



Search for supersymmetry with a compressed mass spectrum in events involving soft leptons, jets and missing transverse momentum with $\mathcal{L}=20.1 \text{ fb}^{-1}$ of $\sqrt{s}=8 \text{ TeV}$ ATLAS data

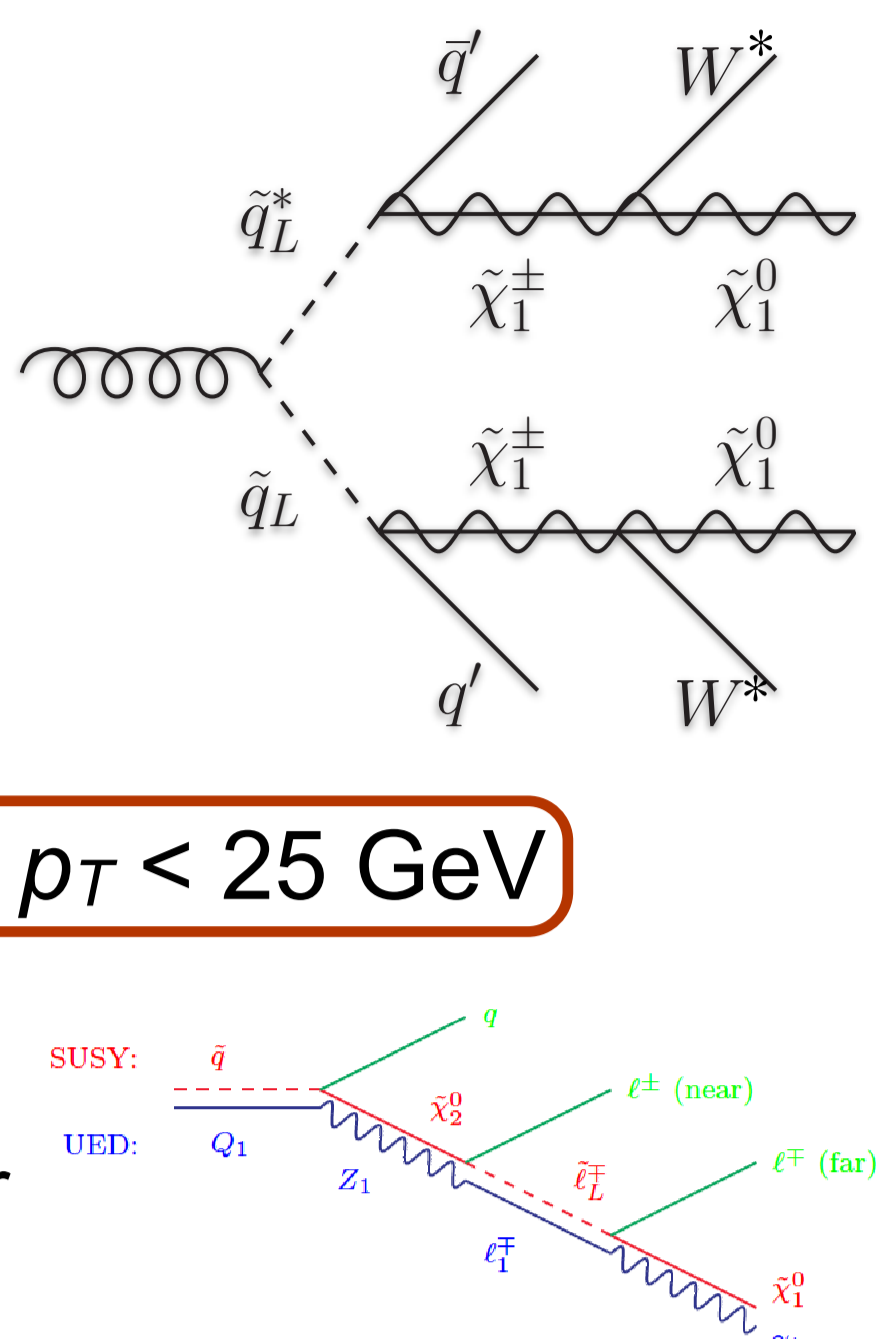
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Introduction

- **Compressed supersymmetry (SUSY)** refers to models where the mass splitting between the sparticles is small, and, as a result, the standard model (SM) particles produced in their decays have low momentum (are soft). Such spectrum occurs, e.g., in “natural” SUSY scenario [1, 2] where at least one top squark and higgsinos are light, resulting in the lightest neutralino and chargino being almost degenerate in mass.
- Compressed spectrum is naturally realised also in the **minimal Universal Extra Dimension (mUED)** model [3]. In this model all the SM fields propagate in (one) compactified extra dimension. Decay chains resemble the ones in SUSY.
- Complimentary to the hard-lepton analysis

Target signatures

- Pair production of coloured SUSY (mUED) particles in strong interaction
- Decaying in one (SUSY) or more (mUED) steps to:
 - **soft muon(electron):** $6 (10) \text{ GeV} < p_T < 25 \text{ GeV}$
 - **jets** (often the leading jet is coming from the initial state radiation (ISR))
 - **large E_T^{miss}** - from escaping dark-matter candidate



Signal regions

- **Seven signal regions (SR)** are defined, targeting different scenarios

	single-lepton one b-jet		single-lepton two b-jets		single-lepton 3-jet 5-jet		dimuon 2-jet
	low-mass	high-mass	low-mass	high-mass	3-jet	5-jet	2-jet
N_{jet}	≥ 3	≥ 2	≥ 2	≥ 2	$\{3,4\}$	≥ 5	≥ 2
p_T^{jets} (GeV)	$> 180, 40, 40$	$> 180, 25, 25$	$> 60, 60$	$> 180, 25, 25$	$> 180, 25, 25$	$> 70, 25$	$> 70, 25$
$N_{b\text{-tag}}$	≥ 1 , but not the leading jet		2				0
E_T^{miss} (GeV)	> 250	> 300	> 200	> 300	> 400	> 300	> 170
m_T (GeV)	> 100				> 100	> 80	
$E_T^{\text{miss}}/m_{\text{eff}}^{\text{incl}}$	> 0.35				> 0.3		
m_{CT} (GeV)			> 150	> 200			

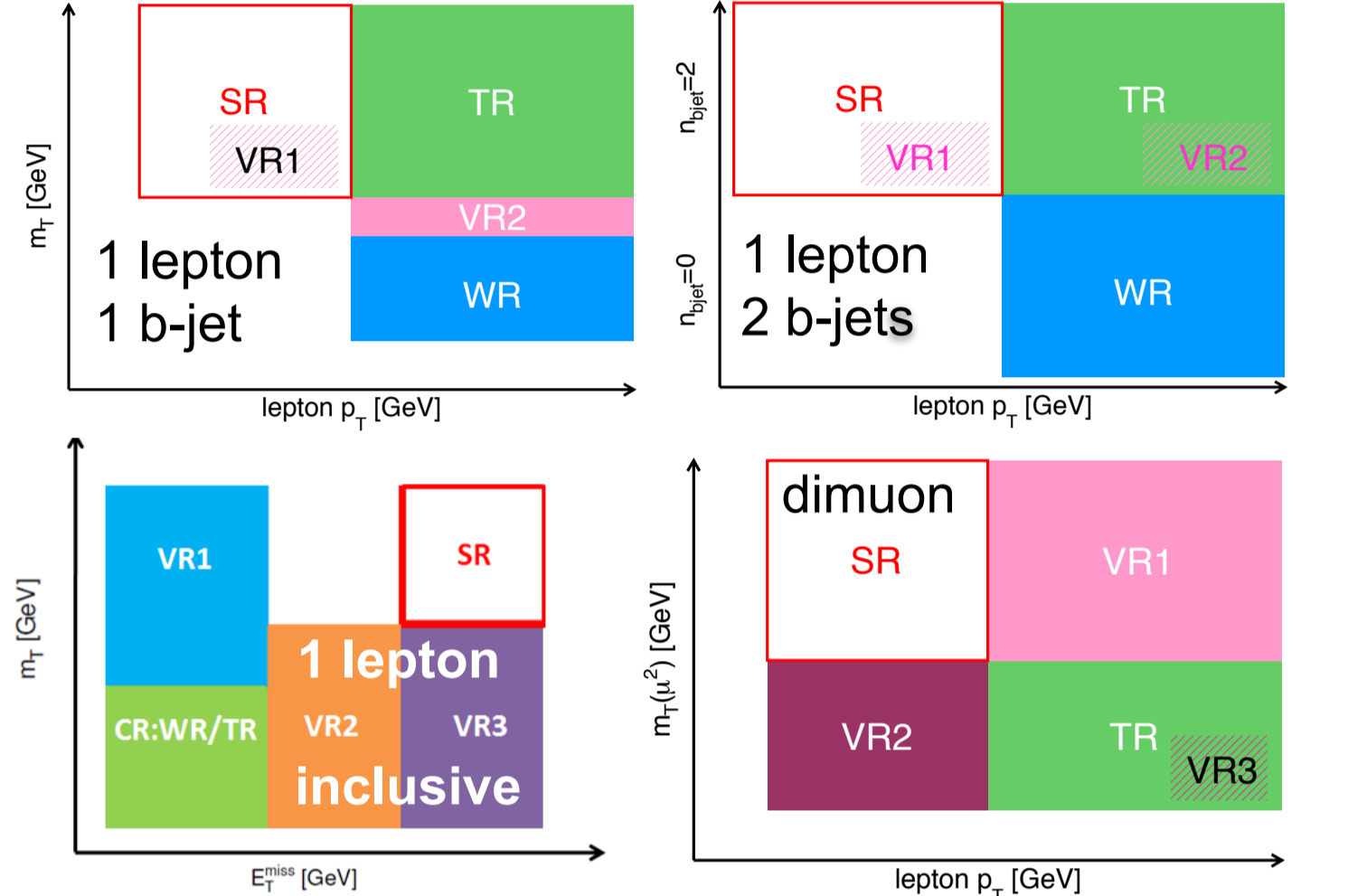
leading jet is ISR $\tilde{t} \rightarrow \tilde{\chi}_1^\pm b \rightarrow \tilde{\chi}_1^0 W^* b$
 leading jets are b-jets from \tilde{t}
 inclusive analysis $\tilde{g} - \tilde{g}$
 $\tilde{q} - \tilde{q}$ **mUED**

- **E_T^{miss} trigger** is used (with $E_T^{\text{miss}} > 80 \text{ GeV}$)
- Overall mass scale of the event: $m_{\text{eff}}^{\text{incl}} = \sum_{i=1}^{N_\ell} p_{T,i}^\ell + \sum_{j=1}^{N_{\text{jet}}} p_{T,j} + E_T^{\text{miss}}$
- Transverse mass, useful to reject $W \rightarrow \ell\nu$ events: $m_T = \sqrt{2p_T^\ell E_T^{\text{miss}} (1 - \cos(\Delta\phi(\vec{\ell}, \vec{p}_T^{\text{miss}})))}$
- Contranverse mass, measure of the masses of pair-produced heavy particles decaying into states involving E_T^{miss} : $m_{\text{CT}}^2(b\text{-jet}_1, b\text{-jet}_2) = [E_T(b\text{-jet}_1) + E_T(b\text{-jet}_2)]^2 - [\vec{p}_T(b\text{-jet}_1) - \vec{p}_T(b\text{-jet}_2)]^2$

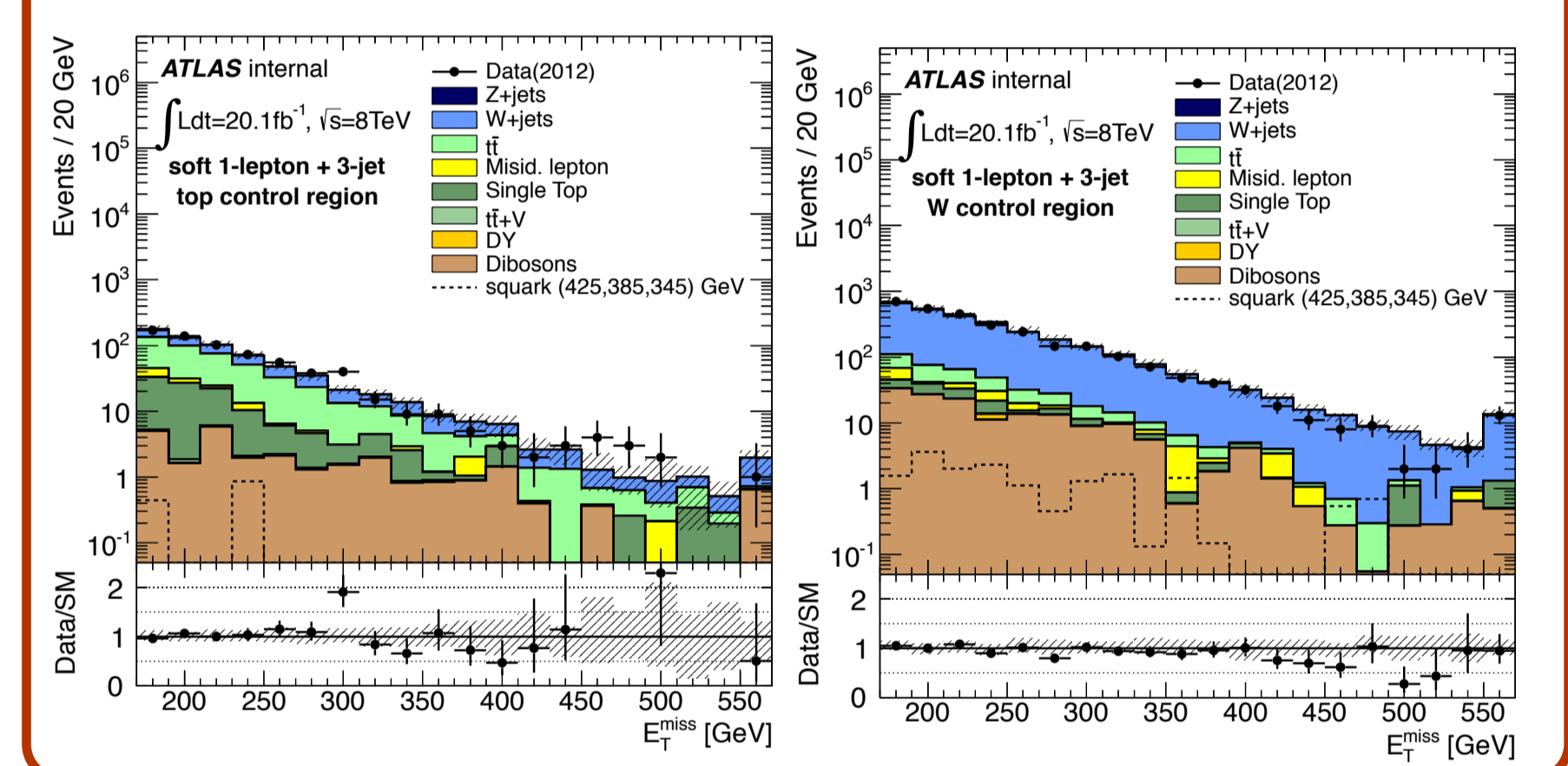
Background estimation

- **$t\bar{t}$ and W/Z +jets**
- Combined fit to the data is performed, based on the profile likelihood method
- Overall normalisation scales for $t\bar{t}$ and W/Z +jets are extracted from respective control regions (CRs) where each of the two backgrounds dominates
- Showing CRs for 1-lepton + 3-jets SR as an example
- The fit results are checked in the validation regions (VRs)
- Good agreement observed, mostly within 1 sigma
- **Misidentified-lepton background**
 - Jet misidentified as a lepton, or lepton coming from b- or c- hadron decays
 - Suppressed by requiring lepton to be well isolated
 - Estimated in a purely data-driven way (the matrix-method)
- Other minor backgrounds (**diboson, single top, $t\bar{t} + V$**) are estimated using MC

CR and VR definitions



Plots in CRs after scaling MC to the data



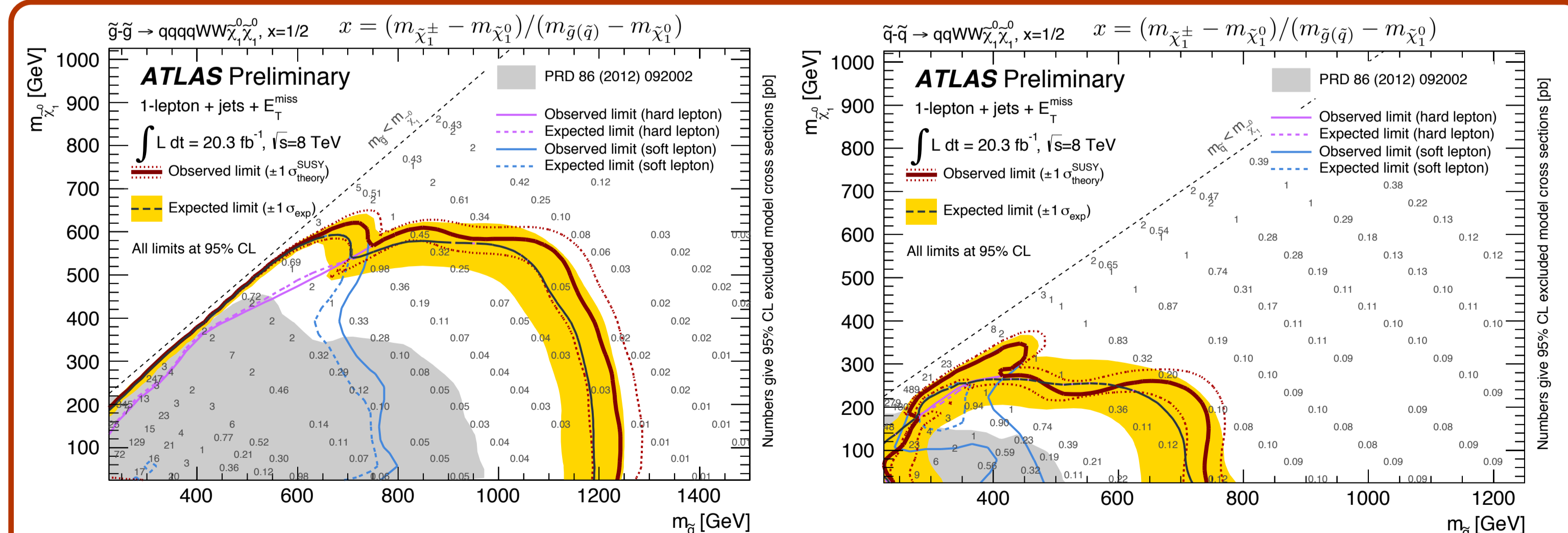
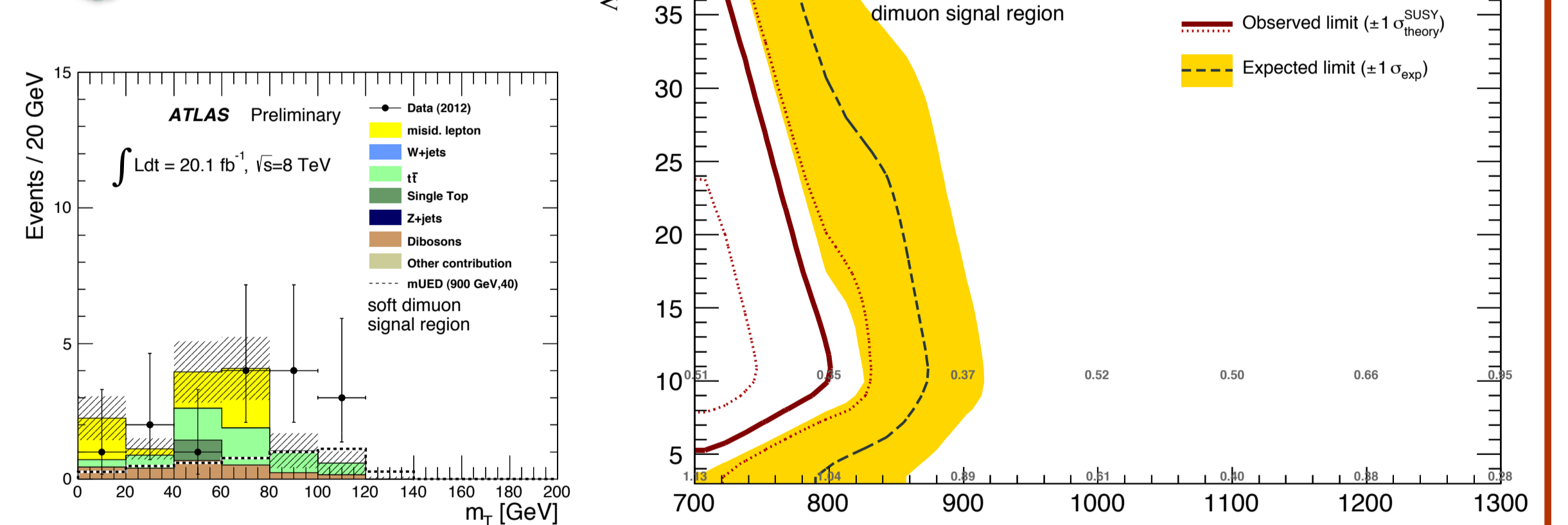
Results

- No significant excess above the Standard Model expectation is observed
- The largest excess is seen in the dimuon channel - 2.3 σ
- Limits on specific models, as well as on the visible cross-section, are obtained

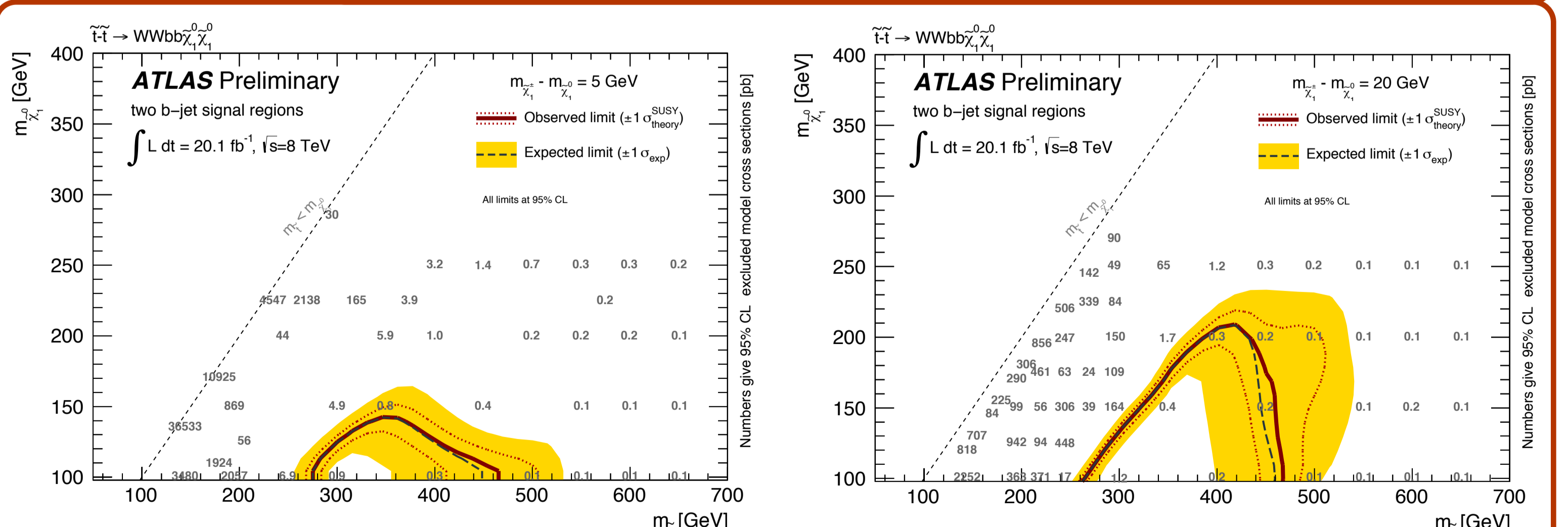
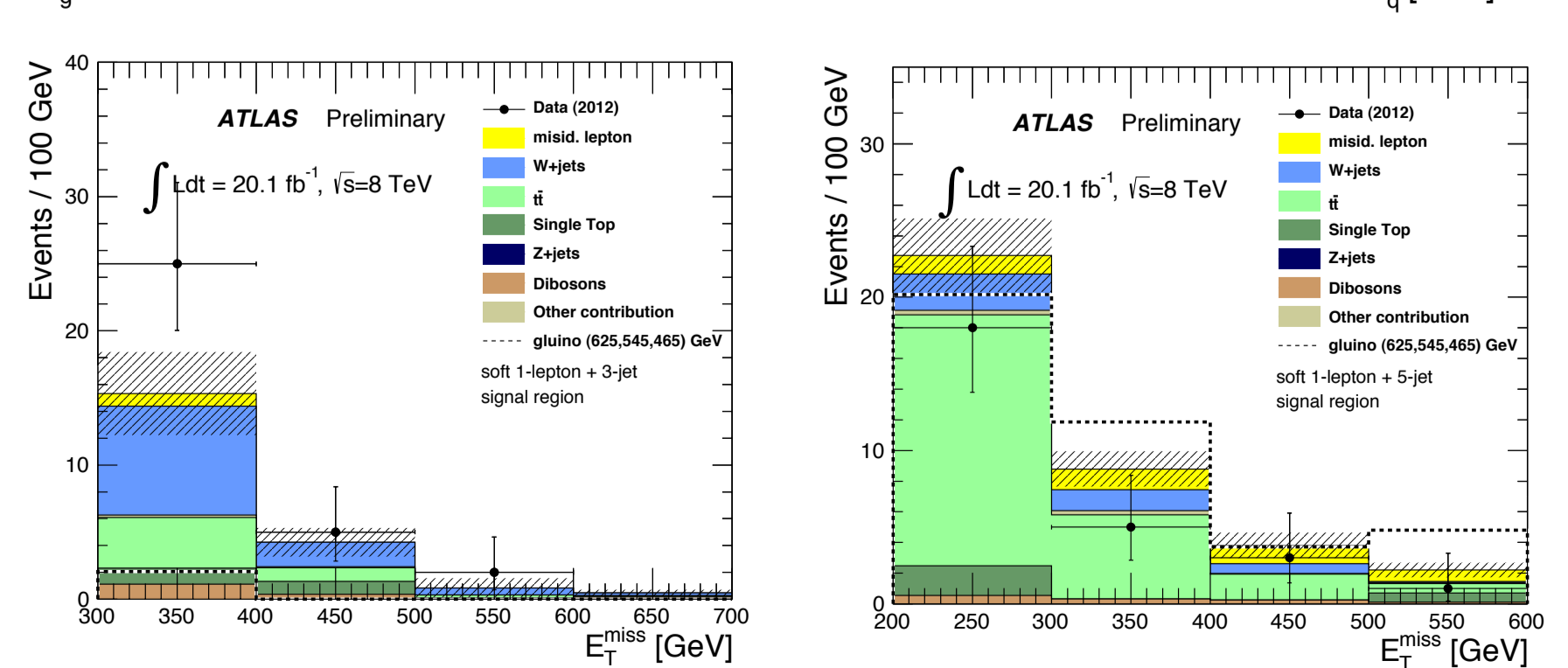
Expected and observed number of events

	single-lepton one b-jet		single-lepton two b-jet		single-lepton 3-jet	single-lepton 5-jet	dimuon 2-jet
	low-mass	high-mass	low-mass	high-mass			
Observed events	8	6	24	3	7	9	7
Fitted background	6.1 ± 1.4	4.0 ± 1.1	24.1 ± 4.1	3.6 ± 1.4	5.6 ± 1.6	14.8 ± 3.7	1.6 ± 1.0

mUED limits



- **$g\bar{g}$ & $q\bar{q}$ production limits**
- Combined soft & hard **single-lepton limits**, and **3- & 5-jets channels**
- Soft lepton excludes regions close to the diagonal



- **Stop-production limits**
- Combined high and low stop-mass limits, for the **2 b-jets channel**

