

# Search for SUSY

with simplified topologies.

Matthias Schläffer

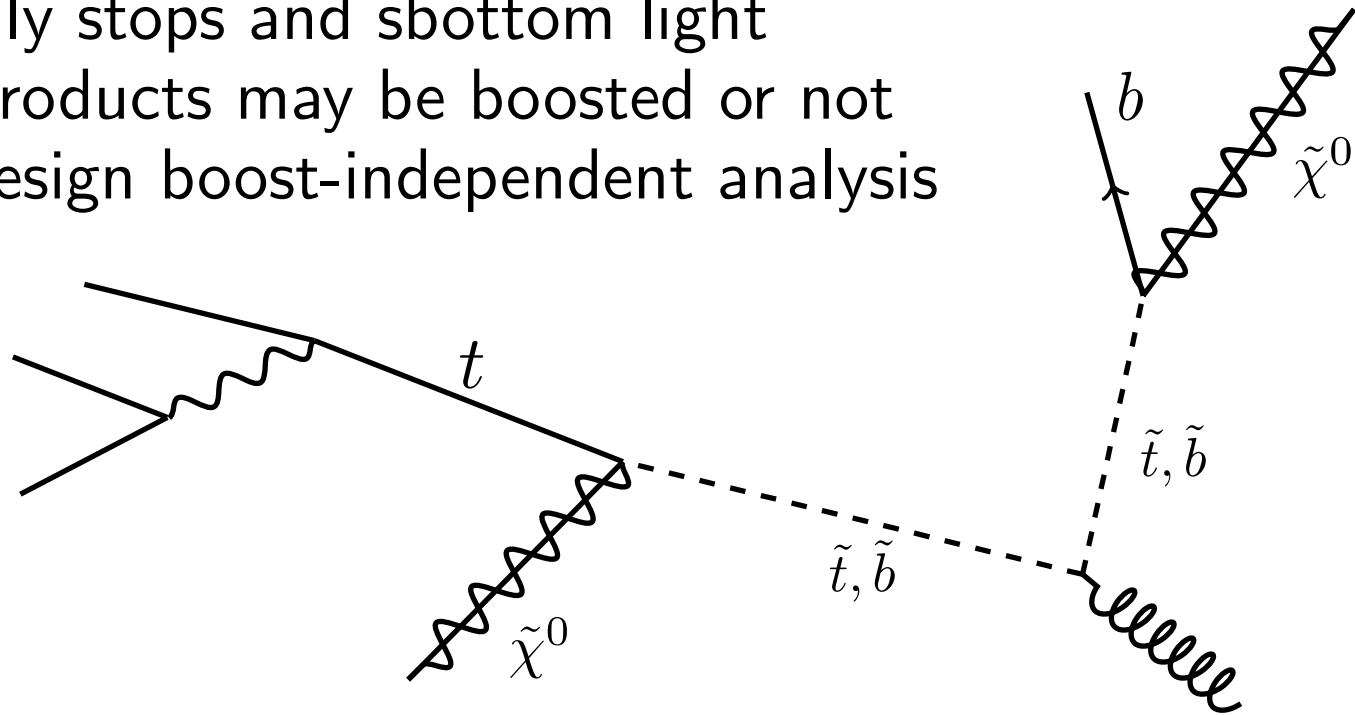
in collaboration with R. Mahbubani, M. Son, M. Spannowsky and A. Weiler

Hamburg, December 2, 2014



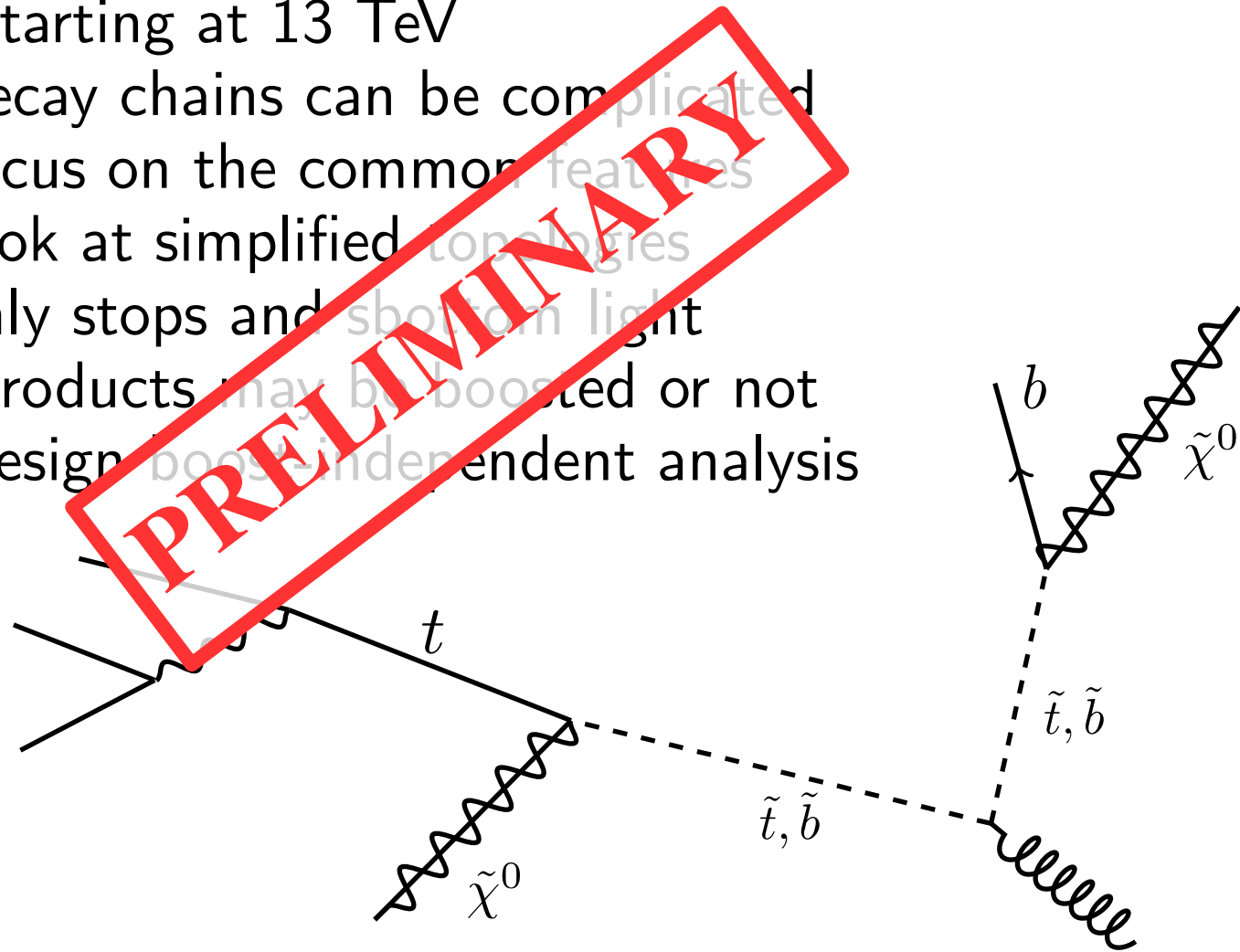
# Introduction

- > SUSY was not yet found
- > LHC is starting at 13 TeV
- > SUSY decay chains can be complicated
  - => focus on the common features
  - => look at simplified topologies
- > Keep only stops and sbottom light
- > Decay products may be boosted or not
  - => design boost-independent analysis



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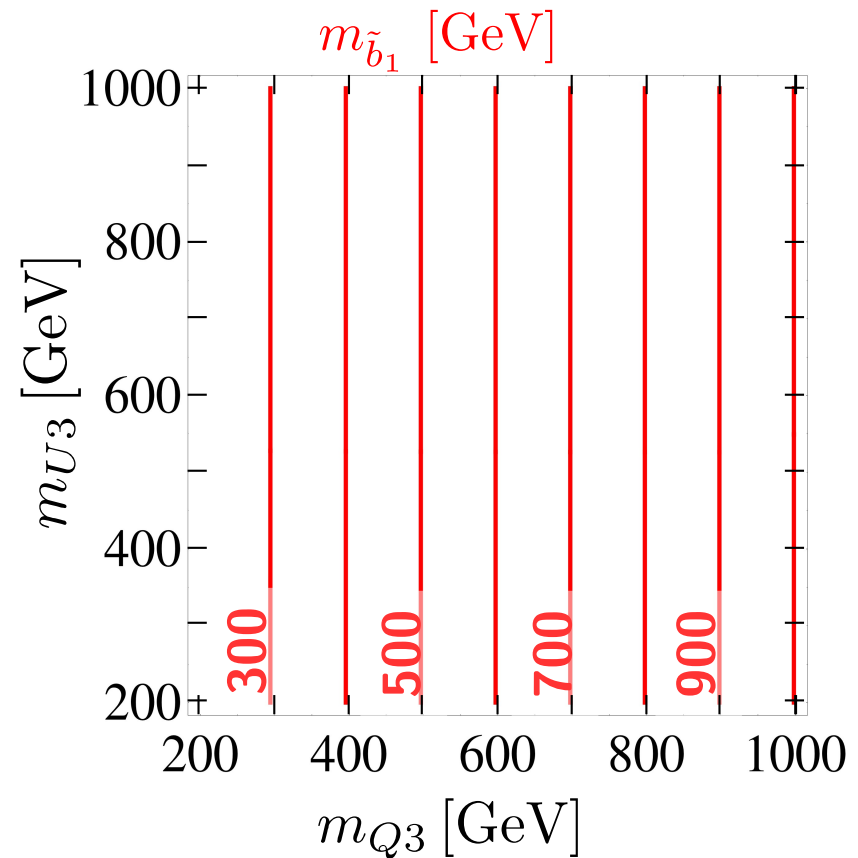
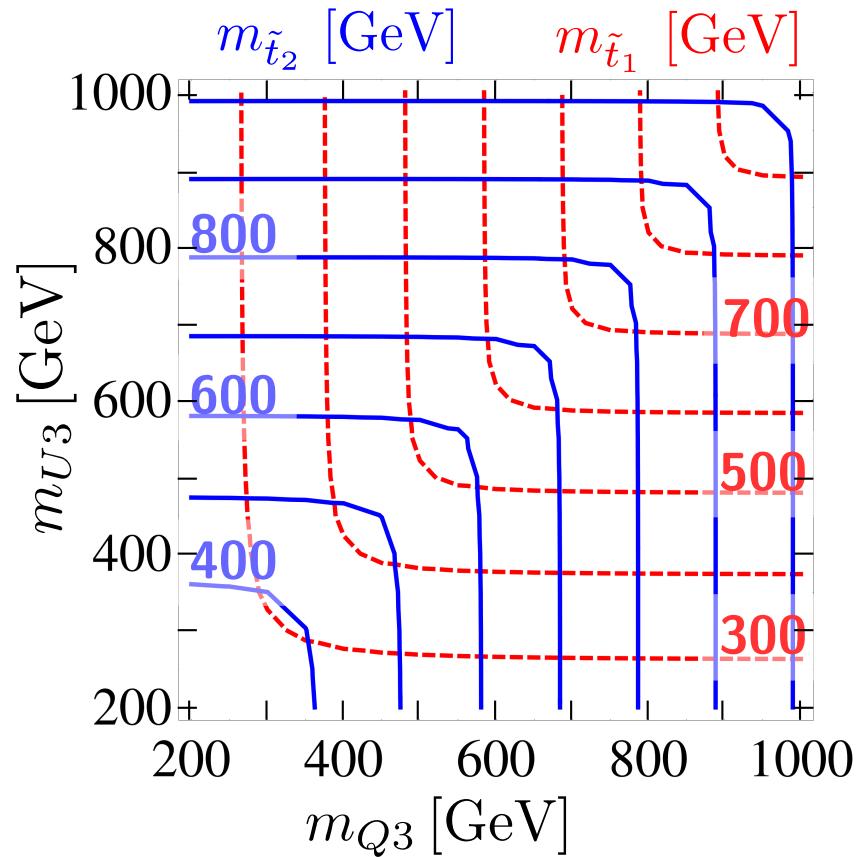


# Parameter Space

$A_t = 200 \text{ GeV}$ ,  $\mu = 200 \text{ GeV}$ ,  $\tan \beta = 10$ ,  $m_{Q3,U3} \in [350, 900] \text{ GeV}$

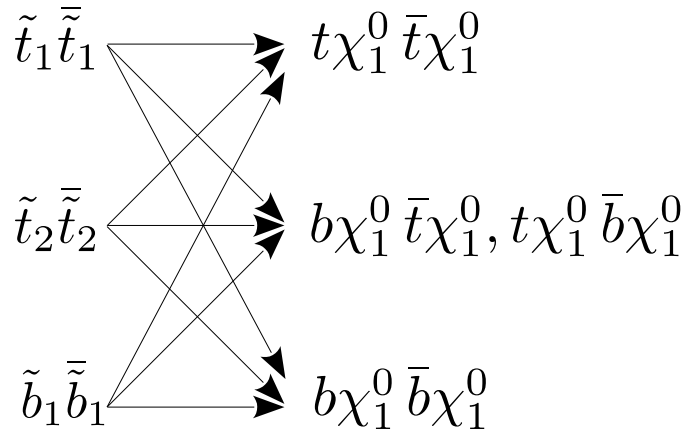
All other parameters heavy

$\Rightarrow m_{\chi_{\pm 0}} \approx 200 \text{ GeV}$



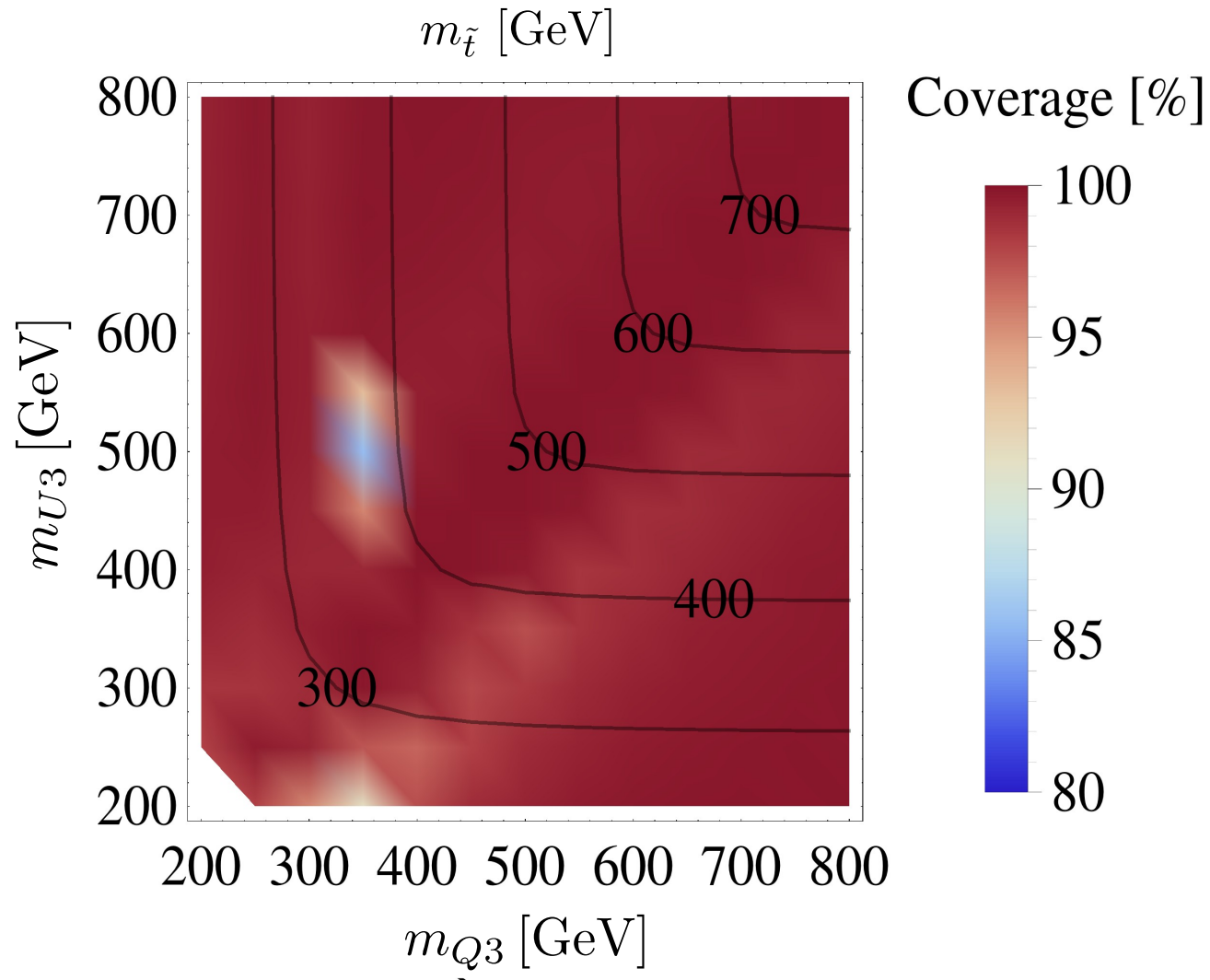
# Simplified Topologies

Signal processes:

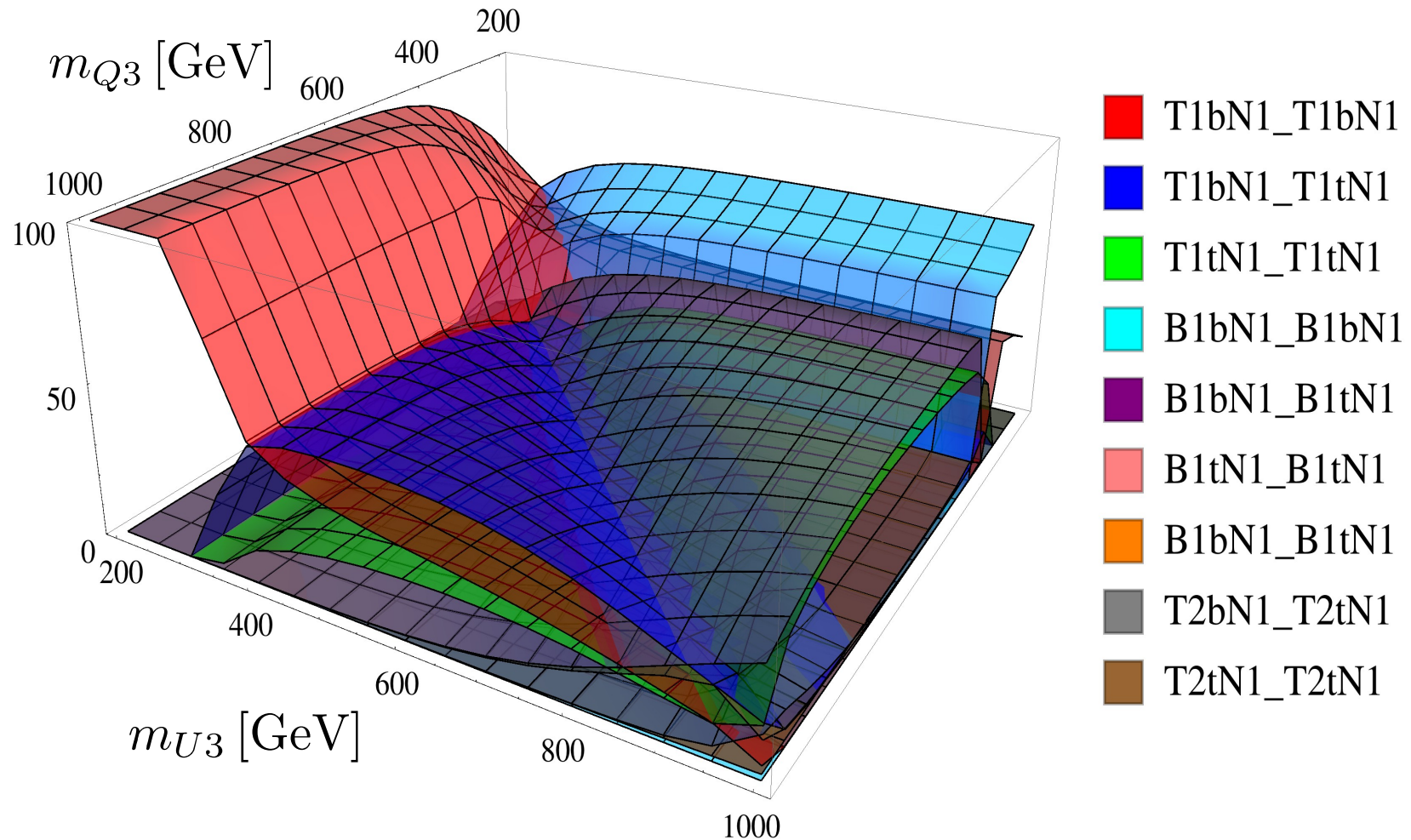


Higgsinos are mass degenerate  
 $\Rightarrow \chi^\pm \rightarrow \ell + \chi^0$  cannot be resolved

By considering only these simplified topologies:  
 Coverage  $\geq 85\%$



# Relative Contributions



# Signal and Background generation

All processes generated with Madgraph 5 + Pythia 6

- > Inclusive generation, rescaled by best available cross section
- > Signal: Matching up to 2 jets  $\sigma_{sig} \approx 0.012 - 3.3 \text{ pb}$
- > MLM matching, scale =  $^{1/6} m_{\tilde{Q}}$
- > Final state: 6 jets and missing Energy

$$\begin{array}{lll} t_{\ell}t + 2j, & t_{\ell} \rightarrow bW_{\ell} & \sigma = 9.2 \text{ pb} \\ W_{\ell} + 3j, & W_{\ell} \rightarrow \ell + \nu_{\ell} & \sigma = 78 \text{ pb} \\ Z_{\ell} + 4j, & Z_{\ell} \rightarrow \nu\bar{\nu} & \sigma = 25 \text{ pb} \\ Z_{\ell} + t\bar{t} & & \sigma = 8.1 \times 10^{-3} \text{ pb} \end{array}$$



# Scale invariant Reconstruction

→ 1. **Boosted regime:** HEPTopTagger, fat jets with  $R = 1.5$

- > Undo clustering
- > Check if invariant mass of 3 sub-jets  $m(j_1 + j_2 + j_3) \approx m_t$
- > Check if invariant mass of 2 of these jets  $m(j_1 + j_2) \approx m_W$

→ 2. **Semi boosted regime:** BDRS Tagger, fat jets with  $R = 1.0$

- > Undo clustering
- > Check if the mass of the original jet is much bigger than sub-jet masses
- > Check if the two sub-jets are not too asymmetric

→ 3. **Unboosted regime:** Normal jets with  $R = 0.4$

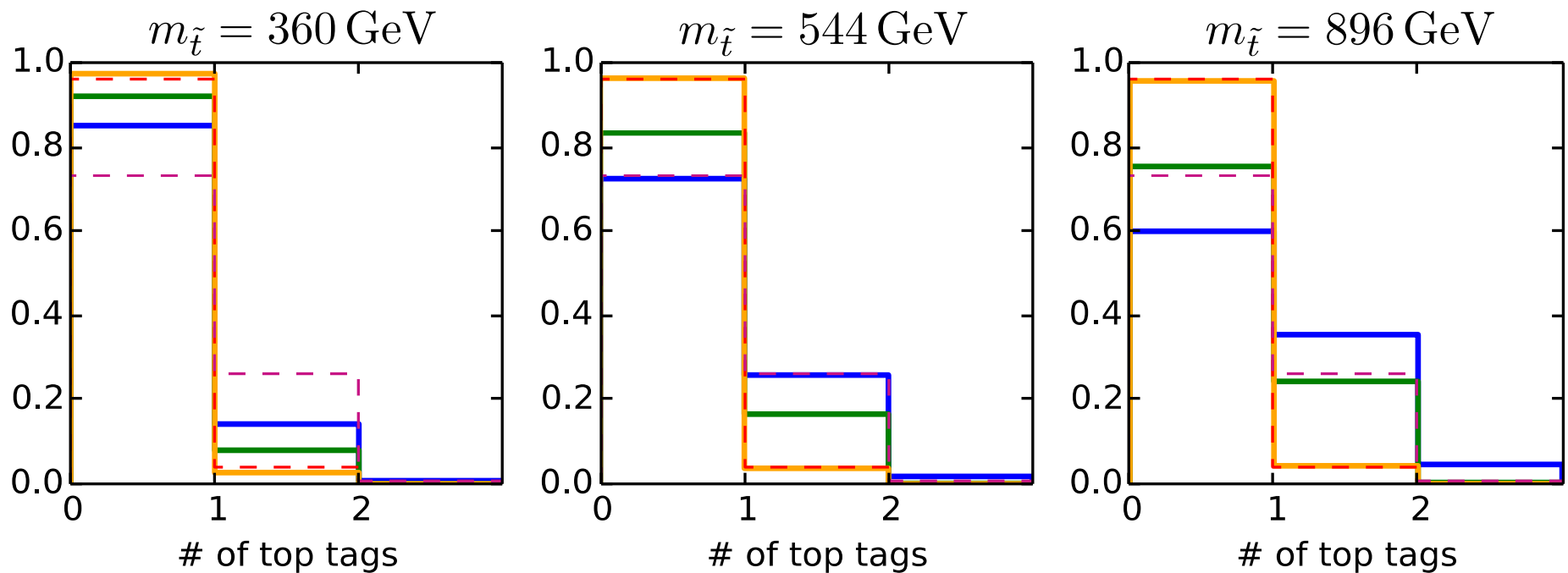
- > Combine 3 jets and see if invariant mass  $m(j_1 + j_2 + j_3) \approx m_t$

Demand: 0 leptons,  $\cancel{E}_T > 100 \text{ GeV}$ ,  $p_T(j_1) > 80 \text{ GeV}$  and  $p_T(j_2) > 60 \text{ GeV}$





# HEP TopTagger efficiency



# Outlook

- > Check efficiency of BDRS tagger and jet combination
- > Include b-tagging
- > Find cuts for the different signal regions to increase S/B
- > Combine the SR to obtain a boost-insensitive tagging

**Stay tuned**

