Long-lived stau, sneutrino dark matter and right slepton spectrum

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Model

- A right-handed neutrino superfield ($\hat{\nu}_R$) has been added to MSSM, giving rise to the *Superpotential*

$$\mathcal{W} = \mathcal{W}_{MSSM} + y_\nu \hat{H}_u \hat{L} \hat{\nu}_R^c$$

- This extra term in Superpotential gives rise to a dirac-mass term for SM neutrinos and hence $y_\nu \sim 10^{-13}$.
- Under the purview of CMSSM the right-handed sneutrino ($\tilde{\nu}_R$) mass parameter $M_{\tilde{\nu}_R}$ runs as,

$$\frac{dM^2_{\tilde{\nu}_R}}{dt} = \frac{2}{16\pi^2} y_\nu^2 A_\nu^2$$

  Hence the smallness of yukawa coupling ensures that $M_{\tilde{\nu}_R}$ remains fixed at it's UV value while all other sfermions evolves to TeV scale $\Rightarrow \tilde{\nu}_R$ can be LSP and a good non-thermal CDM candidate.
- Under the framework of CMSSM, $\tilde{\tau}_R$ can be a NLSP with $\tilde{\nu}_R$ as a LSP $\Rightarrow$ collider signal has been studied in [S.Banerjee, G.Belangar, B.Mukhopadhyaya, P.D.Serpico, JHEP 1607 (2016) 095]

Motivation

- Even under the purview of $\tilde{\nu}$CMSSM one can ask whether $\tilde{\mu}_R$ or $\tilde{\chi}_1^0$ is the N^{2}LSP and how do they affect the collider phenomenology.
- We are looking at both the cases:
  (1) $m_{\tilde{\mu}_R} < m_{\tilde{\chi}_1^0}$ or,
  (2) $m_{\tilde{\mu}_R} > m_{\tilde{\chi}_1^0}$
  but in the pMSSM scenario.
- In the first case $\tilde{\mu}_R$ undergoes a three-body decay into a μ, τ-lepton and $\tilde{\tau}_R$ appearing as a heavy stable charged particle(HSCP). While in the second case $\tilde{\mu}_R$ undergoes two succesive two-body decays via a on-shell $\tilde{\chi}_1^0$ into a μ, τ-lepton and $\tilde{\tau}_R$ appearing as a HSCP.
- One can look for two possible signals:-
  (1) 2 HSCP($\tilde{\tau}_R$) + 2 opposite-sign same flavour leptons(OSSF) + 1 tau-tagged jet.
  (2) 2 HSCP($\tilde{\tau}_R$) + 2 opposite-sign same flavour leptons(OSSF) + 2 tau-tagged jets.
- We are concentrating in the Drell-Yan production of slepton-antislepton for reconstructing $\tilde{\mu}_R$ mass either by MT2 variable(for signal (1)) or by invariant mass distribution(for signal (2)).

Results

- In each case $\tilde{\chi}_1^0$ mass can be estimated using collinear-approximation. [S.Biswas, B.Mukhopadhyaya ,Phys.Rev. D79 (2009) 115009]

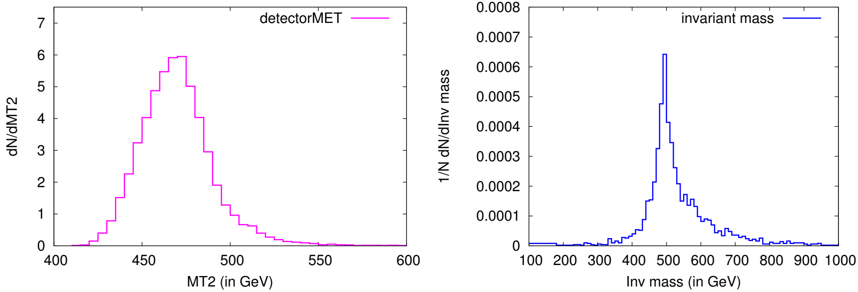

Figure: MT2 and invariant mass distribution for an illustrative benchmark case(1):- $m_{\tilde{\mu}_R}$ =490 GeV,$m_{\tilde{\chi}_1^0}$ =591 GeV and $m_{\tilde{\tau}_R}$ =398 GeV.

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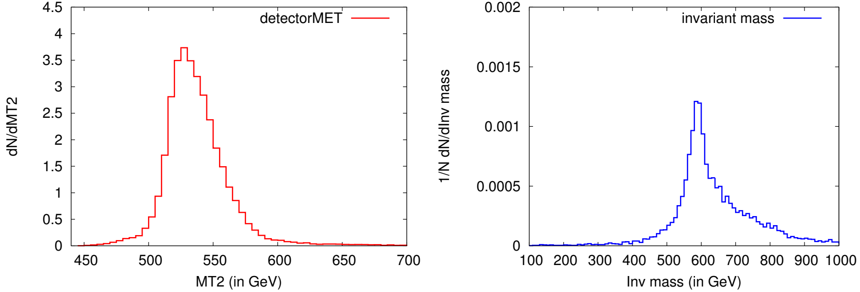

Figure: MT2 and invariant mass distribution for an illustrative benchmark of case(2):- $m_{\tilde{\mu}_R}$ =587 GeV,$m_{\tilde{\chi}_1^0}$ =497 GeV and $m_{\tilde{\tau}_R}$ =421 GeV.


Thank You