

Search for new physics in events with multileptons and jets in 35.9 fb⁻¹ of pp collision data at 13 TeV with the CMS experiment

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on behalf of the CMS collaboration



INTRODUCTION

Latest results from the search for new physics with multileptons and jets in the final state from the CMS Collaboration, using the full luminosity collected during the year 2016.

Why multileptons?

- ☹️ Low leptonic branching fraction of signal models
- 😊 Clean signature with low Standard Model background

This final state signature corresponds to that of several interesting simplified models for **strong production of supersymmetric particles**, for which interpretations are provided.

ANALYSIS STRATEGY

Baseline selection:

Number of selected leptons	≥ 3
N_{jets}	≥ 2
$E_{\text{T}}^{\text{miss}}$	> 50 (70 in low $N_{\text{b jets}}$ and H_{T} category)
$m_{\ell\ell}$	> 12

Off-/on-Z categorization:

Events are classified as off-Z or on-Z depending on whether they contain an opposite-charge, same-flavour pair among the selected leptons with $|m_{\ell\ell} - m_Z| < 15$ GeV. Then:

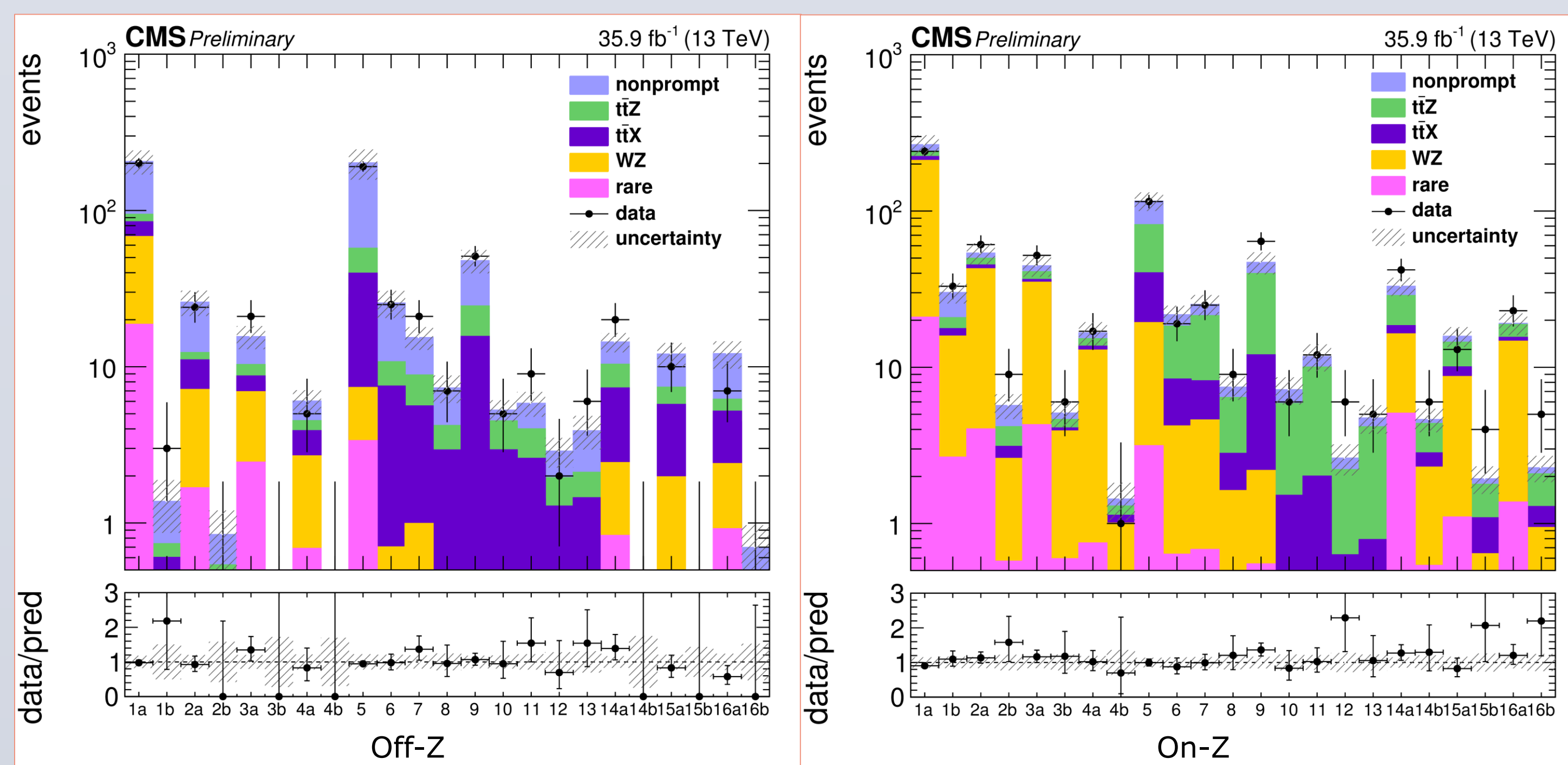
Search region categorization:

The final categorization is then performed according to observables whose values characterize the signature of the guiding signal models: number of b-tagged jets ($N_{\text{b jets}}$), missing transverse energy ($E_{\text{T}}^{\text{miss}}$), sum of transverse momenta of all jets (H_{T}) and minimum transverse mass $M_{\text{T}}^{\text{min}}(p_{\text{T}}^{\ell}, p_{\text{T}}^{\text{miss}})$ among all selected leptons, with the exception of the two forming the Z candidate in the on-Z category.

N_{jets}	$N_{\text{b jets}}$	H_{T} (GeV)	$50(70) \text{ GeV} \leq E_{\text{T}}^{\text{miss}} < 150 \text{ GeV}$	$150 \text{ GeV} \leq E_{\text{T}}^{\text{miss}} < 300 \text{ GeV}$	$E_{\text{T}}^{\text{miss}} \geq 300 \text{ GeV}$
≥ 2	0	60 – 400	SR1 †		SR2 †
		400 – 600	SR3 †		SR4 †
	1	60 – 400	SR5		SR6
		400 – 600	SR7		SR8
	2	60 – 400	SR9		SR10
	400 – 600	SR11		SR12	
≥ 3	60 – 600		SR13		
inclusive	≥ 600		SR14 †		SR15 †

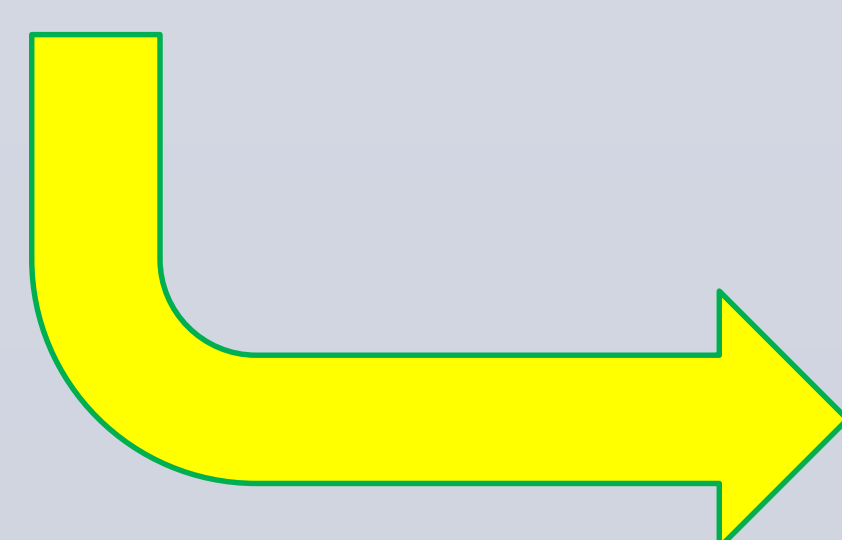
† indicates that the search region is split at $M_{\text{T}}^{\text{min}} = 120$ GeV.

RESULTS



No significant excess over the Standard Model prediction has been found.

These results are interpreted in the context of strong SUSY production models:



CMS Collaboration, "Search for new physics with multileptons and jets in 35.9 fb⁻¹ of pp collision data at $\sqrt{s} = 13$ TeV", CMS-PAS-SUS-16-041



BACKGROUND ESTIMATION

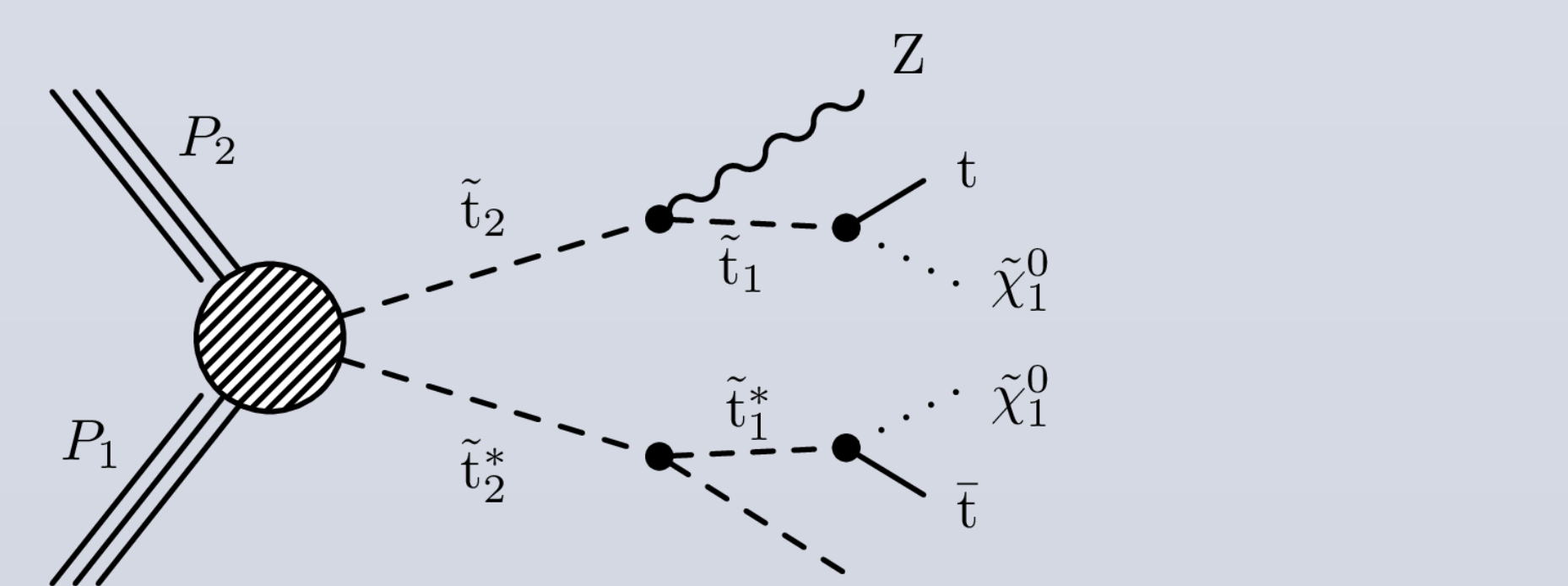
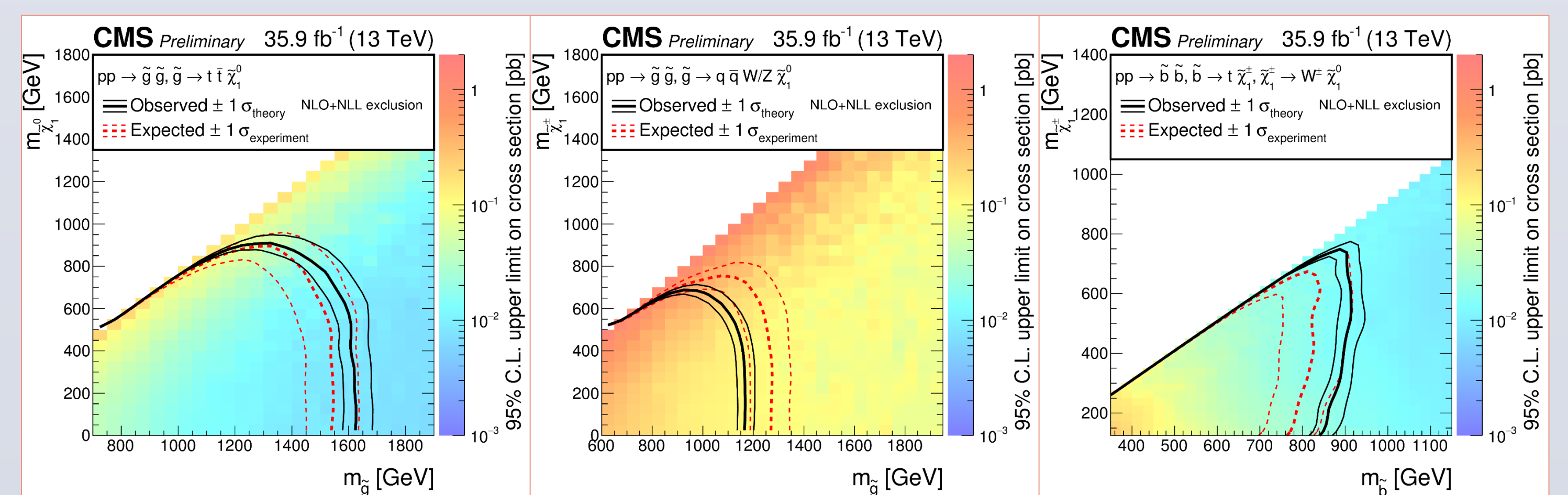
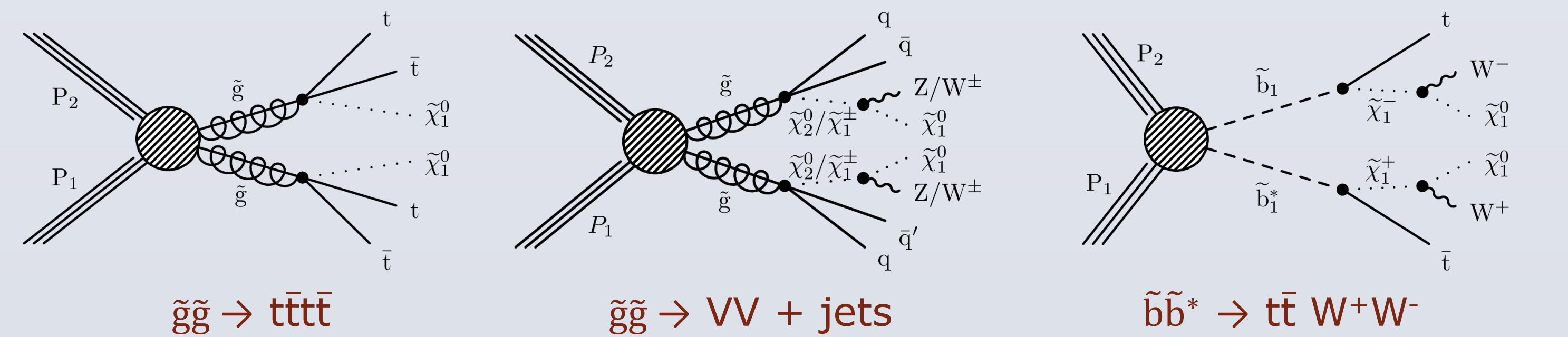
Main SM background processes:

- Events with **nonprompt leptons**, or jets misidentified as leptons. Dominant in off-Z category. Estimated with data-driven method.
- WZ, ttZ**. Most prominent in on-Z search regions with 0 or ≥1 b jets, respectively. Estimated from Monte Carlo simulations, normalization value and uncertainties assessed via simultaneous fit in dedicated control regions.
- Other rare processes: ttW, ttH, VVV (V=W,Z), X+γ. Estimated directly from Monte Carlo simulations.

UNCERTAINTIES

source	effect on yield
luminosity	2.6%
jet energy scale	1 – 10%
b-tag efficiency	1 – 10%
pileup	1 – 5%
lepton efficiencies	9%
HLT efficiencies	3%
lepton eff. FastSim	6%
nonprompt application region stat.	10 – 100%
nonprompt extrapolation	30%
WZ CR normalization	10%
ttZ CR normalization	25%
Limited size of simulated samples	1 – 100%
Modelling of unclustered energy	1-20%
ISR modeling	1-10%
QCD scales cross-section (ttW,ttH)	11 – 13%
QCD scales acceptance (ttW,ttZ,ttH, signal)	1 - 18%
PDFs (ttW,ttZ,ttH)	2 – 3%
other rare bkg.	50%

INTERPRETATIONS



$\tilde{t}_2 \tilde{t}_2^*, \tilde{t}_2 \rightarrow \tilde{t}_1 H$ $\tilde{t}_2 \tilde{t}_2^*, \tilde{t}_2 \rightarrow \tilde{t}_1 H/Z$ $\tilde{t}_2 \tilde{t}_2^*, \tilde{t}_2 \rightarrow \tilde{t}_1 Z$

