Search for direct production of supersymmetric partners of the top quark in the all-jets final state (#260)

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On behalf of the CMS Collaboration

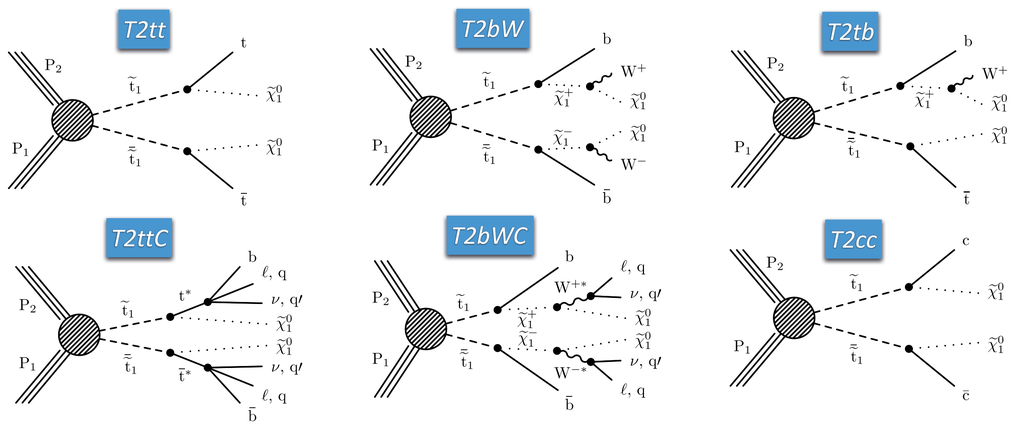
Introduction

Supersymmetry (SUSY) can address many open questions in the standard model (SM)

- introduces a "superpartner" for each SM particle: a natural solution to the hierarchy problem
- the lightest supersymmetric particle (LSP): a good candidate for the dark matter

Natural SUSY expects the superpartner of the top quark ("top squark") around the TeV scale, within the reach of the LHC.

A comprehensive search for pair production of the top squark is presented.



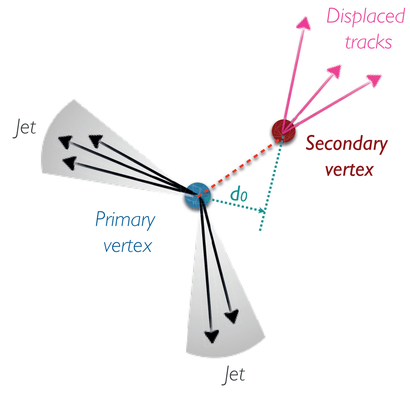
Search strategy

Focuses on all-jets final states:

- expected for signal processes in which all W bosons decay to quarks
- largest accessible branching fraction

Selects events with large missing transverse momentum (p_T^{miss}):

- SUSY signals typically have larger p_T^{miss} due to undetectable LSPs in the decay chain.



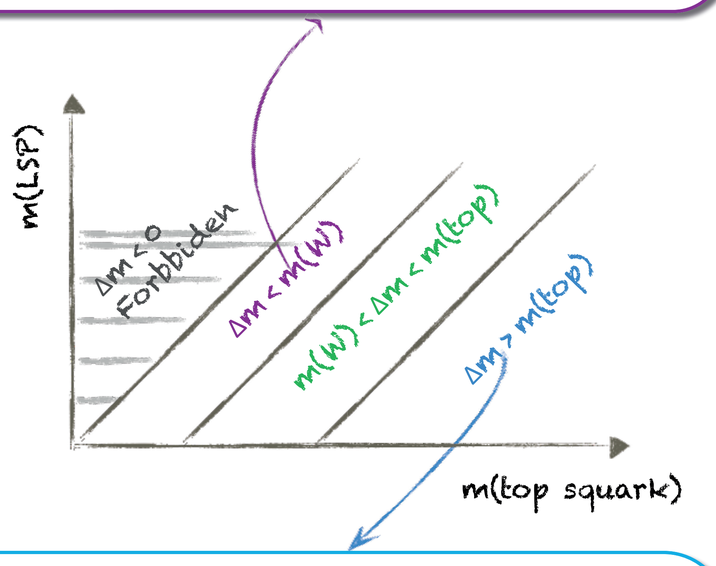
Signals with small Δm (i.e., $< m_W$)

- the b-quarks from top squark decay typically very soft (i.e., low-momentum)
- often evade identification because of the jet p_{T} threshold

Specialized soft b tagging:

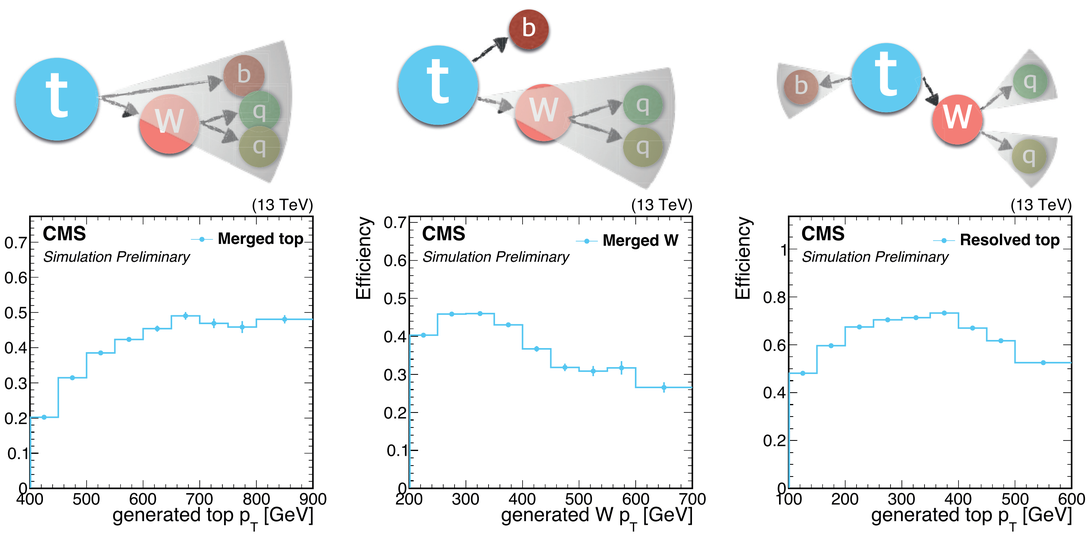
- identifying soft b hadrons, not associated with jets, via the presence of a secondary vertex (SV)

The decay modes of the top squark and the final state signatures depend strongly on the mass difference (Δm) between the top squark and the LSP.



Signals with large Δm (i.e., $> m_t$ or m_W):

- the top squark decays via on-shell top quarks or W bosons, which can be utilized to distinguish signals from backgrounds
- exploit multivariate boosted decision trees (BDT) to identify jets from hadronic top/W decays.



(Misidentification rate: 1-4%) *(Misidentification rate: 2-10%)* *(Misidentification rate: 4-10%)*

Background estimation

Each SM background is estimated by measurement of dedicated data control samples that are similar to the search sample in kinematics, and then translated to the predicted event counts in the search sample with the aid of simulation.

Lost lepton background

- $t\bar{t}, W$+jets processes where the charged lepton from W decay either falls outside of acceptance or is misidentified as a jet
- estimated from a single-lepton control sample

$Z(\nu\nu)$ background

- large p_T^{miss} from the neutrinos
- hybrid method: use $Z(\ell\ell)$+jets sample to get the normalization, and γ+jets sample to correct the p_T^{miss} distributions of the simulated events

QCD multijet background

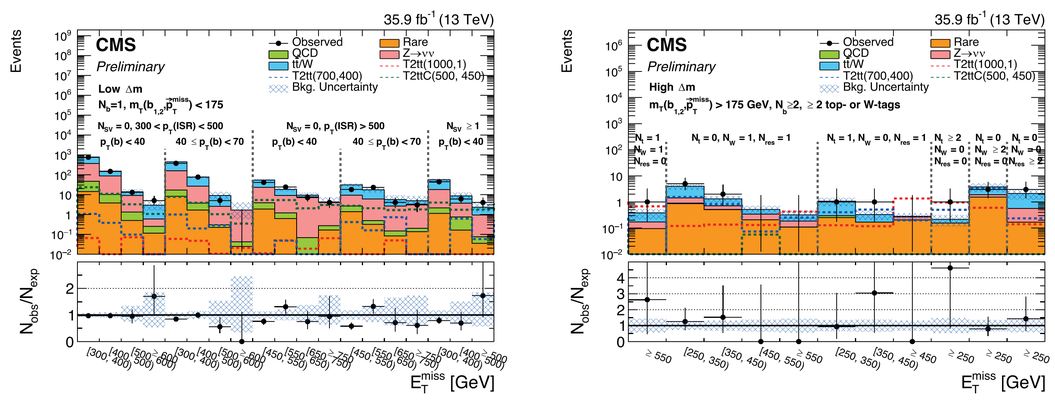
- p_T^{miss} from severe mismeasurement of jet momenta, or neutrinos from decays of heavy-flavour hadrons
- estimated from a QCD enriched sample (requiring $\vec{p}_T^{\text{miss}}$ to be aligned with one of the leading jets)

Rare ($t\bar{t}Z$/dibosons) background

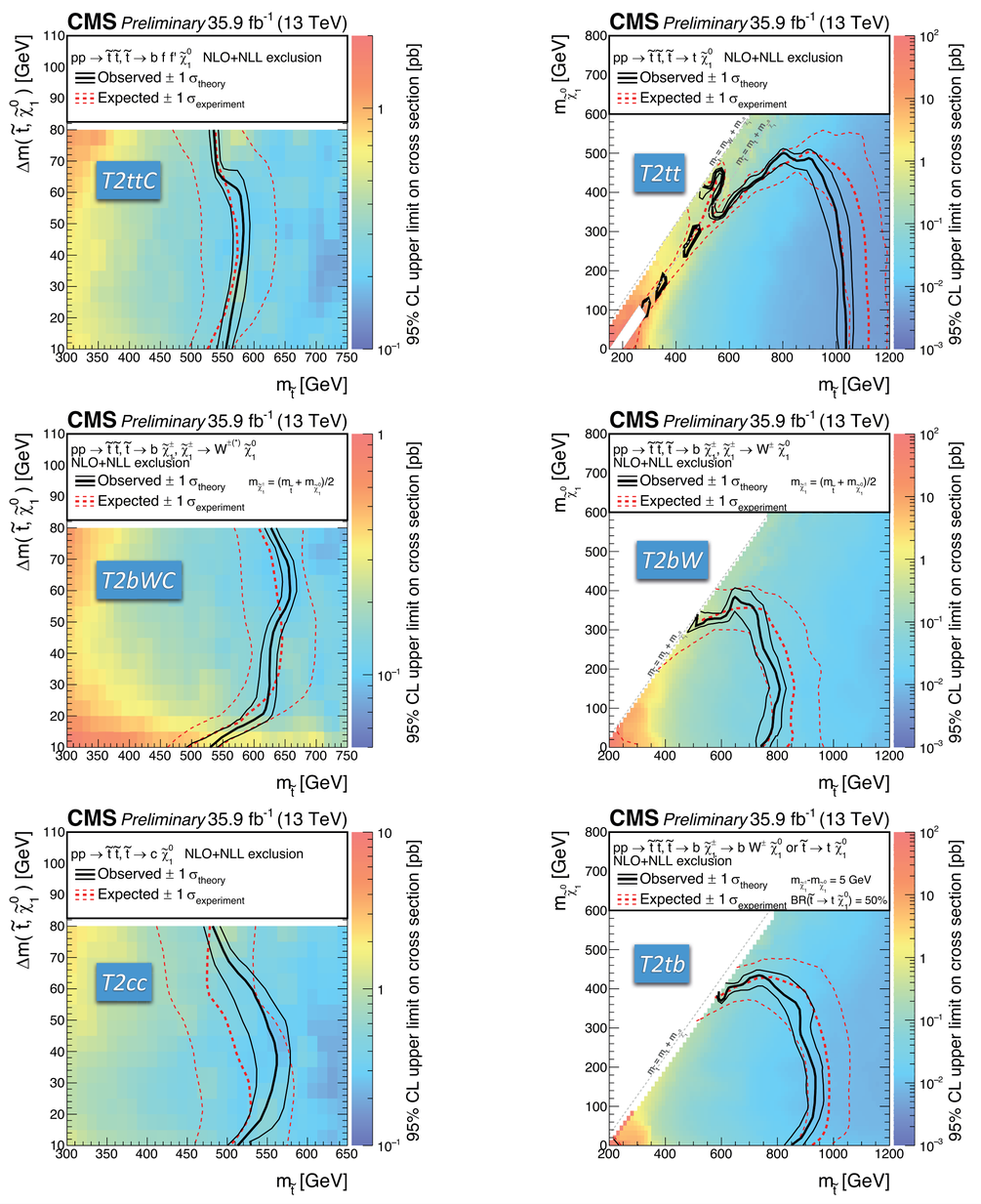
- estimated from simulation
- $t\bar{t}Z$ validated using a three-lepton control sample

Results and interpretation

No statistically significant deviation from the expected SM backgrounds is observed. Exclusion limits are set in the context of simplified SUSY models of direct top squark pair production and various top squark decay models.



(Plots and tables for all 104 orthogonal search regions can be found in [1])



References

[1] CMS Collaboration, "Search for direct top squark pair production in the all-hadronic final state in proton-proton collisions at $\sqrt{s}$ = 13 TeV", CMS-PAS-SUS-16-049

[2] CMS Collaboration, "Search for direct top squark pair production in the fully hadronic final state in proton-proton collisions at $\sqrt{s}$ = 13 TeV corresponding to an integrated luminosity of 12.9 fb^{-1}", CMS-PAS-SUS-16-029

[3] CMS Collaboration, "Searches for pair production of third-generation squarks in $\sqrt{s}$ = 13 TeV pp collisions", *accepted by EPJC*, arxiv: 1612.03877