Impact of LHC Searches on a Light Top Squark: Model-Independent Analysis

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Outline

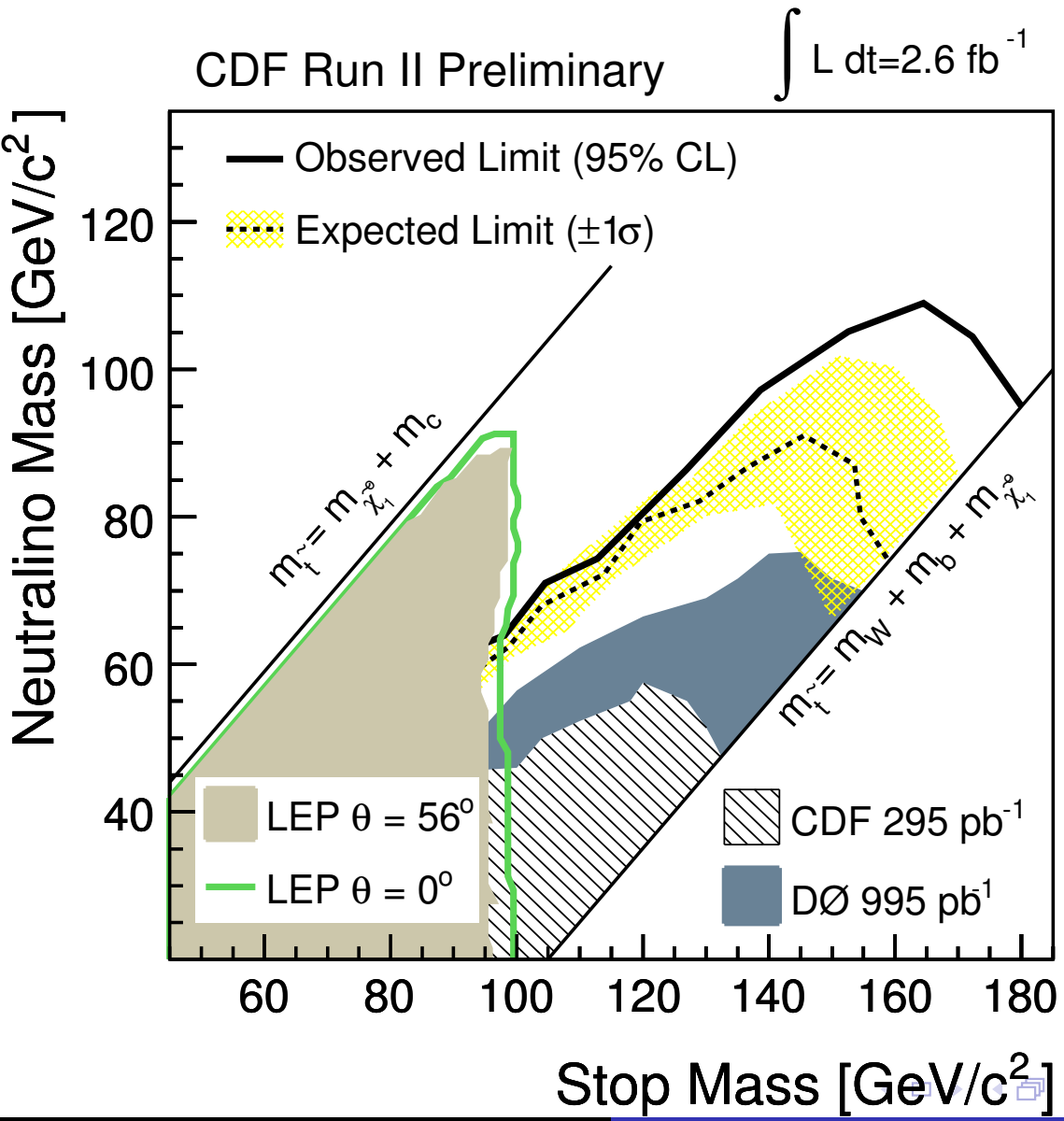
- Motivation
- Overview
- Results

Motivation

- NLSP stop is favored by electroweak baryongenesis and the naturalness in electroweak symmetry breaking in MSSM.
- Near degeneracy of NLSP stop and LSP neutralino can accommodate co-annihilation mechanism motivated by proper dark matter relic density.
- The search for NLSP stop has been implemented by both LEP and Tevatron, assuming

$$\tilde{t}_1 \to c\tilde{\chi}_1^0$$

Motivation


CDF Run II Preliminary
∫ L dt=2.6 fb-1
Observed Limit (95% CL)
Expected Limit (±1σ)
Neutralino Mass [GeV/c2]
Stop Mass [GeV/c2]
m~t = m χ̃01 + mc
m~t = mW + mb + m χ̃01
LEP θ = 56°
LEP θ = 0°
CDF 295 pb-1
DØ 995 pb-1
40
60
80
100
120
140
160
180

Overview

- We choose the simplified scenario which parametrizes the new physics by a simple particle spectrum. Particles that are not involved are assumed to be decoupled.
- Only three parameters: $M_{\tilde{g}}$, $M_{\tilde{t}_1}$ and $M_{\tilde{\chi}_1^0}$.
- NLSP stop decay

$$\tilde{t}_1 \to c\tilde{\chi}_1^0$$

- NLSP stop production

$$pp \to \tilde{t}_1\tilde{t}_1^*, j\tilde{t}_1\tilde{t}_1^*, \tilde{g}\tilde{g}$$

with $\tilde{g} \to t\tilde{t}_1^* + \bar{t}\tilde{t}_1$

Overview

- LHC analysis results with 1 fb^{-1}.
  - ◇ jets plus missing transverse momentum
  - ◇ monojet plus large missing energy
  - ◇ b-jets with or without lepton plus missing energy
  - ◇ two same-sign isolated leptons plus hadronic jets and missing energy

- Mass ranges

$$M_{\tilde{\chi}_1^0} + M_c < M_{\tilde{t}_1} < M_{\tilde{\chi}_1^0} + M_b + M_W$$

$$M_{\tilde{g}} > M_{\tilde{t}_1} + M_t$$

- Madgraph/Madevent production of $\tilde{g}\tilde{g}$, $\tilde{t}_1\tilde{t}_1^*$, $j\tilde{t}_1\tilde{t}_1^*$
  Pythia particle decays, parton showering and hadronization
  PGS-4 detector effects
  Prospino next-to-leading order cross sections

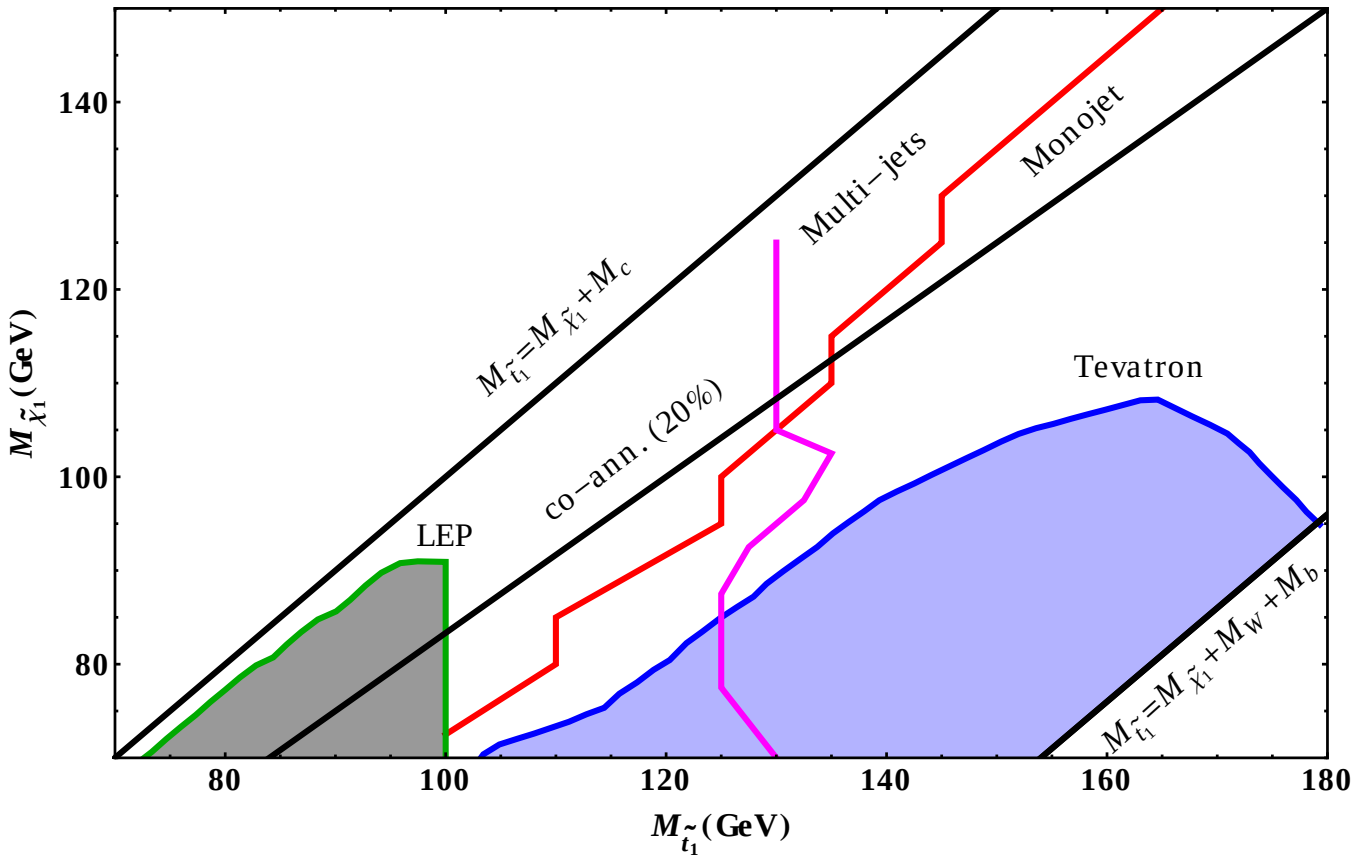
Results

- We first consider

$$pp \to \tilde{t}_1 \tilde{t}_1^* + j\tilde{t}_1 \tilde{t}_1^*$$

with $$M_{\tilde{\chi}_1^0} + M_c < M_{\tilde{t}_1} < M_{\tilde{\chi}_1^0} + M_b + M_W$$

Results



- Monojet: 20% co-annihilation region with $M_{\tilde{t}_1} \lesssim 140$ GeV is essentially ruled out.
- Multi-jets: $M_{\tilde{t}_1} \lesssim 130$ GeV is essentially ruled out.

Results

- Next we consider

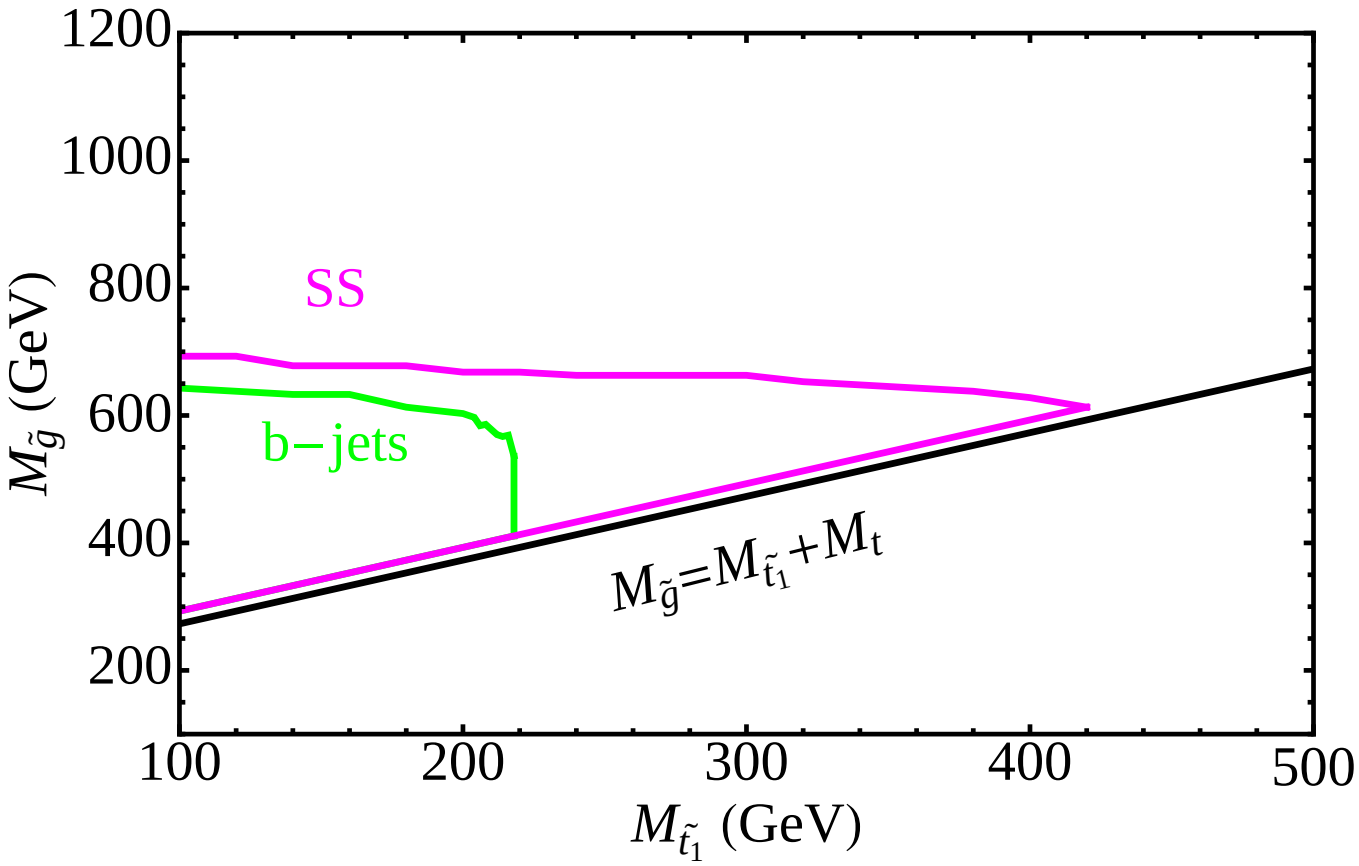
$$pp \to \tilde{t}_1 \tilde{t}_1^* + j\tilde{t}_1 \tilde{t}_1^* + \tilde{g}\tilde{g}$$

with $\tilde{g} \to t\tilde{t}_1^* + \bar{t}\tilde{t}_1$

and $M_{\tilde{g}} > M_{\tilde{t}} + M_t$

Also, we fix $\frac{M_{\tilde{t}_1} - M_{\tilde{\chi}_1^0}}{M_{\tilde{\chi}_1^0}} = 20\%$ in order to remove one unknown mass parameter $M_{\tilde{\chi}_1^0}$.

Results



- b-jets: $M_{\tilde{t}_1} \gtrsim 200$ GeV, $M_{\tilde{g}} \gtrsim 600$ GeV
- same sign dileptons: $M_{\tilde{t}_1} \gtrsim 400$ GeV, $M_{\tilde{g}} \gtrsim 700$ GeV