ > tau+ sv3, sv3 > vt n1), (n2 > vt sv3 , sv3 > vt n1)

add process p p > x1- n2, (x1- > sl3- vt , sl3- > tau- n1), (n2 > sl3- tau+, sl3- > tau- n1)

add process p p > x1- n2, (x1- > sl3- vt , sl3- > tau- n1), (n2 > vt sv3 , sv3 > vt n1)

add process p p > x1- n2, (x1- > tau- sv3 , sv3 > vt n1), (n2 > sl3- tau+, sl3- > tau- n1)

add process p p > x1- n2, (x1- > tau- sv3 , sv3 > vt n1), (n2 > vt sv3 , sv3 > vt n1).

In the run_card.dat, we set the following information and others are kept default:

50000 = nevents ! Number of unweighted events requested.

In the param_card.dat, we set the following information and others are kept default:

1000015 300 # Msl3

1000016 300 # Msn3

1000022 0.0 # Mneu1

1000023 600 # Mneu2

1000024 600 # Mch1

pythia_card.dat is not changed.

We generate the point used in Table2 by the following process with MadGraph5 and Pythia6. In the proc_card.dat, we set the following information:

import model mssm –modelname;

generate p p > x1+ x1-, (x1+ > sl3+ vt, sl3+ > tau+ n1), (x1- > sl3- vt , sl3- > tau- n1)

add process p p > x1+ x1-, (x1+ > tau+ sv3, sv3 > vt n1), (x1- > tau- sv3 , sv3 > vt n1)

add process p p > x1+ x1-, (x1+ > sl3+ vt, sl3+ > tau+ n1), (x1- > tau- sv3 , sv3 > vt n1)

add process p p > x1+ x1-, (x1+ > tau+ sv3, sv3 > vt n1), (x1- > sl3- vt , sl3- > tau- n1)

In the run_card.dat, we set the following information and others are kept default:

50000 = nevents ! Number of unweighted events requested.

In the param_card.dat, we set the following information and others are kept default:

1000015 300 # Msl3

1000016 300 # Msn3

1000022 0.0 # Mneu1

1000024 600 # Mch1

pythia_card.dat is not changed.

References

[1] https://www.hepdata.net/record/79042.

[2] https://www.hepdata.net/record/79043.

Table 1: The cut-flows of atlas_1708_07875 in SR-LowMass for ($m_{\tilde{\chi}_1^\pm}/m_{\tilde{\chi}_2^0}$, $m_{\tilde{\chi}_1^0}$) = (600 GeV, 0 GeV). $\tilde{\chi}_1^\pm$ and $\tilde{\chi}_2^0$ are wino dominated and $\tilde{\chi}_1^0$ is bino dominated. We do the validation according to the web [1] and begin our comparison at the step >= **2 medium τ, matched to trigger objects** because we don't know how **Total events** was generated by ATLAS.

Signal Region	SR LowMass			
Process	Production of $\tilde{\chi}_1^\pm\tilde{\chi}_2^0$			
Point	$m_{\tilde{\chi}_1^\pm} = m_{\tilde{\chi}_2^0}$ = 600 GeV; $m_{\tilde{\chi}_1^0}$ = 0 GeV			
Generated Events	100000			
Selection	ATLAS		CheckMATE	
	events	efficiency	events	efficiency
>= 2 medium τ, matched to trigger objects	33.5	-	33.5	-
>= 1 opposite sign τ pair	24	71.6%	23.3	69.6%
b-jet veto	22.2	92.5%	22.1	94.8%
Z-veto	21.3	95.9%	21.2	95.9%
di-tau + E_T^{miss} trigger only	13.3	62.4%	13.8	65.1%
m_{T2} > 70 GeV	11.8	88.7%	11.3	81.9%

Table 2: The cut-flows of atlas_1708_07875 in SR-HighMass for ($m_{\tilde{\chi}_1^\pm}$, $m_{\tilde{\chi}_1^0}$) = (600 GeV, 0 GeV). $\tilde{\chi}_1^\pm$ is wino dominated and χ_1^0 is bino dominated. We do the validation according to the web [2] and begin our comparison at the step >= **2 medium τ, matched to trigger objects** because we don't know how **Total events** was generated by ATLAS.

Signal Region	SR HighMass			
Process	Production of $\tilde{\chi}_1^+\tilde{\chi}_1^-$			
Point	$m_{\tilde{\chi}_1^\pm}$ = 600 GeV; $m_{\tilde{\chi}_1^0}$ = 0 GeV			
Generated Events	100000			
Selection	ATLAS		CheckMATE	
	events	efficiency	events	efficiency
>= 2 medium τ, matched to trigger objects	21.2	-	21.2	-
>= 1 opposite sign τ pair	21	99.1%	20.9	98.6%
b-jet veto	20.3	96.7%	20.3	97.1%
Z-veto	19.7	97.0%	19.7	97.0%
at least one medium and one tight τ	16.3	82.7%	16.7	84.8%
$p_T, \tau_1 > 80$ GeV(di-tau + E_T^{miss} trigger only)	16.1	98.8%	16.5	98.8%
m$(\tau_1, \tau_2) > 110$ GeV	13.5	83.9%	15.2	92.1%
$E_T^{miss} > 110$ GeV (asymmetric di-tau trigger only)	12.5	92.6%	12.7	83.6%
$m_{T2} > 90$ GeV	10	80.0%	7.7	60.6%