Inclusive SUSY searches at CMS

On behalf of the CMS collaboration

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LHCP 2014 The Second Annual Conference on Large Hadron Collider Physics

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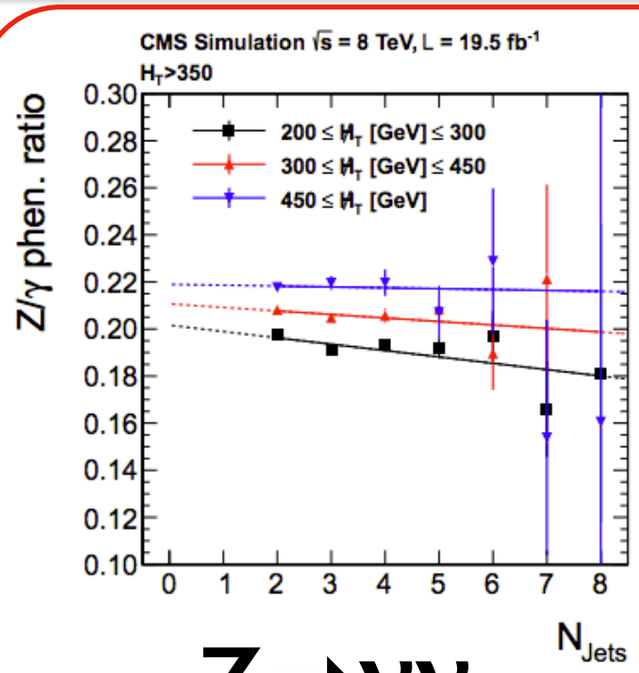
Introduction

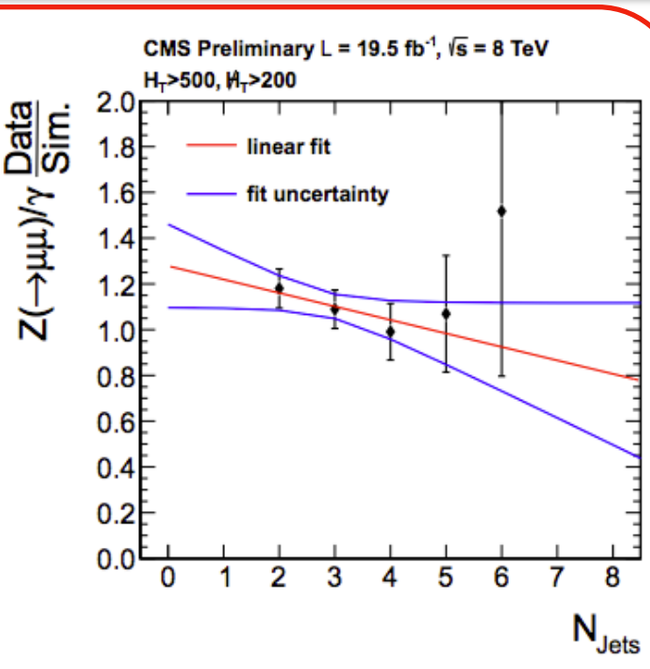
- CMS SUSY analyses cover a wide range of different possible production mechanisms and final states
- Inclusive analyses can cover a wide range of SUSY phase space
- Four **19.5fb^{-1} 8TeV** results
  - **Multijet + MET** - all hadronic analysis, binned in jet multiplicity
  - **M_{T2}** - all hadronic analysis, using novel M_{T2} kinematic variable
  - **1ℓ +b** - uses novel **$\Delta\Phi$**(W, ℓ) technique to separate signal from background
  - **3ℓ +b** - tri-leptonic signature massively suppresses SM backgrounds
- Note: all results shown are *simplified models* - i.e. **100% BR**!
- More CMS SUSY talks:
  - Strong SUSY (plenary) - Markus Stoye (Weds)
  - 3rd Generation - Hannsjorg Weber (this session!)
  - Electroweak Production - Pieter Everaerts (Thurs)

Multijet + MET

- **All-hadronic** analysis - **Jets + MET**
- Binned in HT, MHT and jet multiplicity
  - N_{jet} = 3-5, 6-7, ≥8
- Remains inclusive by having no b-jet requirement
- Main backgrounds:
  - Z(**νν**)+jets
  - W(**ℓ ν**)+jets, $t\bar{t}$ (lost leptons)
  - QCD
- Data-driven background estimates

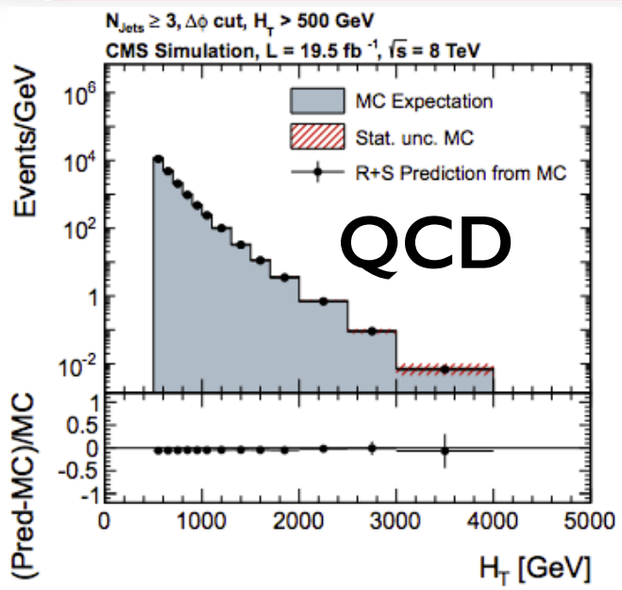
arXiv:1402.4770
SUS-13-012

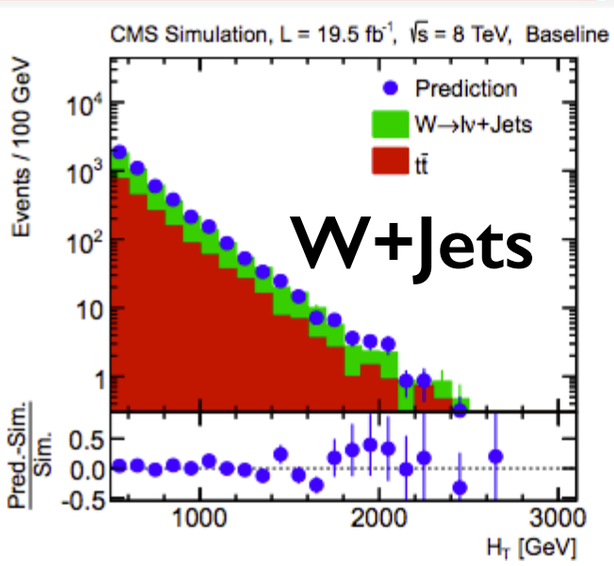




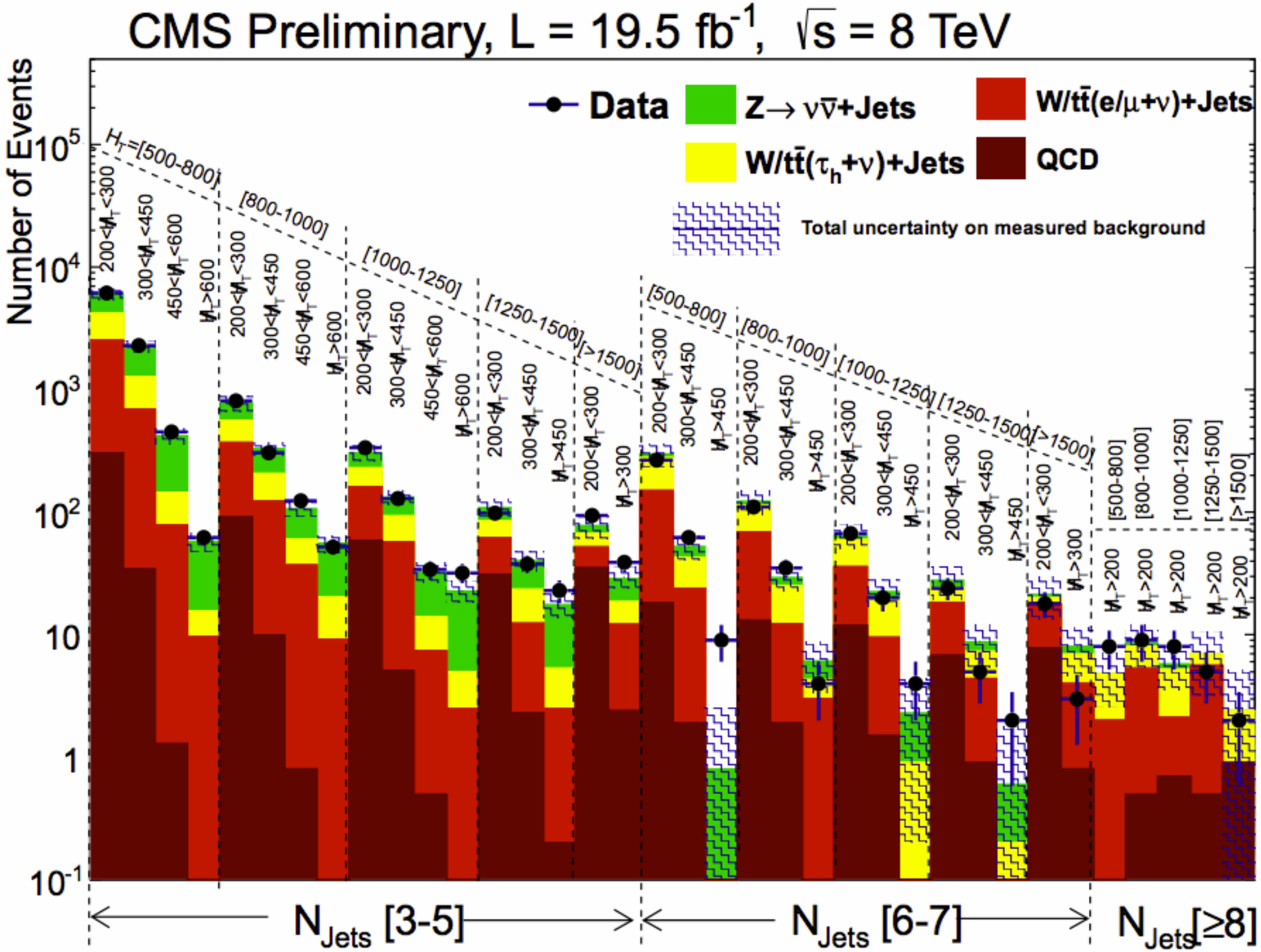
Z→νν

- Photon control sample
- Measure ratio of Z/γ in MC and data
- Extrapolate to signal region



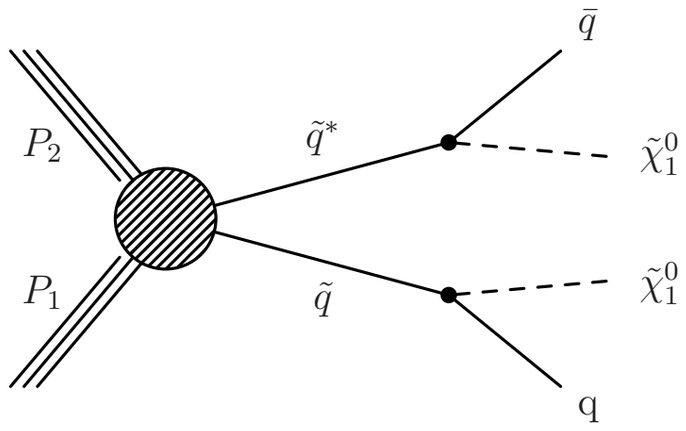


MJ+MET - Results

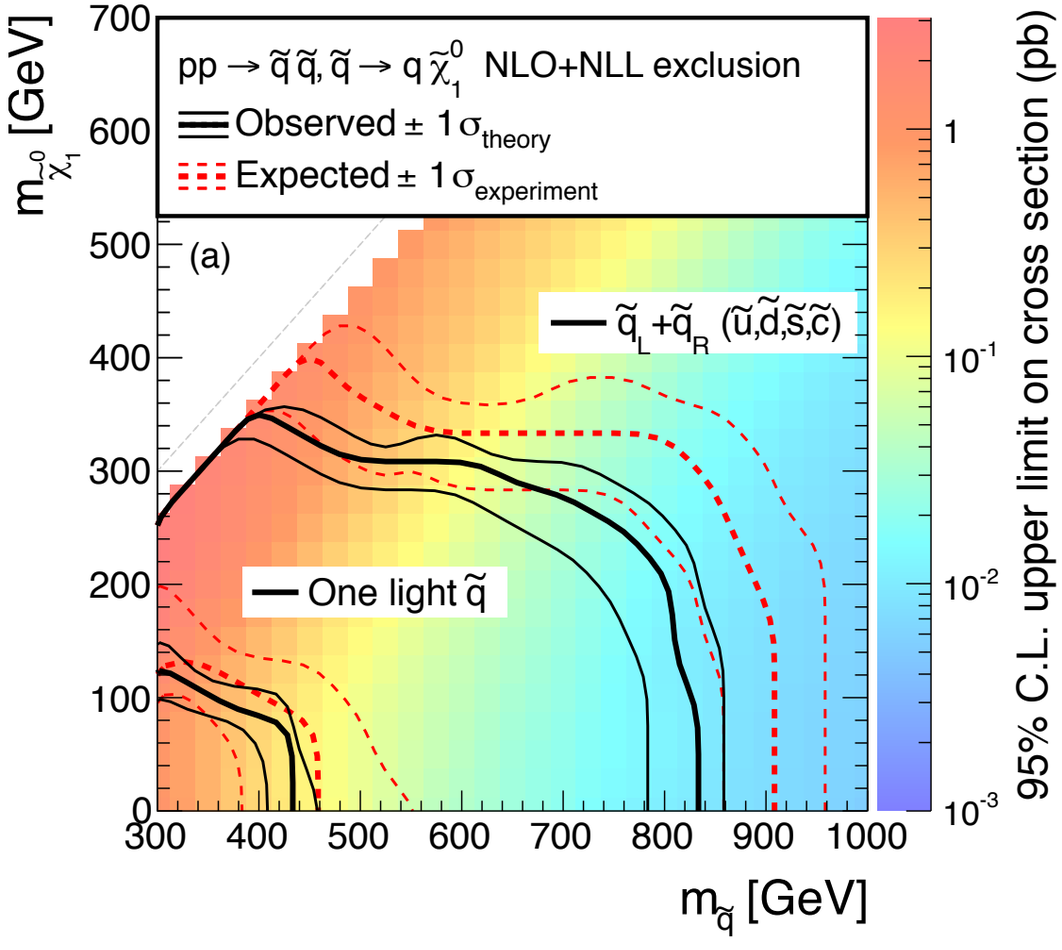


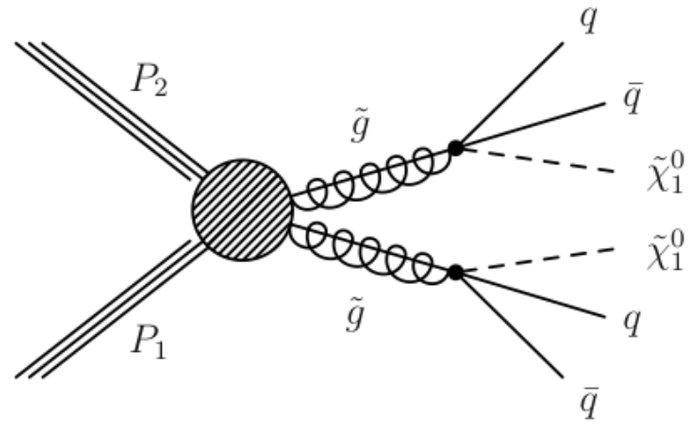
Full results

MJ+MET - Interpretation



CMS , L = 19.5 fb^{-1}, $\sqrt{s}$ = 8 TeV





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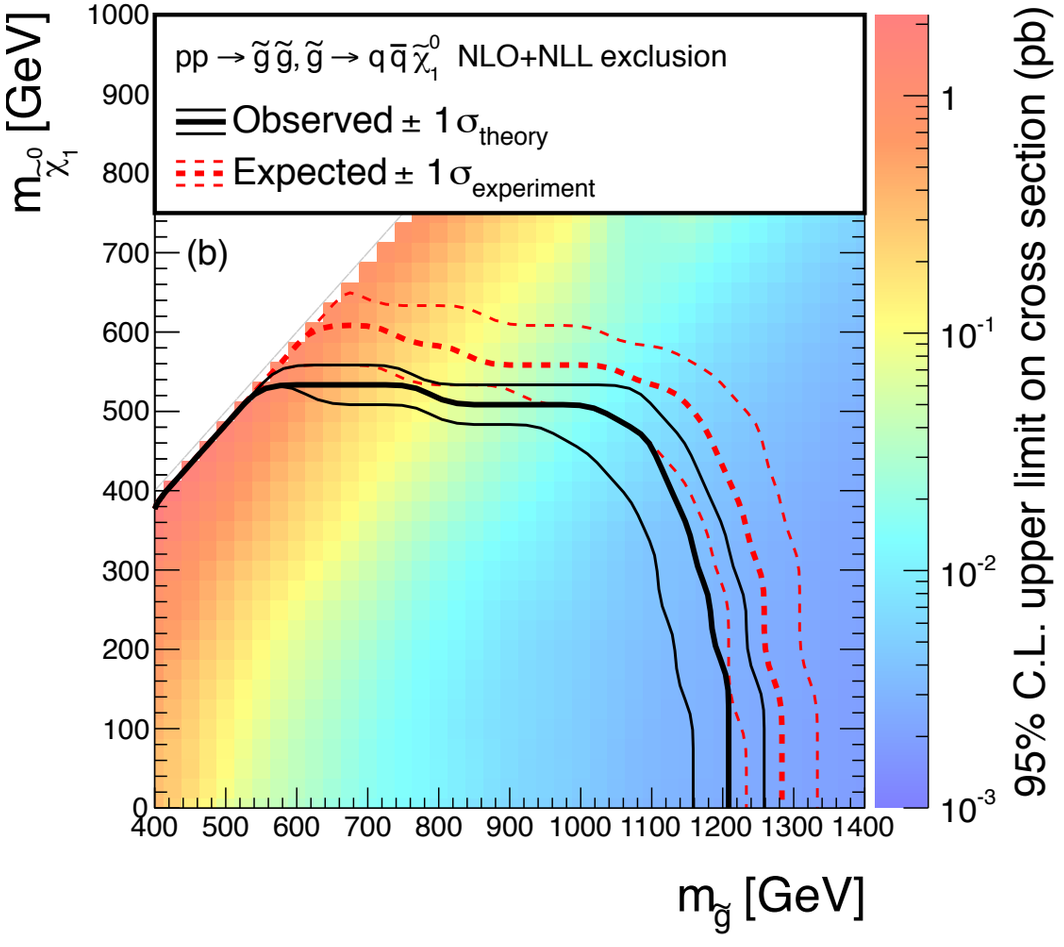
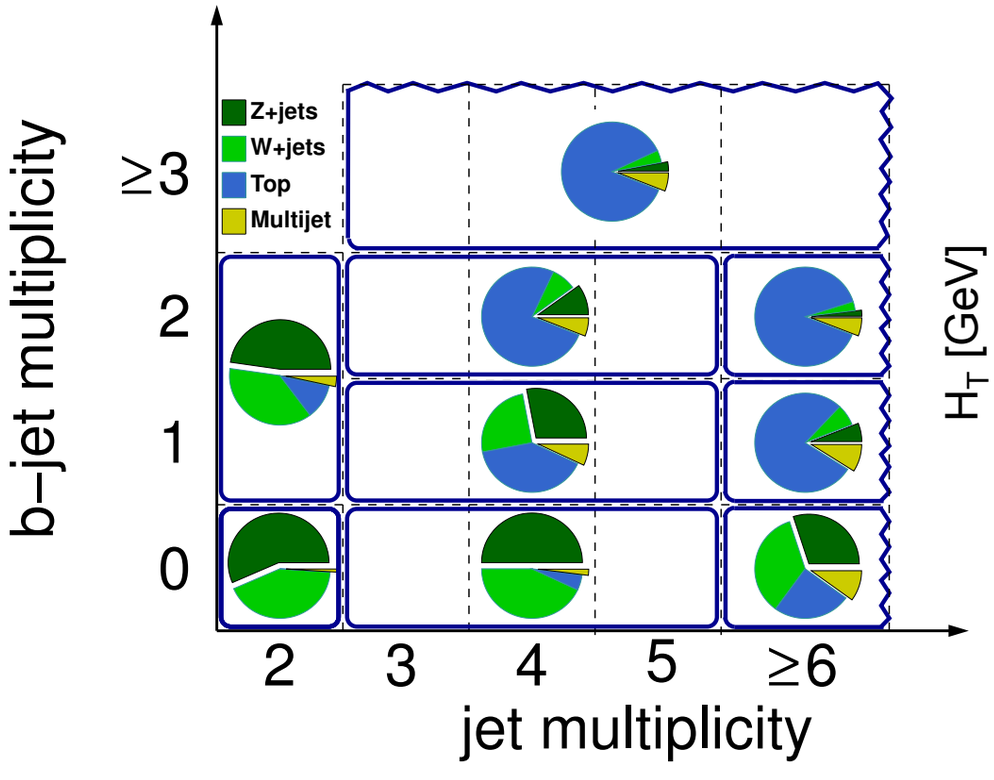
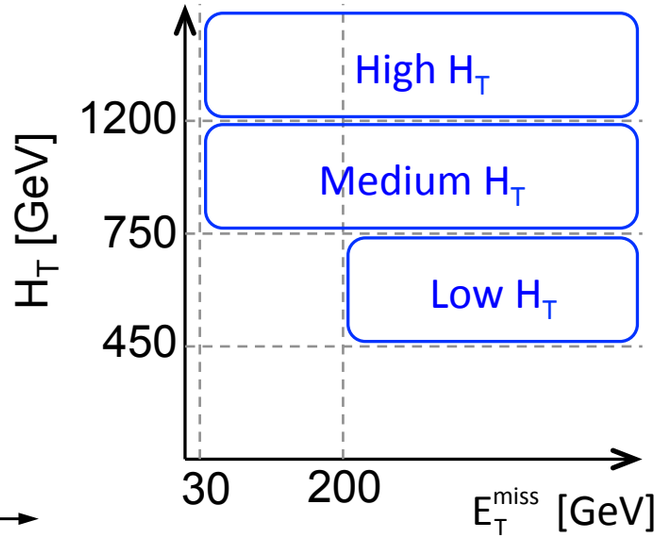


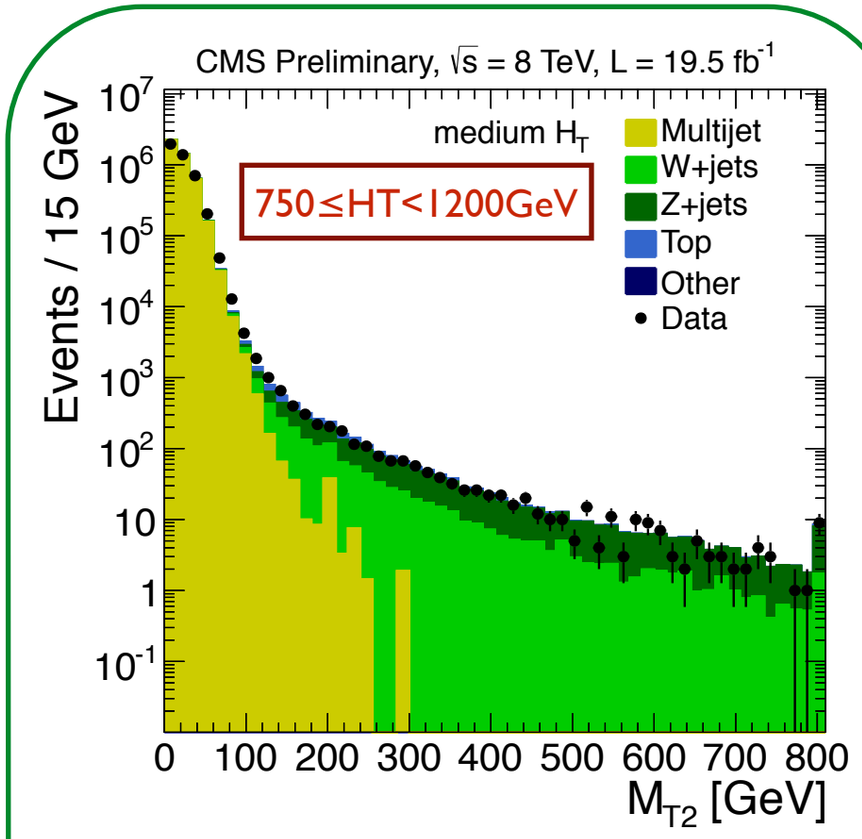
M_{T2} Hadronic

- **All-hadronic** final state
- Uses M_{T2} kinematic variable - "stransverse mass"
- Similar backgrounds to multijet+MET
  - employ data-driven estimates
- Events categorized by M_{T2}, HT, n_{jet} and n_b
  - sensitivity to a wide range of SUSY decays
- Lowest bin in M_{T2} chosen to make QCD multijet background negligible

$$M_{T2}(m_{\tilde{\chi}}) = \min_{\vec{p}_T^{\,\tilde{\chi}(1)} + \vec{p}_T^{\,\tilde{\chi}(2)} = \vec{p}_T^{\,miss}} [\max(M_T^{(1)}, M_T^{(2)})]$$

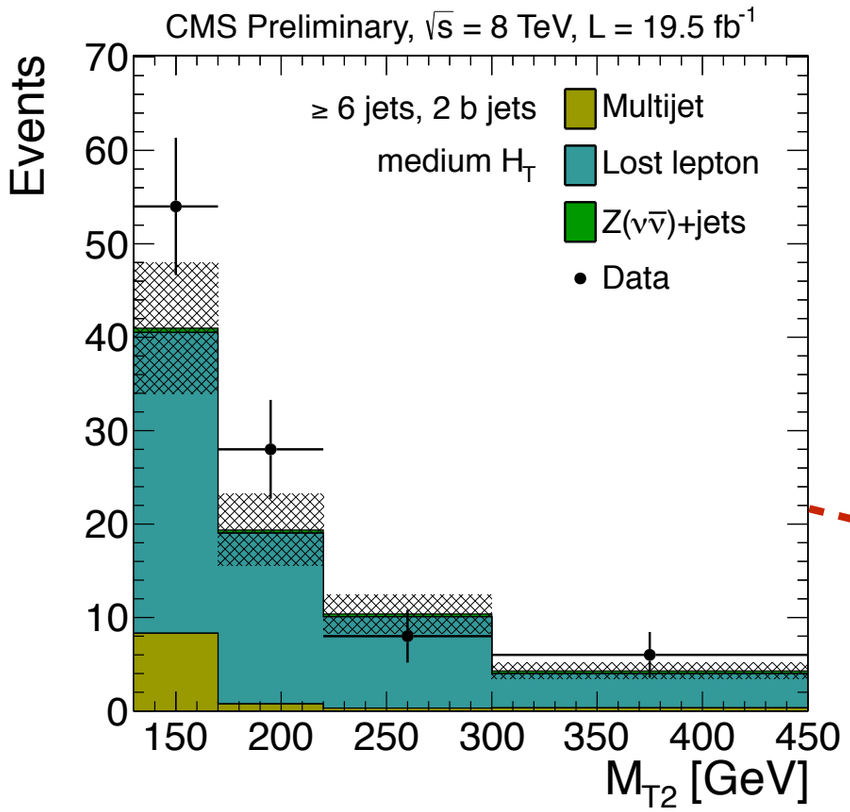


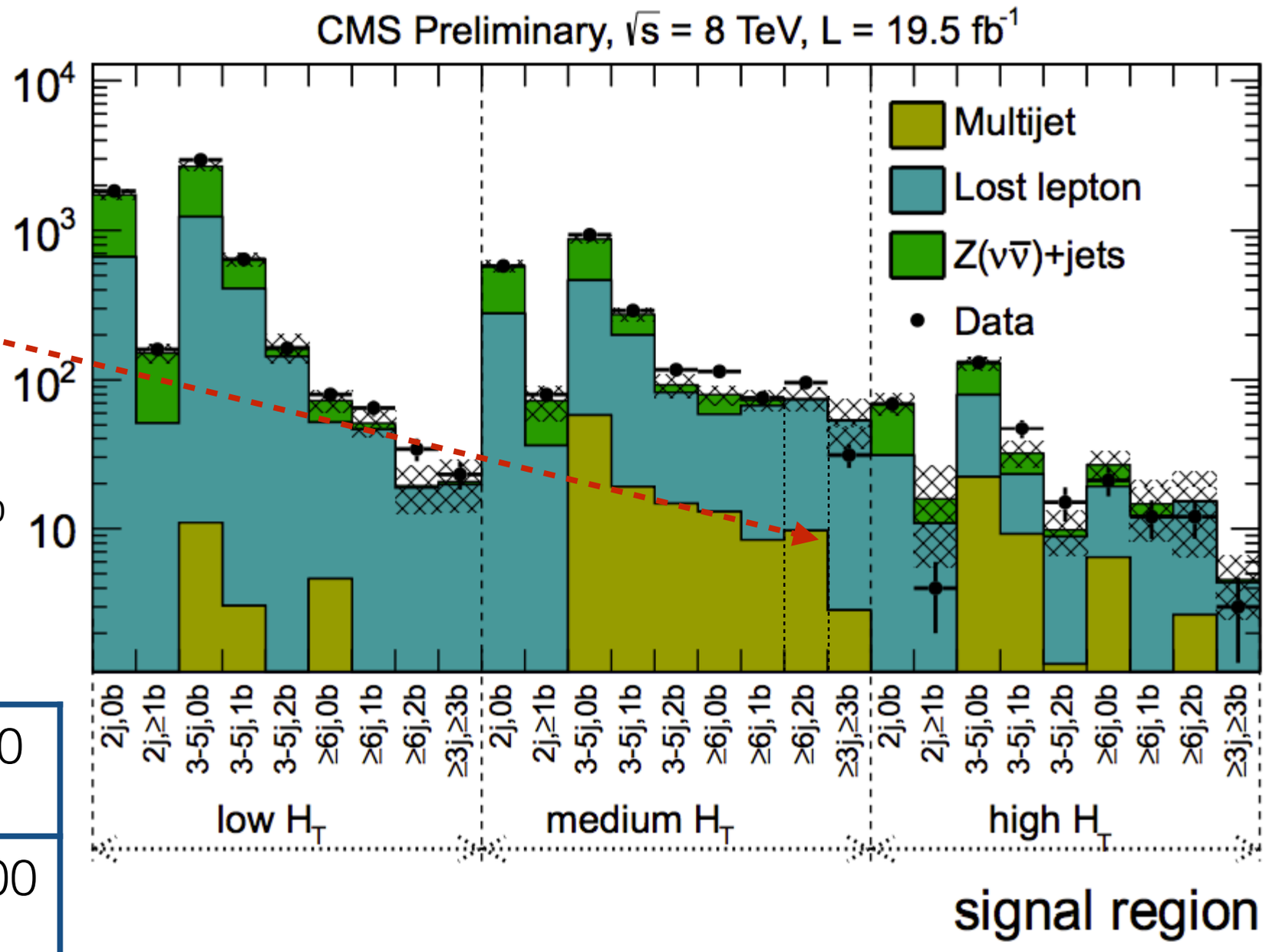




Note: summed over all M_{T2}, n_{jet} and n_b bins!

MT2 Results



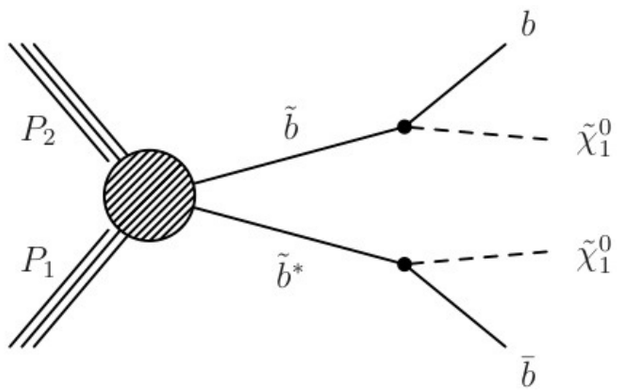


Low HT	450 ≤ HT < 750 GeV
Medium HT	750 ≤ HT < 1200 GeV
High HT	HT > 1200 GeV

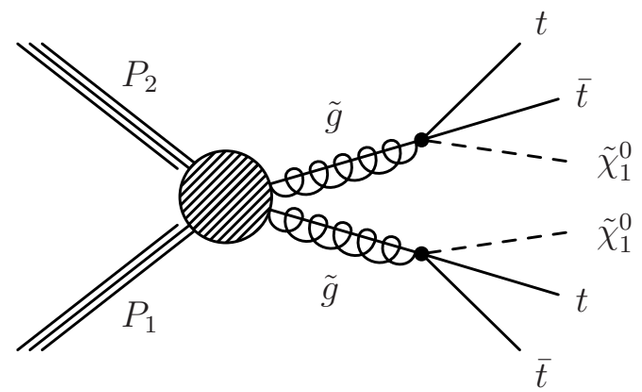
Full results

MT2 Interpretations

- Set limits on direct-sbottom and gluino production, using multiple analysis bins per interpretation
- Use analysis bins with highest sensitivity to given model



CMS Preliminary, 19.5 fb^{-1}, $\sqrt{s}$ = 8 TeV



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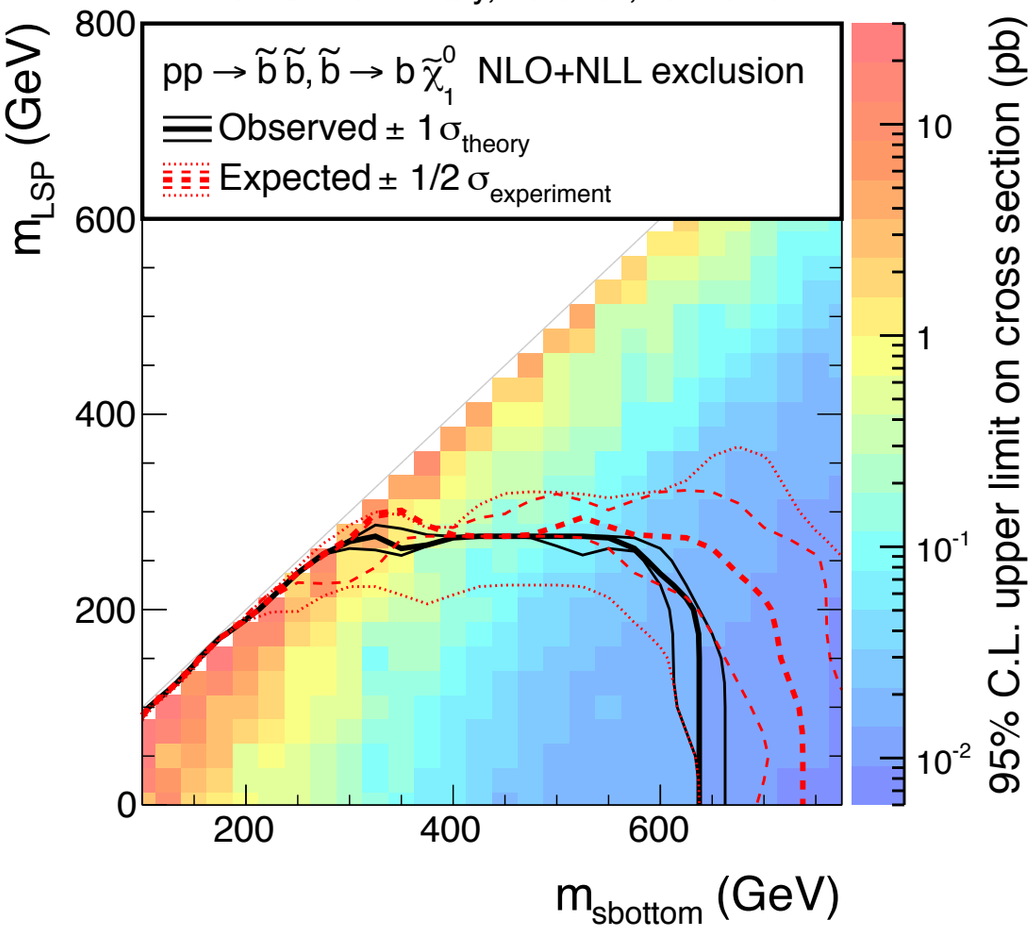
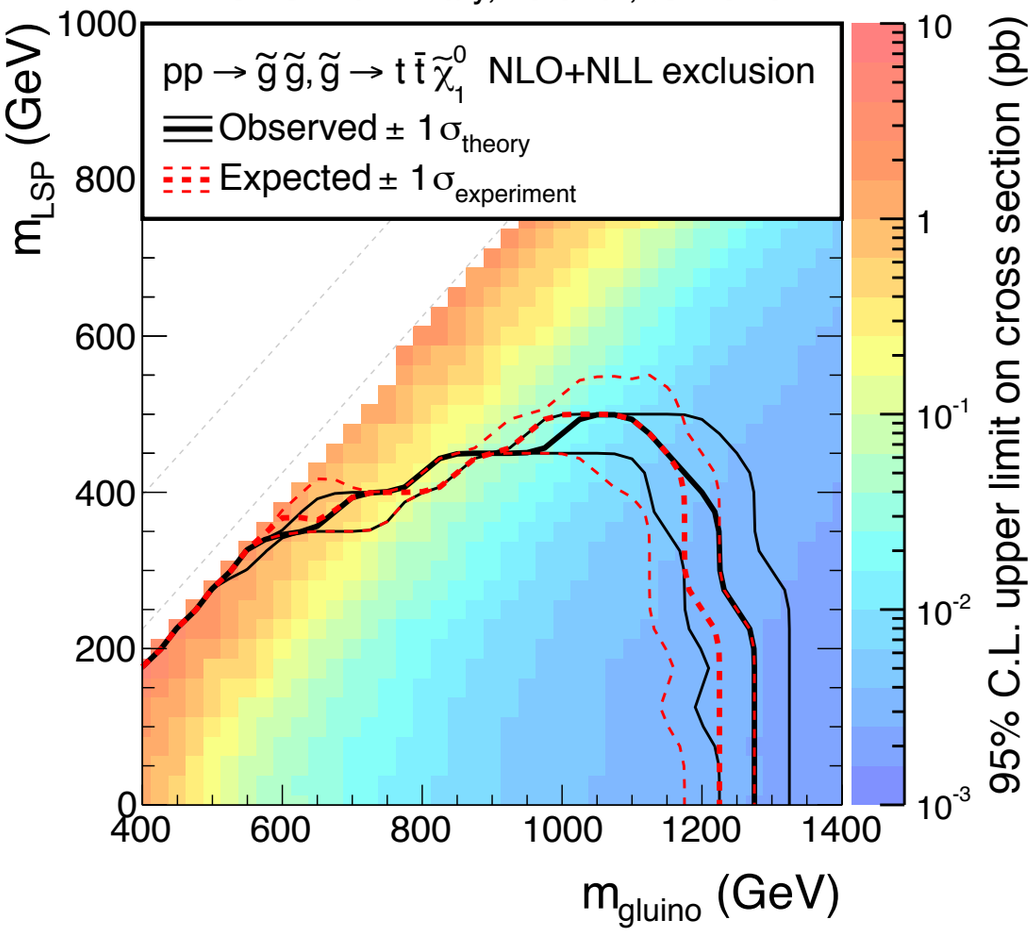


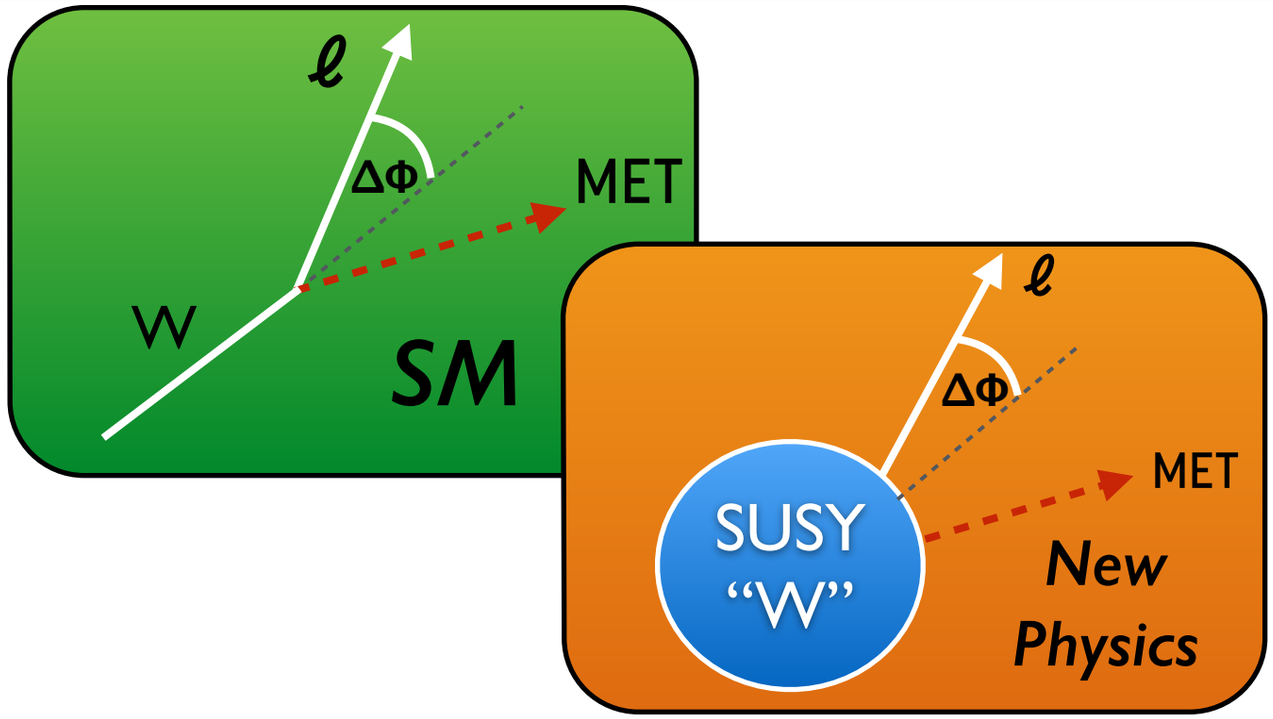


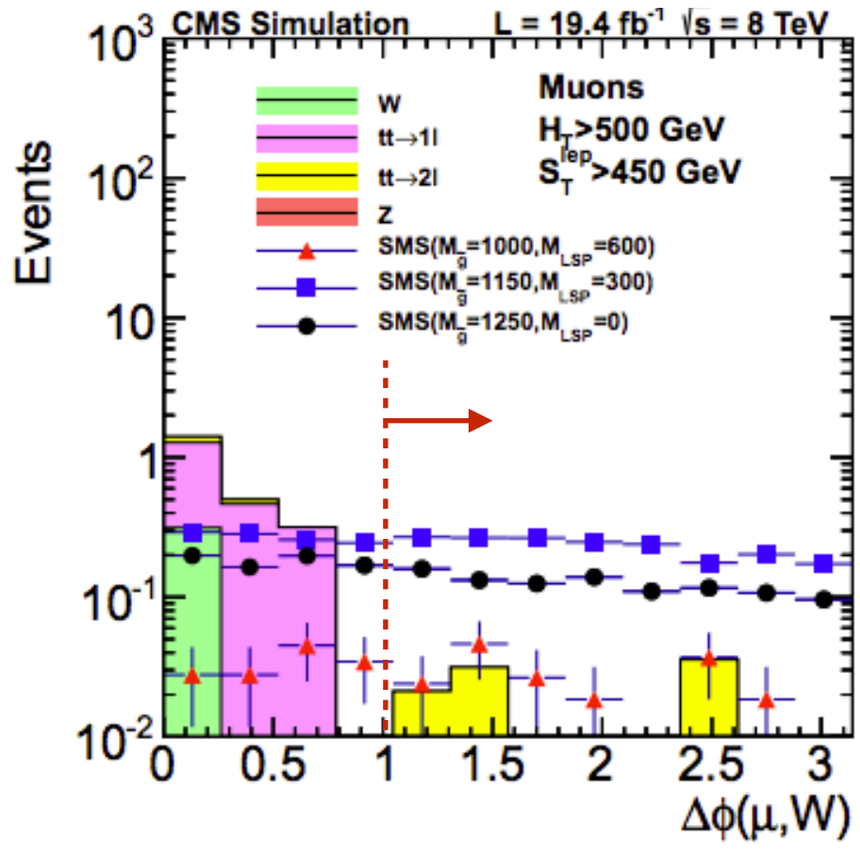
1ℓ + b

- Search for a **single lepton (e/mu) and b-tagged jets**
- Focus on one of three search strategies:
  - Search using **ΔΦ**(W, ℓ)
    - Require **ΔΦ**(W, ℓ)>1
    - only fully leptonic $t\bar{t}$ remains
    - expect large tail from heavy SUSY decays
- Data-driven estimation for dominant backgrounds

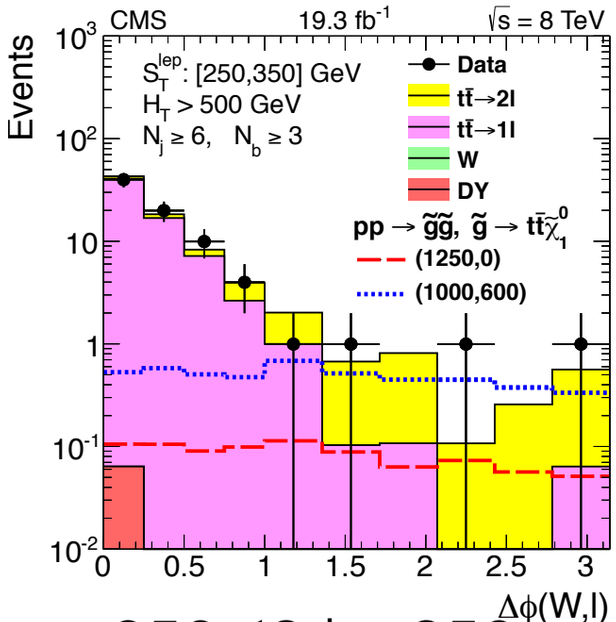
$$R_{CV} = \frac{N(\Delta\phi(l,W) > 1)}{N(\Delta\phi(l,W) < 1)} < 10\%$$

arXiv:1311.4937

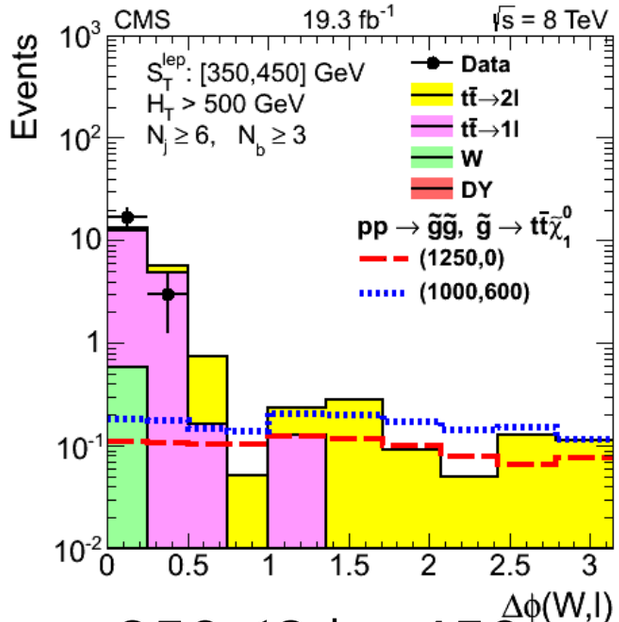




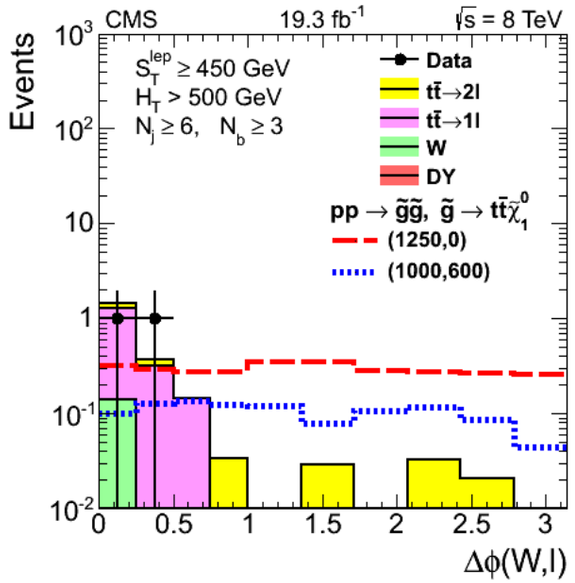
1ℓ +b results



$250 \leq S_T^{lep} < 350$

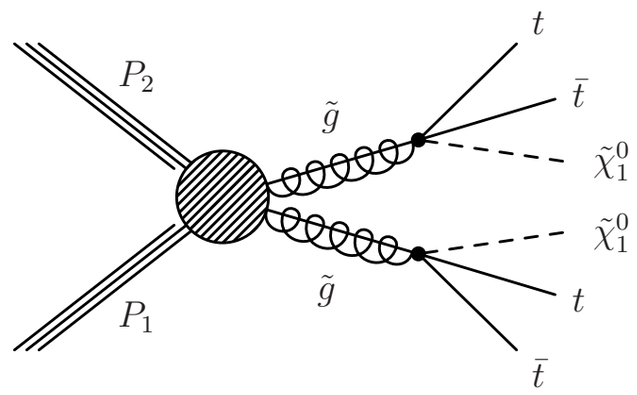


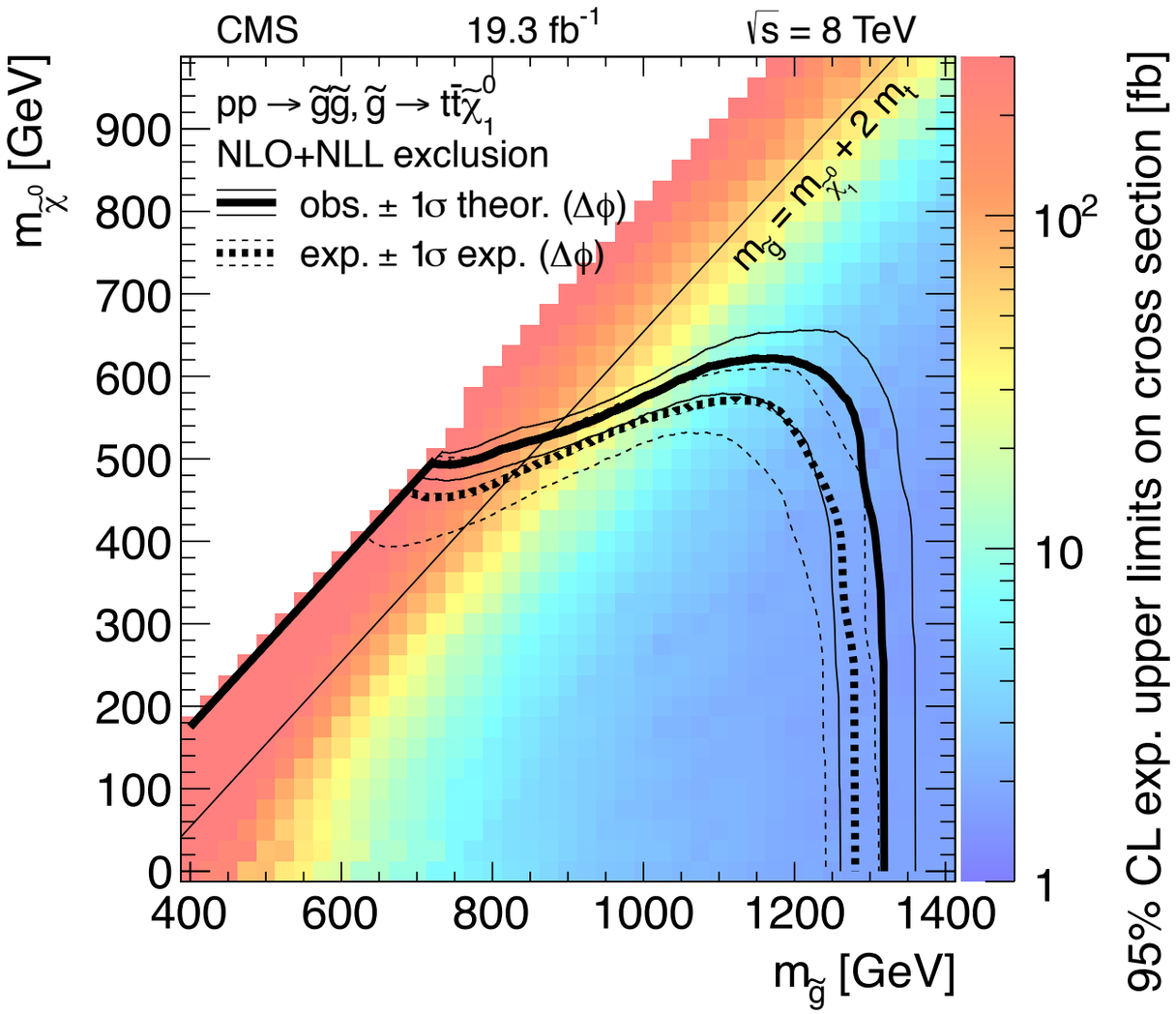
$350 \leq S_T^{lep} < 450$



$S_T^{lep} \geq 450$

Full results

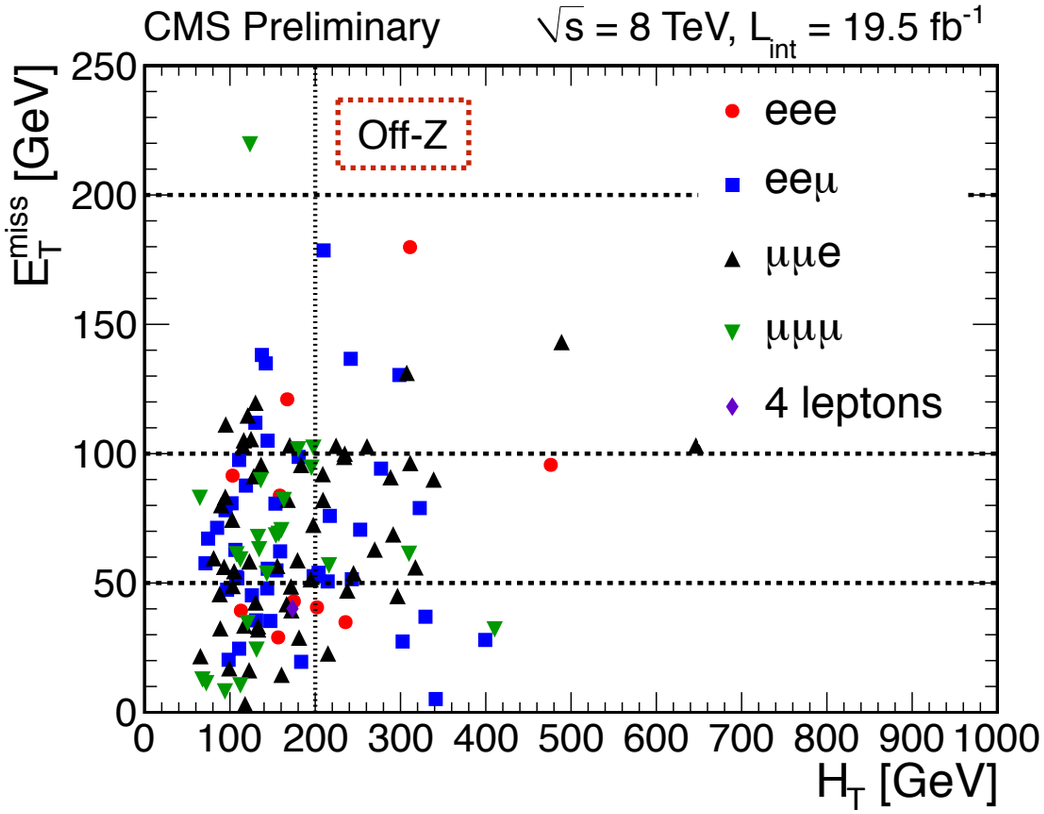




3ℓ +b

- Target a **3ℓ +b** final state
  - lower SUSY branching fraction offset by strongly suppressed backgrounds
  - Binned in HT, MET, n_{jet} and n_b
- Backgrounds from events with:
  - 3 prompt leptons from di-boson (WZ) prod
    - largely suppressed by b-tag requirement
  - 3 prompt leptons from rare SM ($t\bar{t}$+V/H, $t\bar{b}$+Z, VVV)
    - very small
  - Non-prompt leptons

Variable	Baseline	Search Regions		
Sign/Flavor	3 e/μ	On-Z		Off-Z
$N_{b\text{-jets}}$	≥ 1	1	2	≥ 3
N_{jets}	≥ 2	2–3		≥ 4
H_T (GeV)	≥ 60	60–200		≥ 200
E_T^{miss} (GeV)	≥ 50	50–100	100–200	≥ 200



Event content after pre-selection

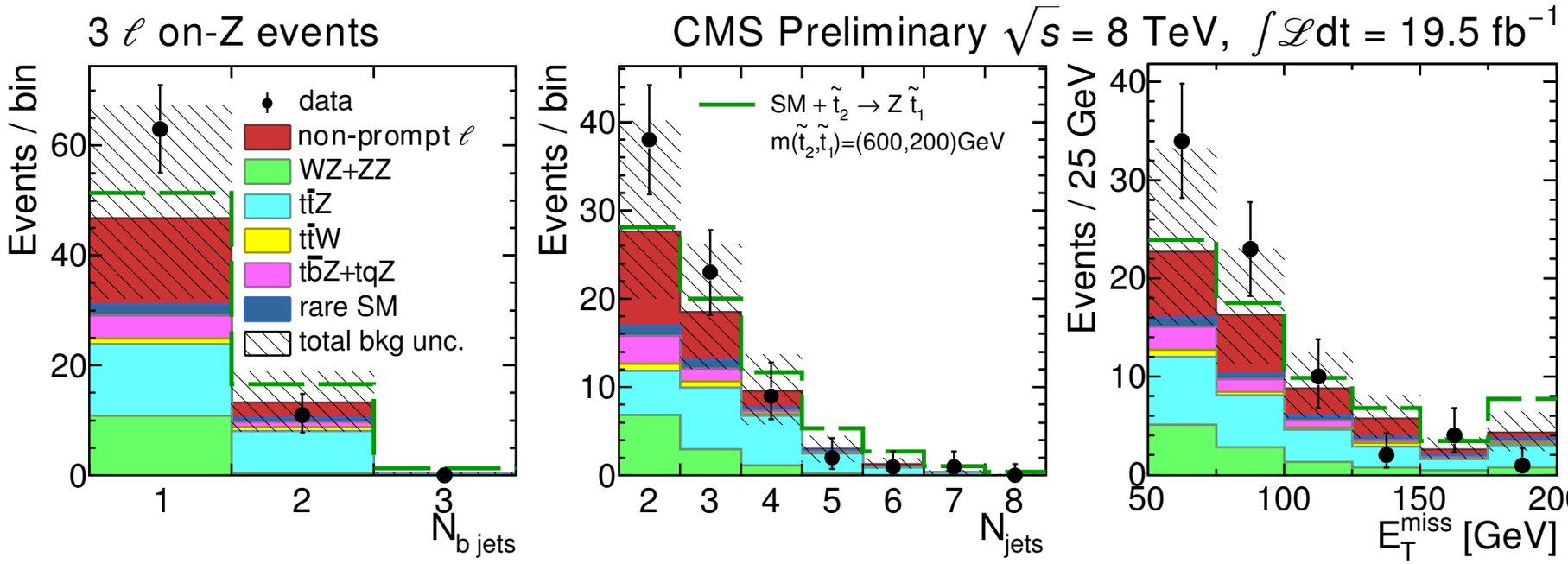
SUS-13-008

3 ℓ +b - Results

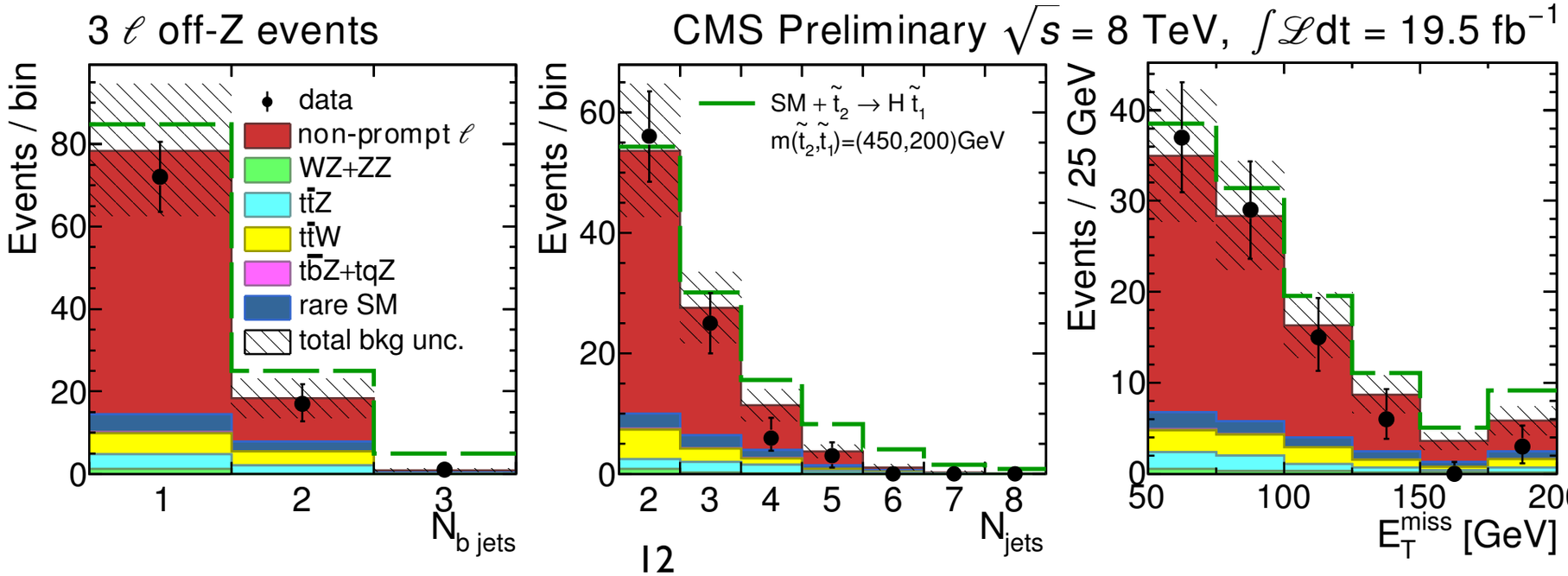
- Results shown from recent re-interpretation
  - 3 ℓ +b signature one of three leptonic signatures

SUS-13-024
arXiv:1405.3886

On-Z mass

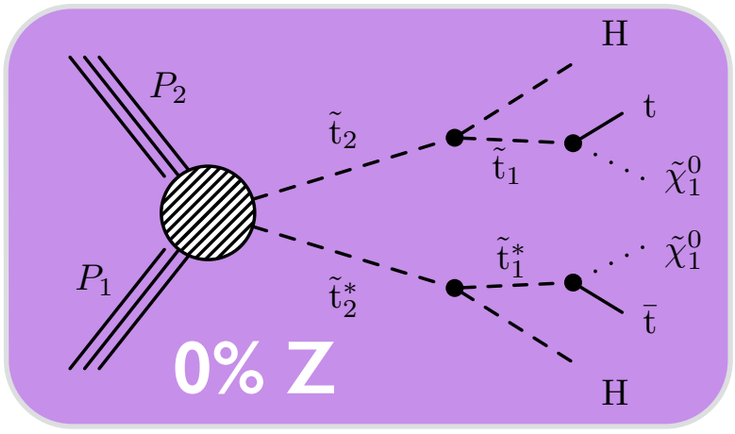


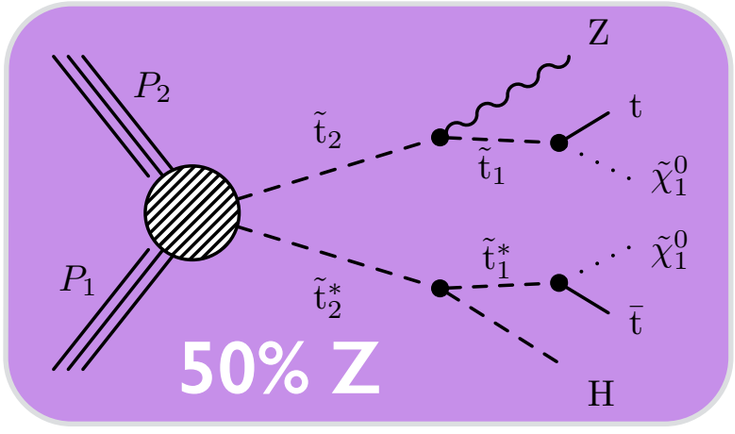
Off-Z mass

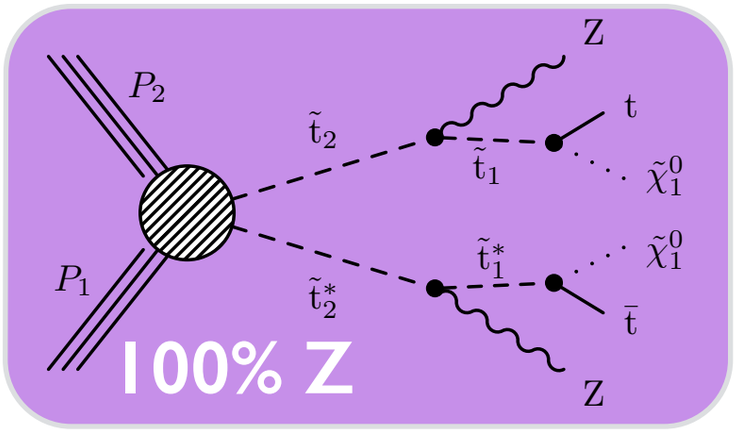


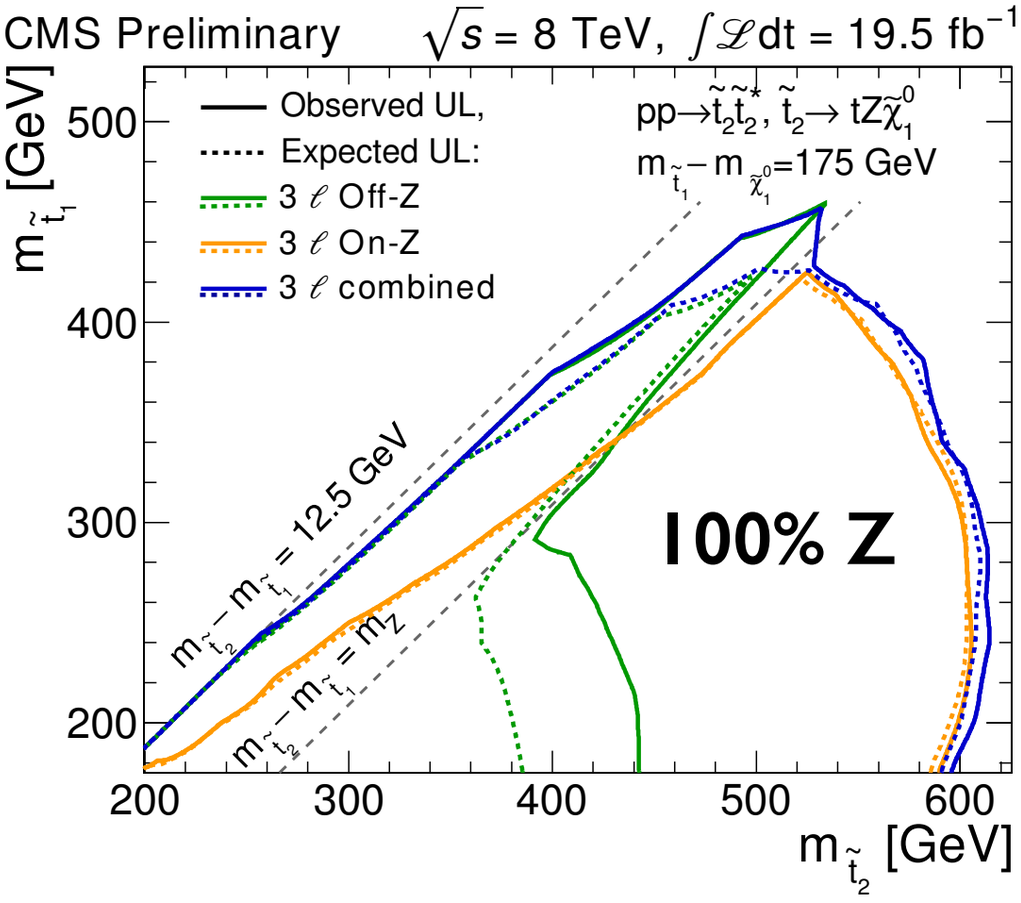
3 ℓ +b - Interpretations

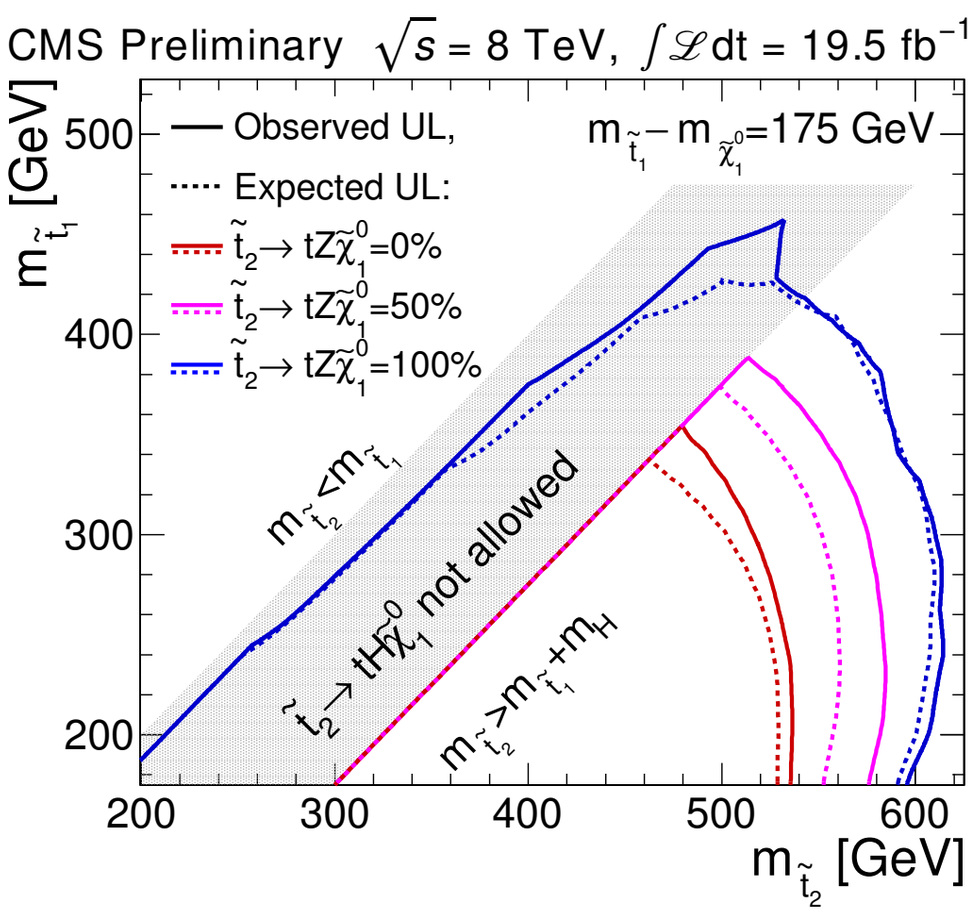
- Limits produced for direct stop production with intermediate decays to Z and/or H
- 3 ℓ +b channel drives overall limits for each model









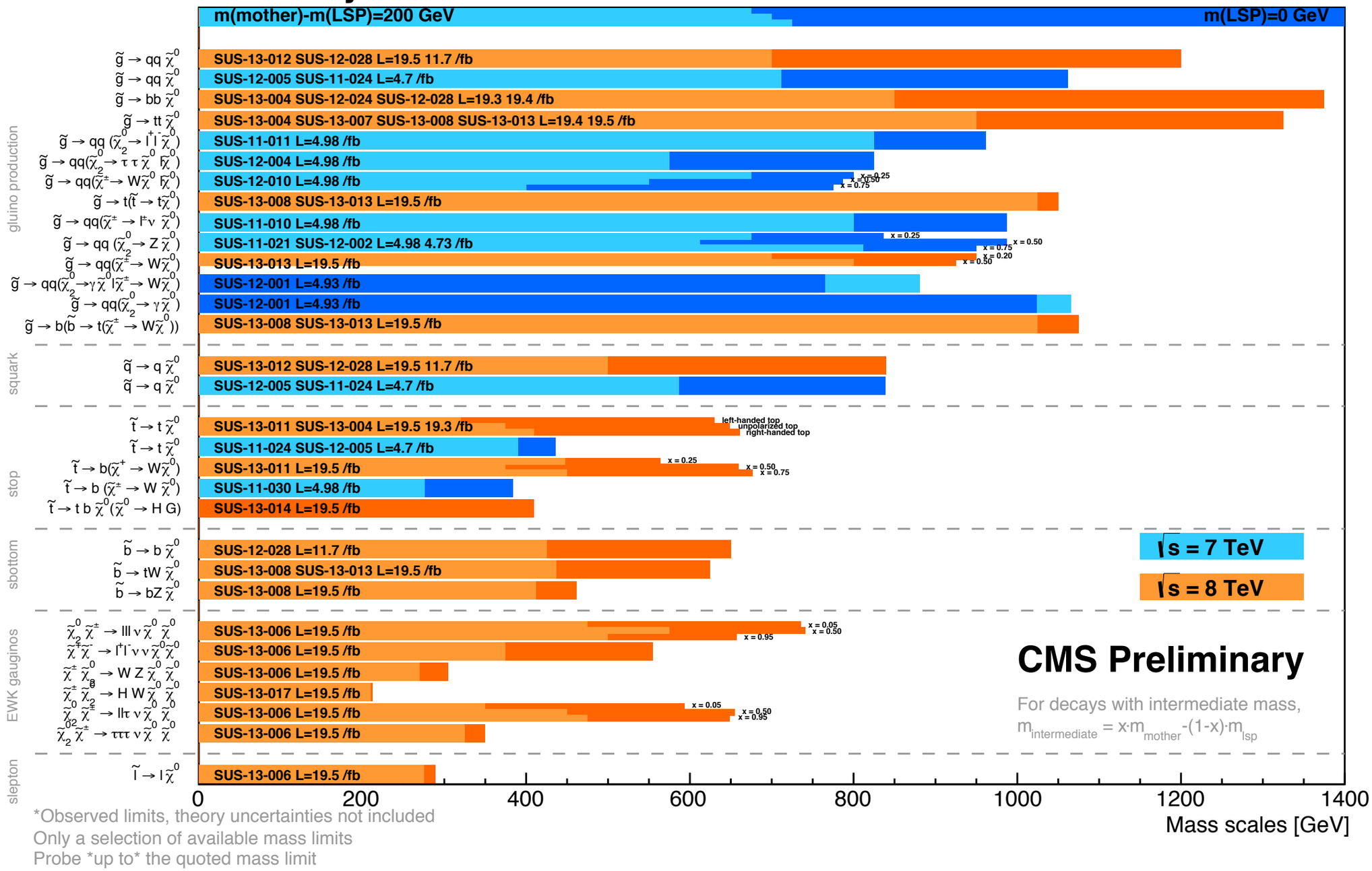


Conclusions

- CMS has a large number of inclusive SUSY analyses with good sensitivity to a broad region of phase space
- Unfortunately, no significant excesses have been observed in Run I
- Run II is just around the corner bringing new experimental challenges, but most importantly a large increase in $\sqrt{s}$
- Much more ground still to cover…

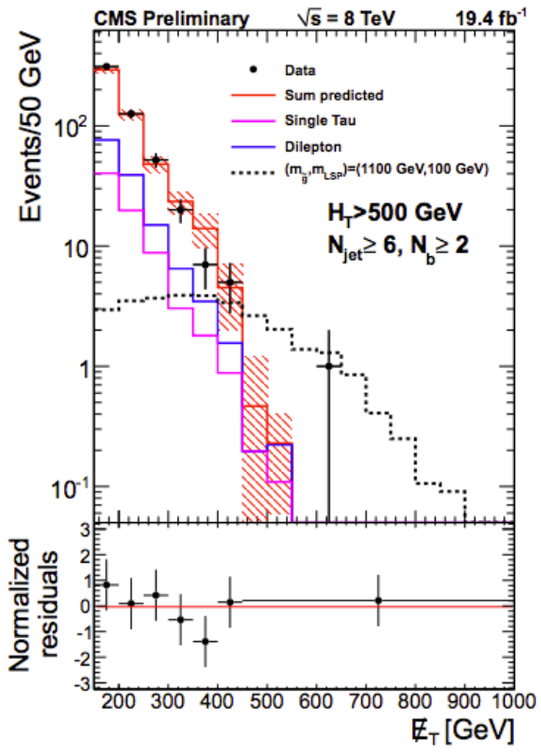
Backup

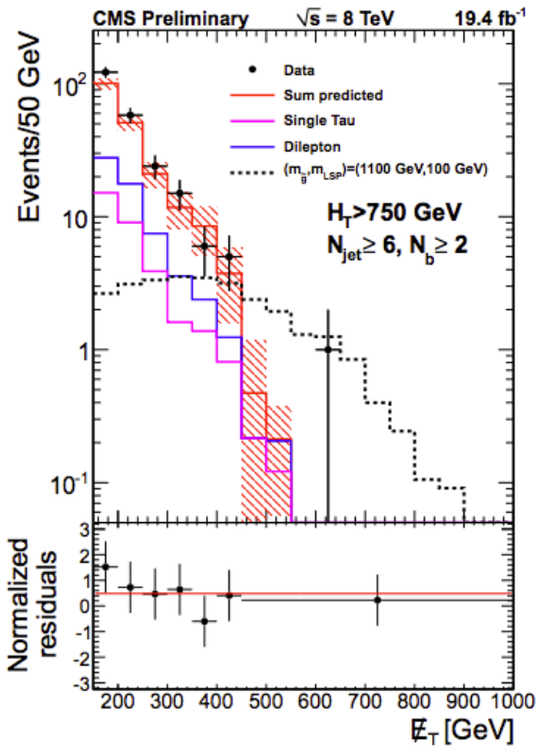
CMS SUSY Program

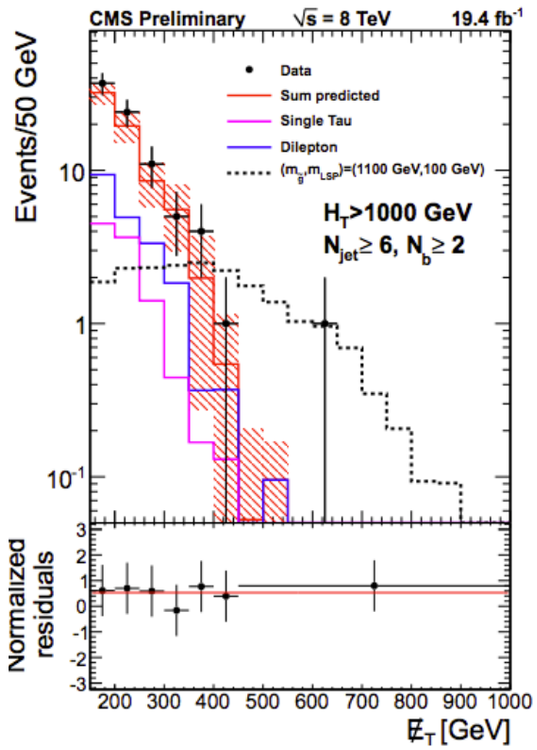


Full results: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSUS

1ℓ +b - continued







- Two other search strategies used:
  - Search in MET and HT spectra using "Lepton Spectrum" technique
  - OTHER TECHNIQUE

Direct gluino production