Search for Supersymmetry in Single Lepton + B-jets and Opposite-Sign Dilepton Final States at CMS.

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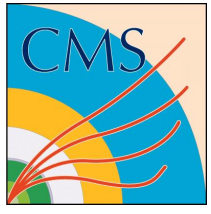


Outline

- Search for SUSY in Single Lepton + B-jets Final States
  - 2011
  - 2012
- Search for SUSY in Opposite-Sign Dilepton Final States
- Summary and Outlook
- Backup

Outline

> **Search for SUSY in Single Lepton + B-jets Final States**
  - 2011
  - 2012

> **Search for SUSY in Opposite-Sign Dilepton Final States**

> **Summary and Outlook**

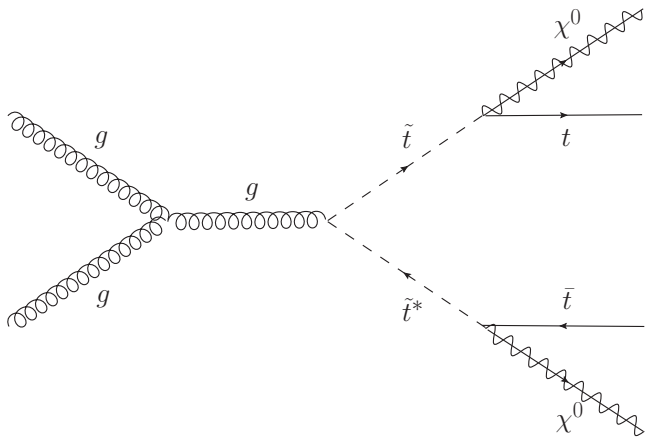
> **Backup**

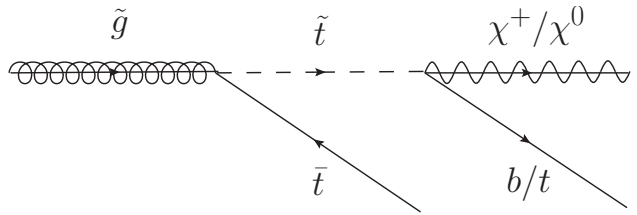
Motivation

- Top and bottom squark may be (significantly) lighter than 1^{st} and 2^{nd} generation squarks

$\longrightarrow$ May result in excess of events with a large b-jet multiplicity from $\tilde{t}\tilde{t}^*$ or $\tilde{b}\tilde{b}^*$ pair production and gluino decays

- In addition: Expect significant amount of $\not{E}_T$ from stable LSP and isolated lepton from top, chargino or neutralino decay



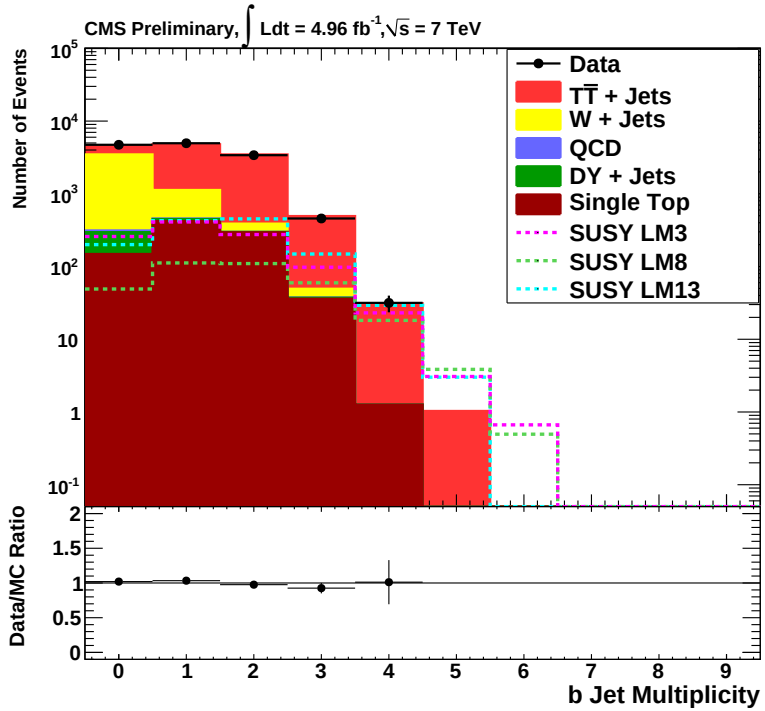


Search for SUSY in Single Lepton + B-jets Final States 2011

Event Selection

- 1 isolated muon or electron with $p_T > 20\,\text{GeV}$
- Veto on events with 2^{nd} (looser) lepton
- ≥ 4 jets with $p_T > 40\,\text{GeV}$ [a]
- $H_T > 375\,\text{GeV}$ (scalar sum of the p_T of selected jets)
- $\not{E}_T > 60\,\text{GeV}$
- ≥ 1, ≥ 2 or ≥ 3 b-jets

[a] Reconstructed with the anti-k_T algorithm (distance parameter of 0.5) from particle flow objects



B-jets: Selected jets with at least two tracks that have an impact parameter significance $\geqq 3.3$.

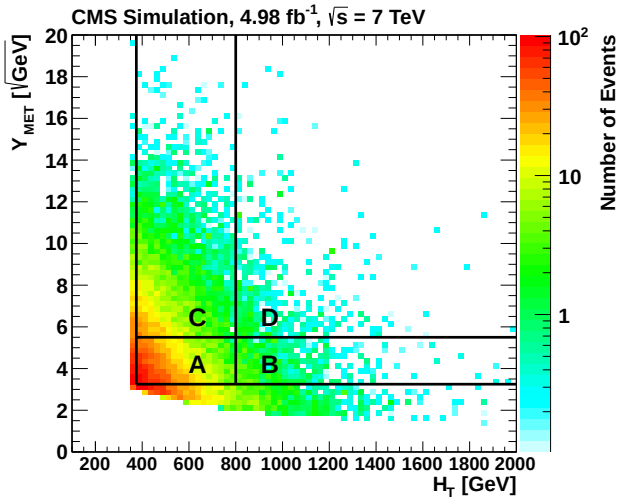
Paper [a] submitted to PRD

[a] http://arxiv.org/abs/1211.3143

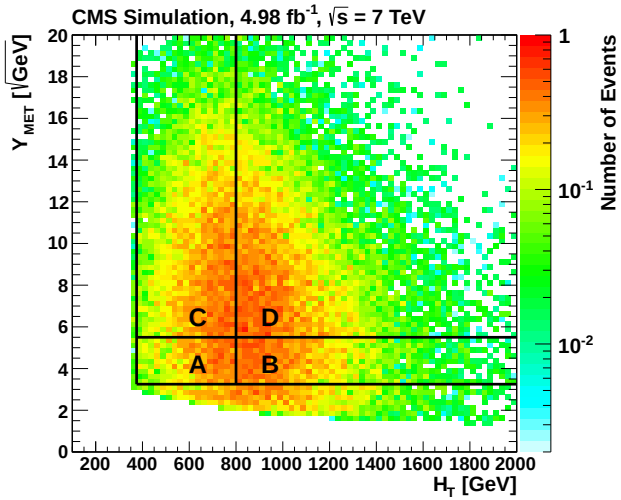
Background Estimation from Data

- Main background after b-tag requirement: $t\bar{t}$+Jets events
- For these H_T and $Y_{\text{MET}} \equiv \not{E}_T / \sqrt{H_T}$ are nearly uncorrelated

$\longrightarrow$ Use factorization method to estimate SM background in signal enriched region D from control regions A, B and C



SM

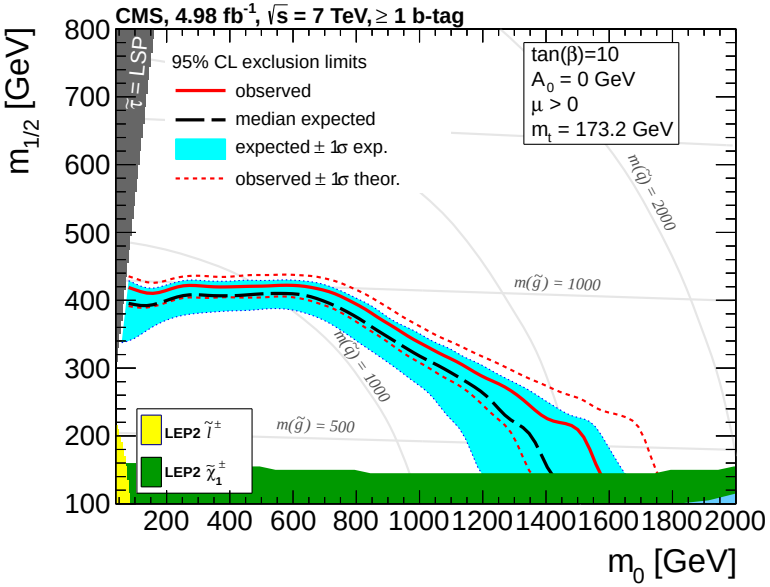


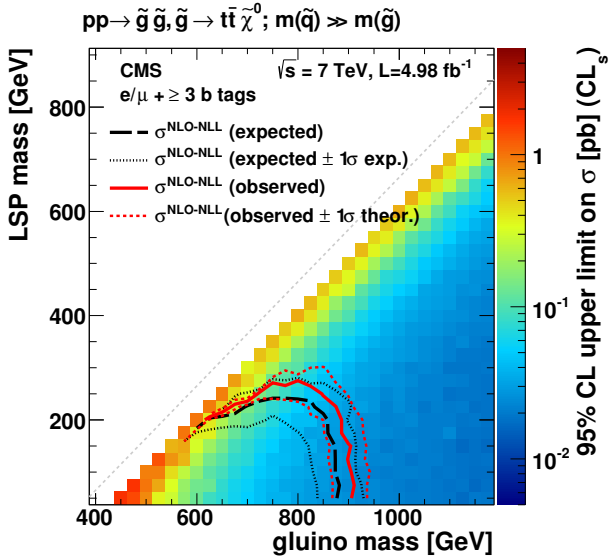
cMSSM benchmark scenario LM8

- $\frac{N_C}{N_A} = \kappa \frac{N_D}{N_B} \Rightarrow N_D = \kappa N_B \frac{N_C}{N_A}$ (κ = Correlation factor)

Results and Interpretation

- No excess observed
- Limits set in cMSSM and heavy flavor simplified model





cMSSM

- $A_0 = 0,\ \tan\beta = 10,\ \mu > 0$
- $\geq$ 1 b-jet

T1tttt

- $\tilde{g}\,\tilde{g} \rightarrow t\bar{t}\,t\bar{t}\,\tilde{\chi}_1^0\tilde{\chi}_1^0$
- $\geq$ 3 b-jets

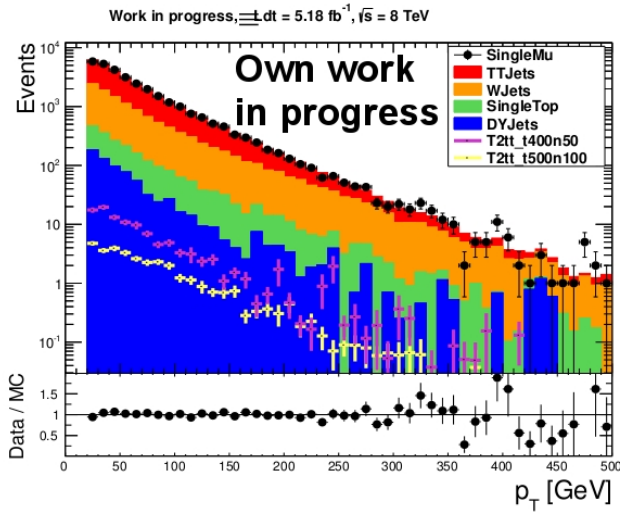
Search for SUSY in Single Lepton + B-jets Final States 2012

In contrast to 2011, rather focus on production channels than signatures:

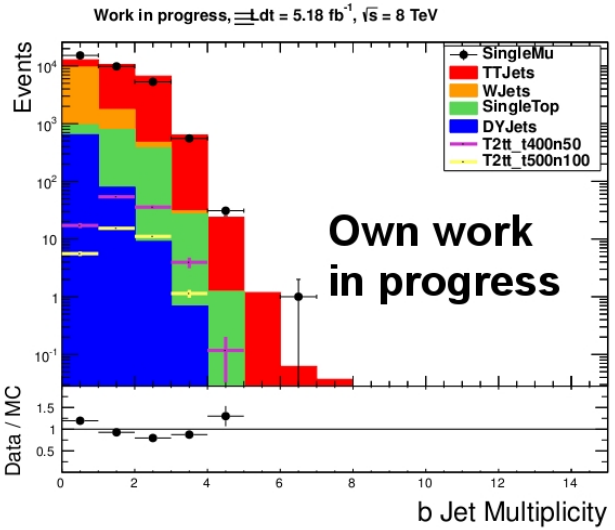
- $\tilde{t}\,\tilde{t}^{*} \rightarrow t\,\bar{t}\,\chi_1^0\,\chi_1^0$
- $\tilde{g}\,\tilde{g}\,/\,\tilde{g}\,\tilde{q}$ with $\tilde{g} \rightarrow \tilde{t}\,t$ or $\tilde{g} \rightarrow \tilde{b}\,b$

Event Selection

- 1 isolated muon or electron with $p_T > 20\,(\mathbf{30})$ GeV
- Veto on events with 2^{nd} (looser) lepton
- $\geq$ **3 jets** with $p_T > 40$ GeV
- $\mathbf{H_T > 300\,GeV}$ (under study)
- $\not{E}_T > 60$ GeV (under study)
- Require b-jets to supress W+Jets and single top (t-channel) events



Muon p_T



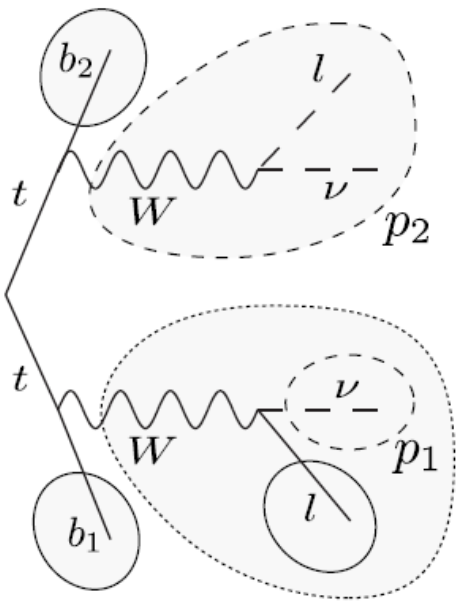
Number of b-jets in the muon channel

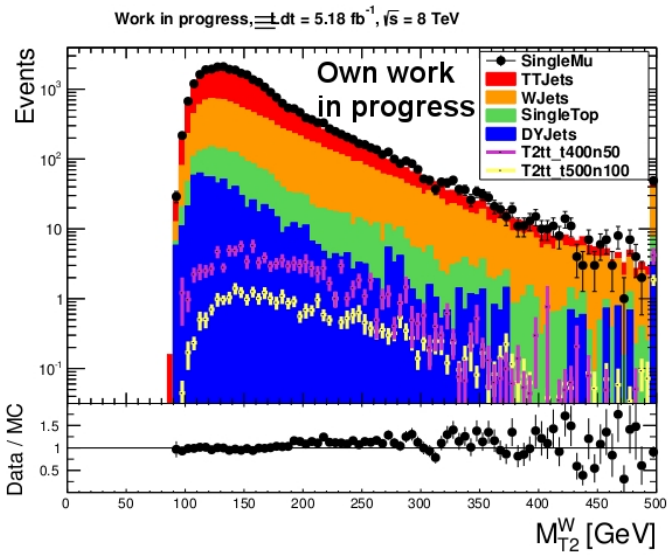
Search for Direct Stop Pair Production using M_{T2}^W

After an additional cut on $\sqrt{m_T = p_{T\text{lep}} \not{E}_T (1 - \cos\phi)}$ an important SM background are **dileptonic $t\bar{t}$ events**, where one lepton is lost

$\longrightarrow$ Exploit different origin of $\not{E}_T$ to distinguish between SM background and signal (for details see JHEP 1207 (2012) 110):

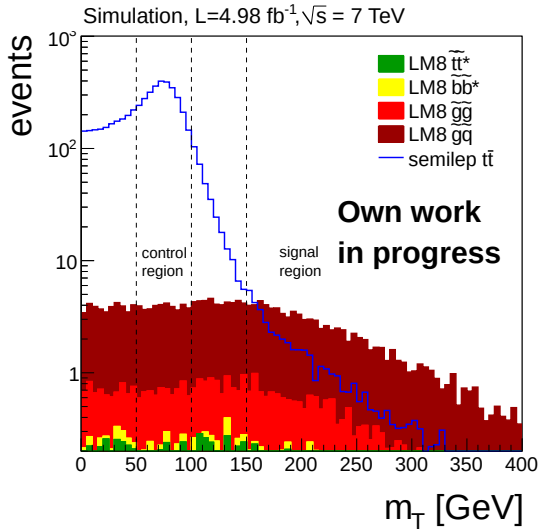
$$M_{T2}^W = \min\, m_y \text{ consistent with } \begin{cases} \vec{p}_{T,1} + \vec{p}_{T,2} = \not{E}_T \\ p_1^2 = 0 \\ (p_1 + p_l)^2 = p_2^2 = m_W^2 \\ (p_1 + p_l + p_{b,1})^2 = (p_2 + p_{b,2})^2 = m_y^2 \end{cases}$$





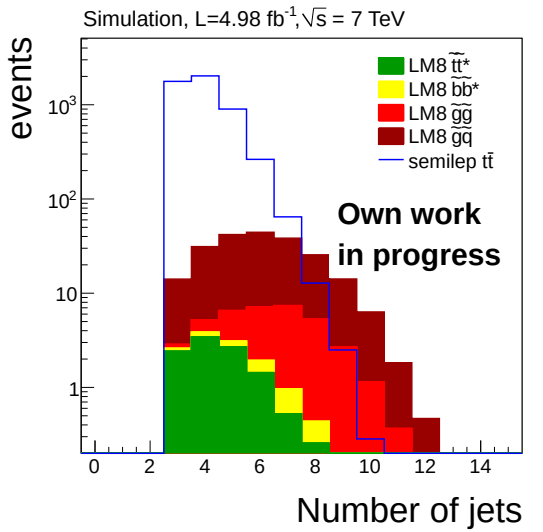
Search for Gluino-Mediated Production of 3rd Gen. Squarks

- After an increased cut on $\not\!\!E_T$ ($> 100\,\text{GeV}$) the dominant SM background consists of **semileptonic $t\bar{t}$ events**.
- For these $\sqrt{m_T = p_{T\text{lep}}\,\not\!\!E_T\,(1-\cos\phi)}$ and the jet mutliplicity are only slightly correlated.



⟶ Analysis Strategy

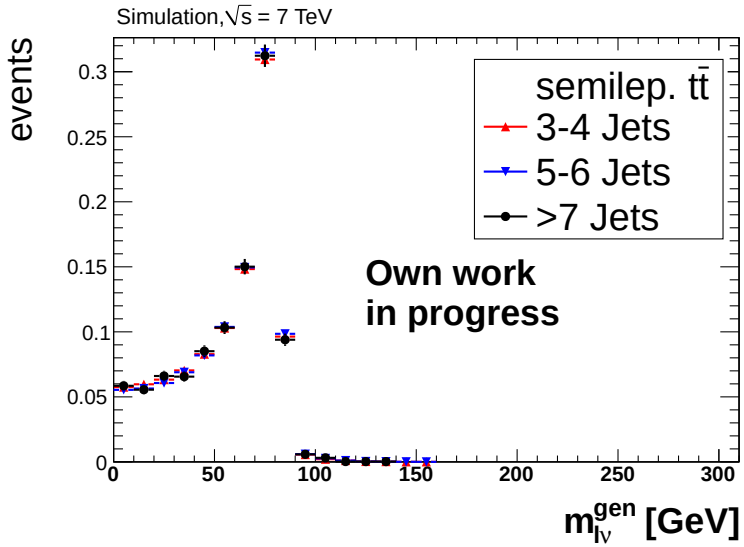
- Measure jet multiplicity in control region defined by $50\,\text{GeV} < m_T < 100\,\text{GeV}$
- Use this distribution as template for the jet multiplicity of the SM background in signal region defined by $m_T > 150\,\text{GeV}$
- Search for deviations at large jet multiplicites, which are expected from $\tilde{g}\,\tilde{g}$ / $\tilde{g}\,\tilde{q}$ production



For the moment: Use 2011 sample (larger statistics)

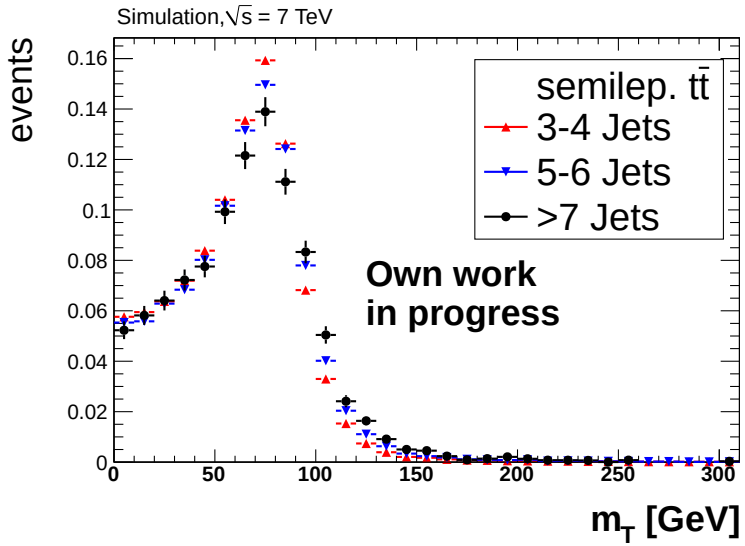
Search for Gluino-Mediated Production of 3rd Gen. Squarks

Gen level



$$m_{l\nu}^{\text{gen}} = \sqrt{p_{T\,\text{lep}}^{\text{gen}}\, p_{T\nu}^{\text{gen}} (1 - \cos\phi)}$$

Reco level



$$m_T = \sqrt{p_{T\,\text{lep}}\ \not{E}_T\ (1 - \cos\phi)}$$

- Smearing at larger jet multiplicities due to limited jet energy resolution
- Other backgrounds:
  - W+Jets and single top
  - Other $t\bar{t}$: Mainly semilep. and dilep. $t\bar{t}$ with at least one τ

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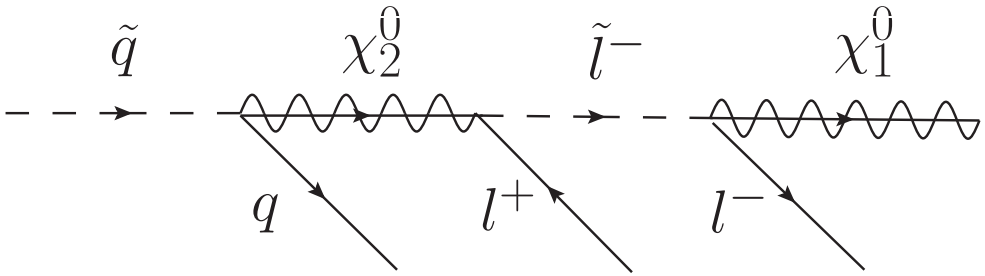
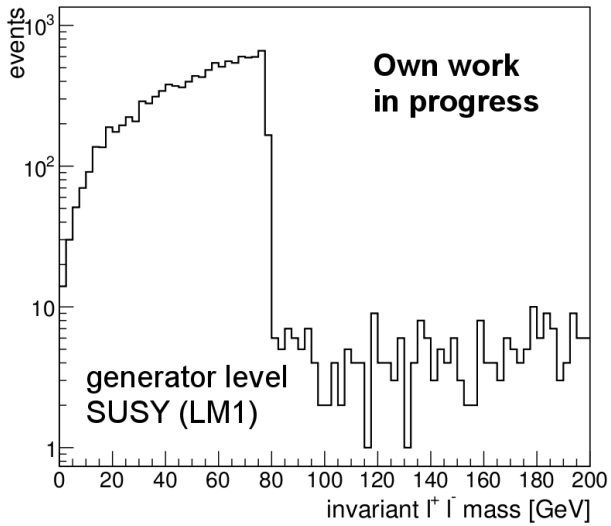
Search for SUSY in Opposite-Sign Dilepton Final States

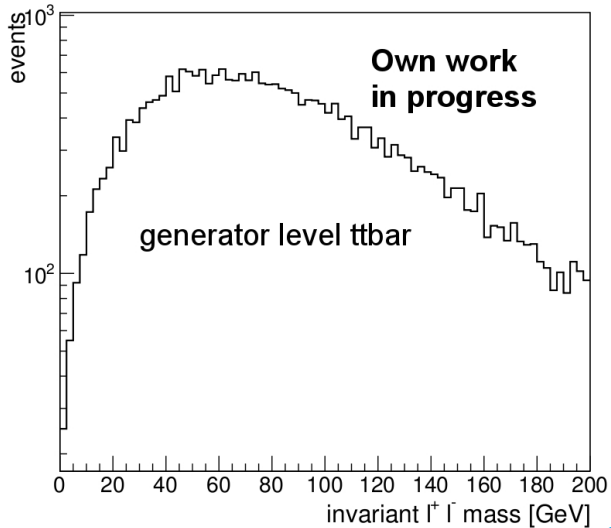




Event Selection

- 2 isolated muons or electrons
  - opposite sign
  - $p_T > 20\,(10)$ GeV
- $\geq$ 2 jets with $p_T > 40$ GeV
- $H_T > 100$ GeV
- $\not{E}_T > 150$ GeV

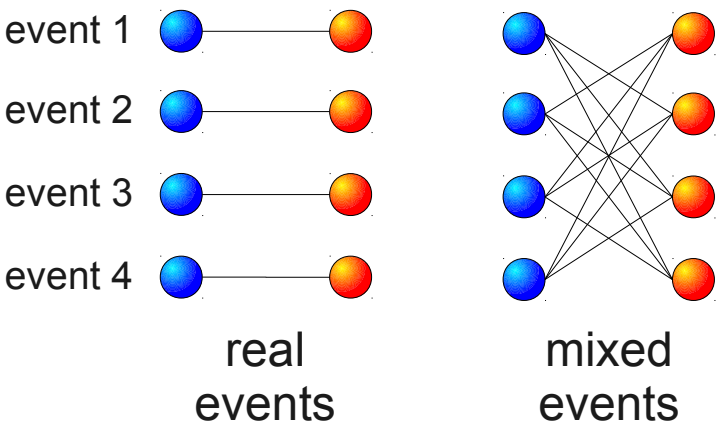
$\longrightarrow$ Main background: dileptonic $t\bar{t}$

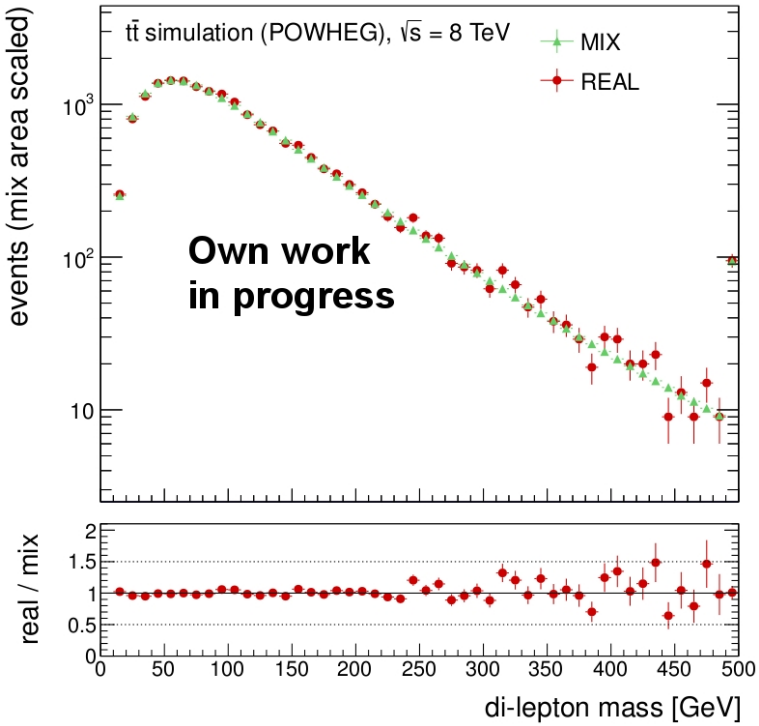


Event Mixing Method

- In signal events P_{l+} and P_{l-} can be expetced to be correlated
- In dileptonic $t\bar{t}$ events P_{l+} and P_{l-} are expected to be less correlated as the leptons originate from different decay branches

$\longrightarrow$ Combine P_{l+} of n events with P_{l-} of (n-1) events to predict SM background from data





$\longrightarrow$ m_{ll} distribution of simulated $t\bar{t}$ events gets well reproduced by distribution of mixed events

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Summary and Outlook

- No signal in single lepton + b-jets final states in 2011 data ($\sqrt{s} = 7\,\text{GeV}$) observed

  $\longrightarrow$ Limits set upon parameters of cMSSM and different simplified models

- Search for SUSY in direct top squark production and gluino-mediated production of 3^{rd} generation squarks at $\sqrt{s} = 8\,\text{GeV}$ is work in progress

- Method to predict SM background from data in search for SUSY in opposite-sign dilepton final states established

  $\longrightarrow$ Extend search to complete set of 2012 data in the beginning of next year

Summary and Outlook

Thank's for listening!

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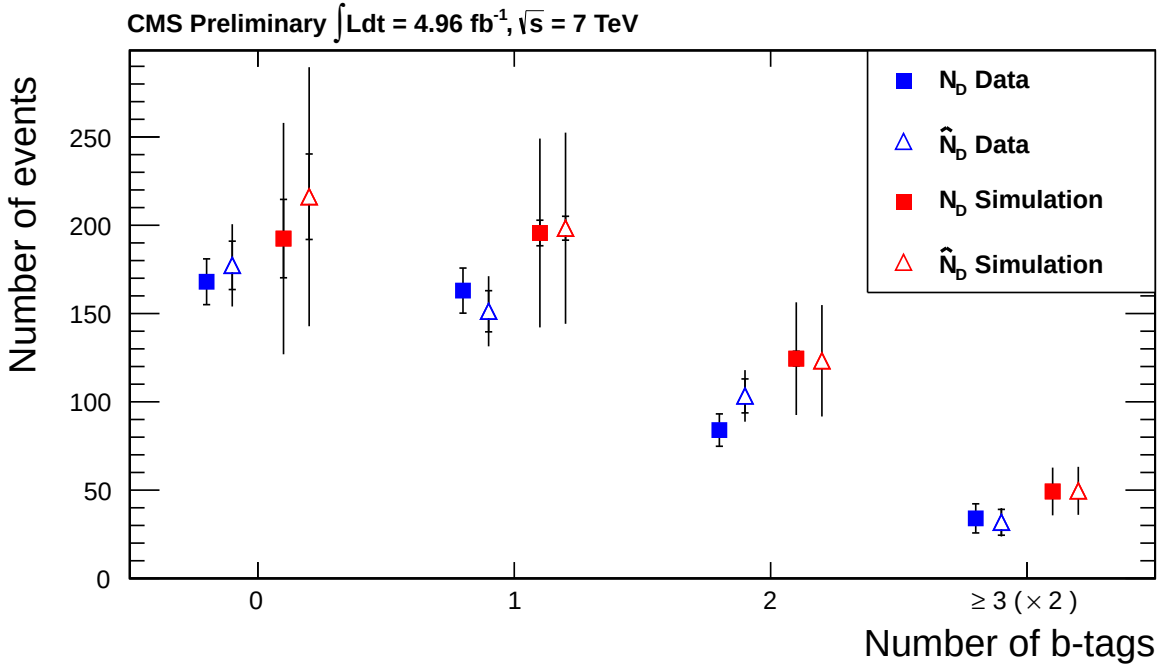
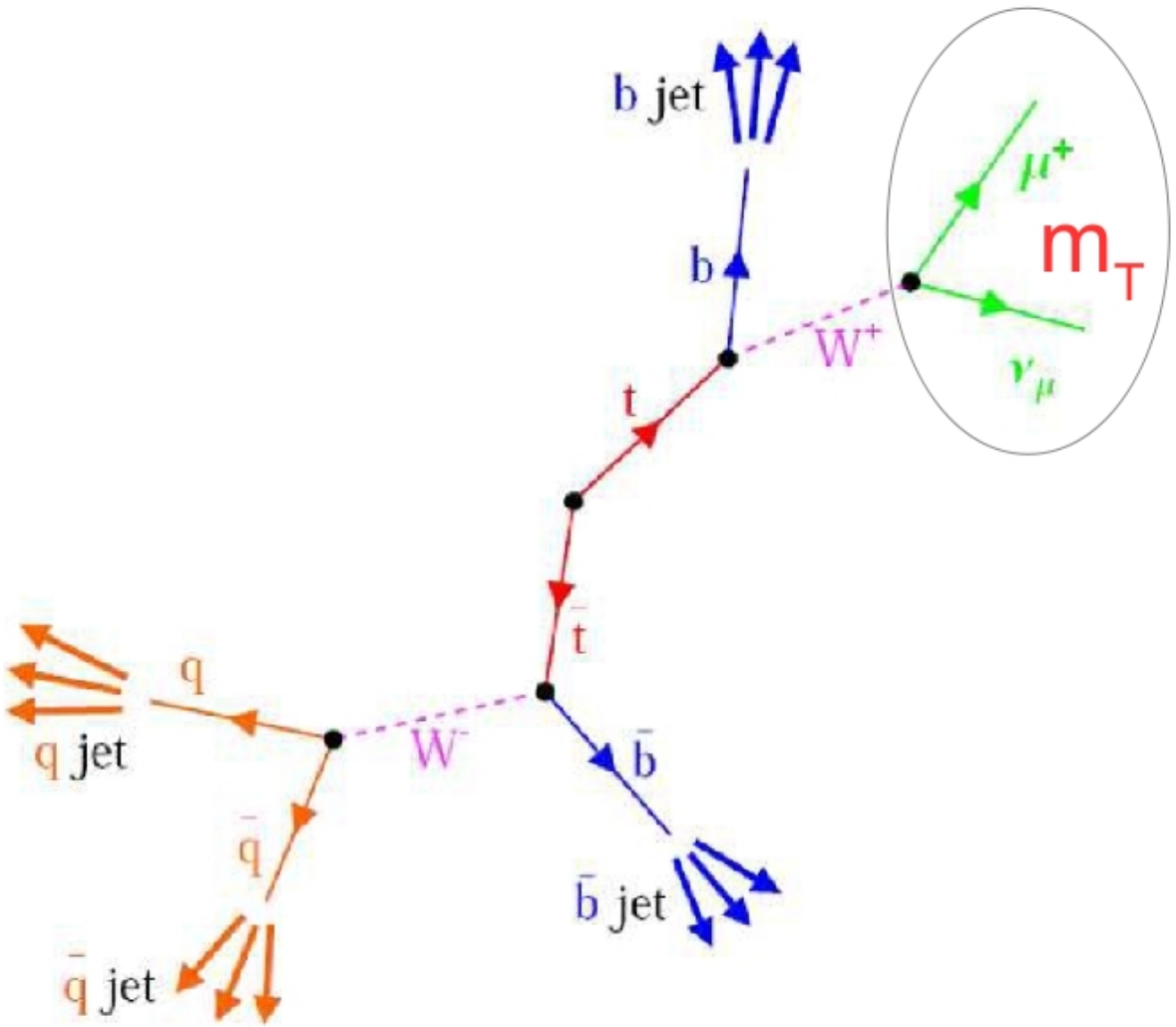
Backup: 2011 Results

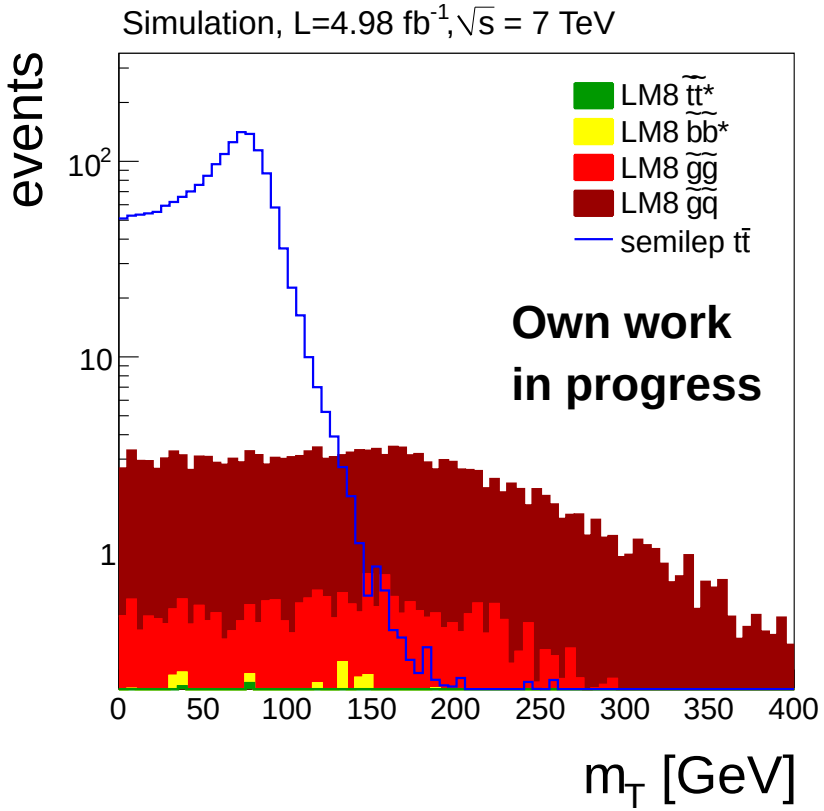


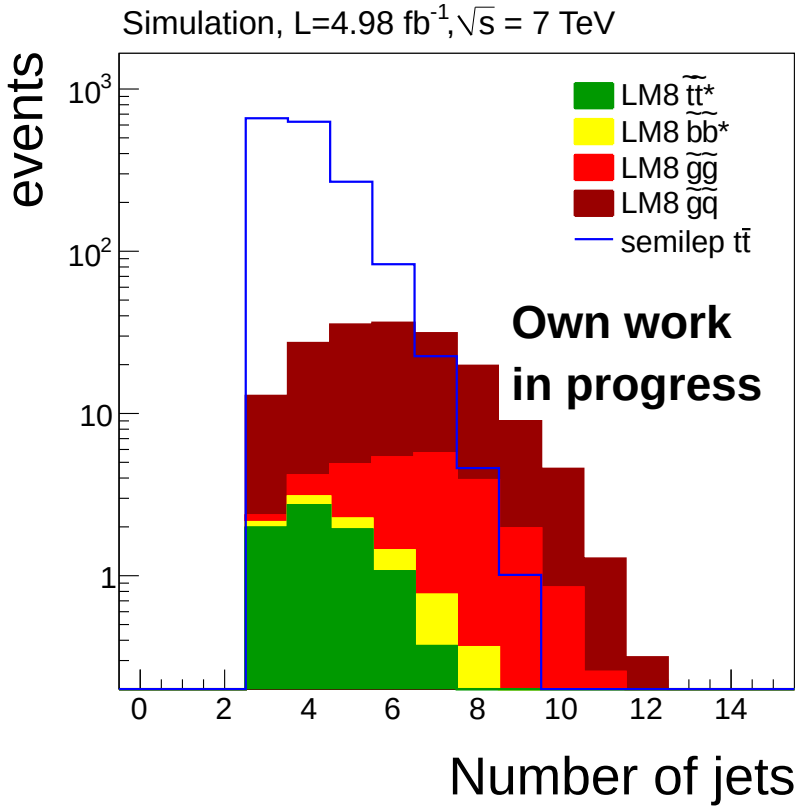
- Number of simulated and predicted simulated events agree well → **Test on simulated events closes**
- Agreement between data and prediction from data within uncertainties → **No excess observed**

Backup: Search with m_T and nJets



Backup: Search with m_T and nJets

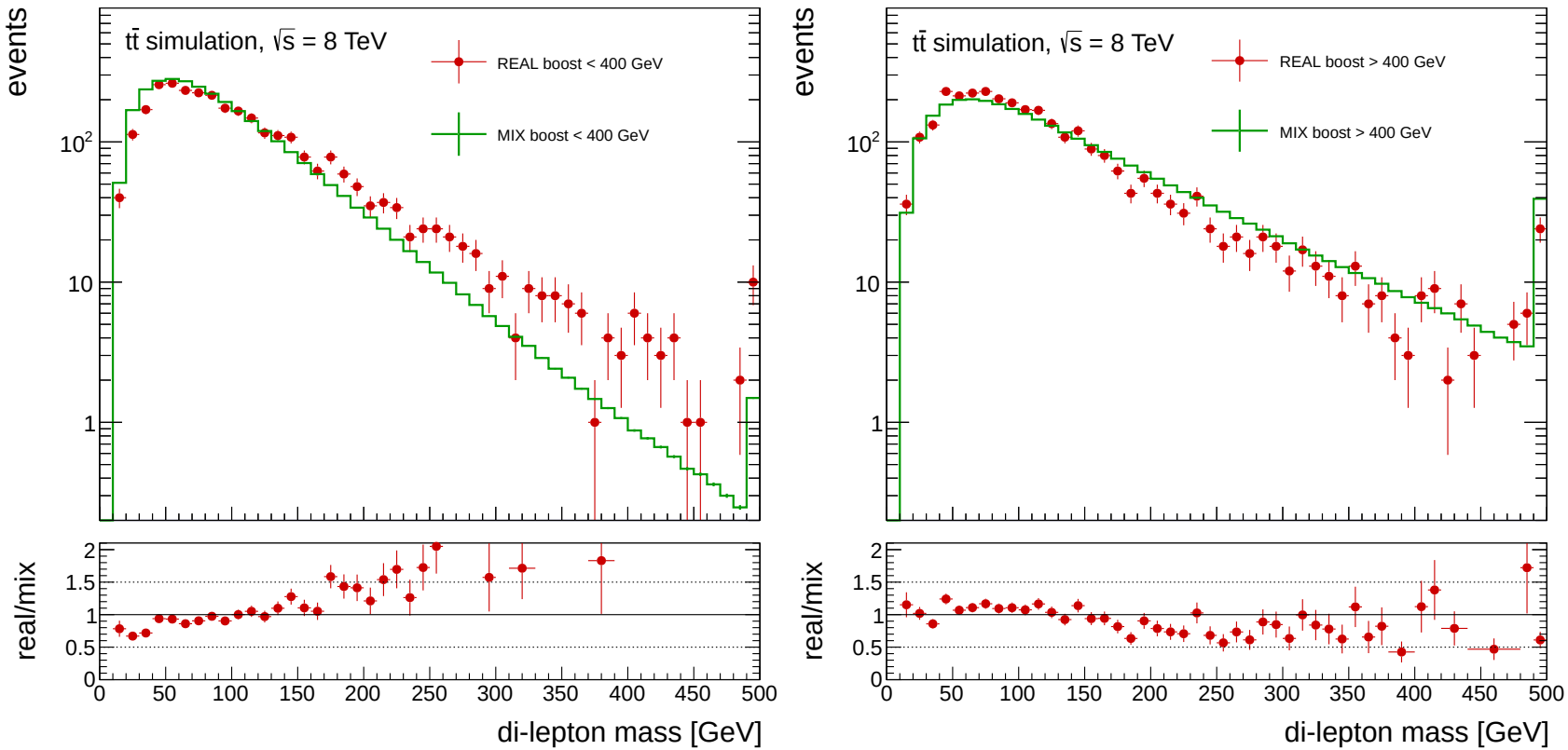




$$\not{E}_T > 150\,\text{GeV}$$

Backup: Event Mixing Method

Own work in progress.



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Own work in progress.