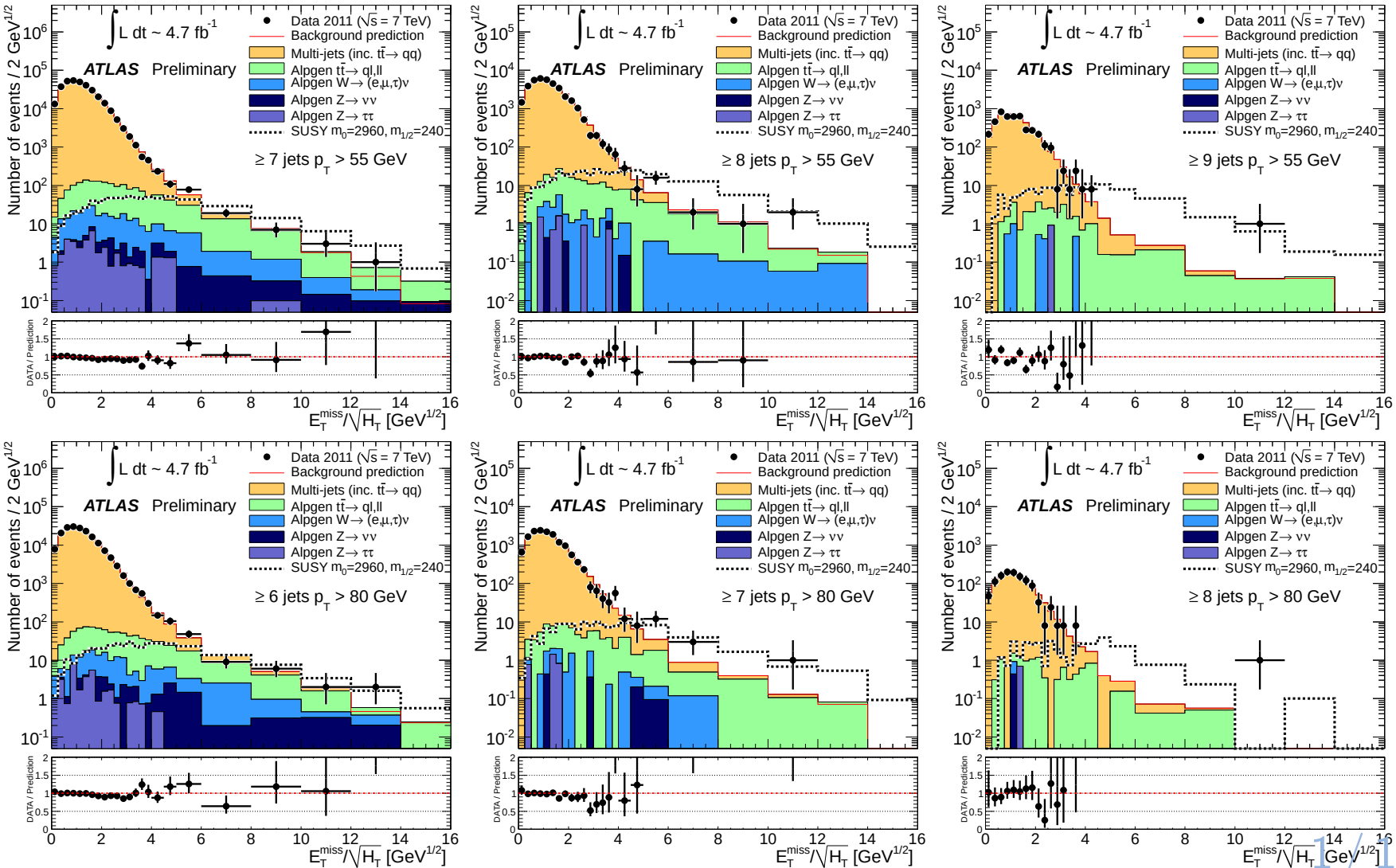
SUSY High Jet Multiplicity + E_T^{miss} Hunt

Christopher Young

IoP Meeting 2-4 April 2012



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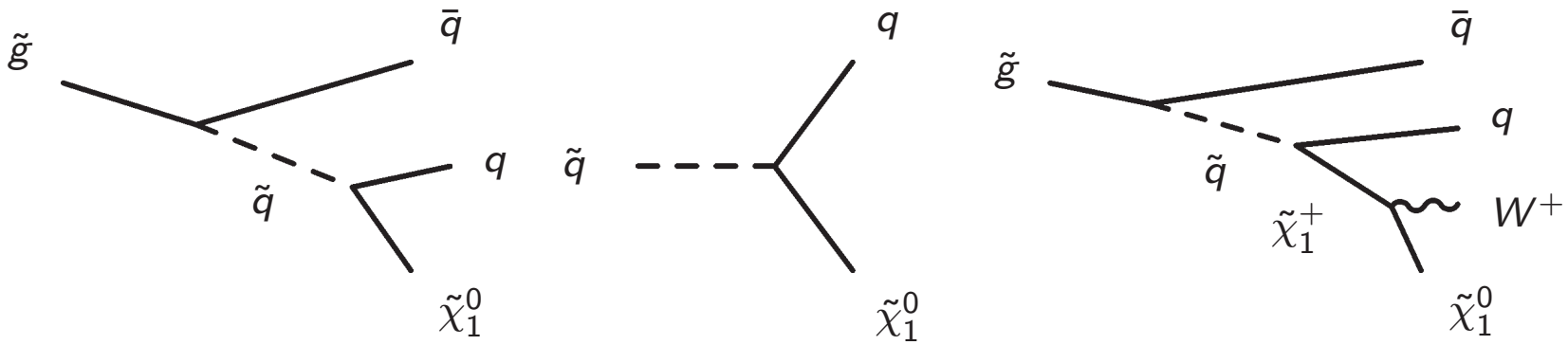
Introduction

- SUSY strong production is characterised by the pair and associated production of squarks ($\tilde{q}$) and gluinos ($\tilde{g}$).
- These can then decay either directly to the LSP (usually assumed to be the lightest neutralino) or through a series of intermediate SUSY particles.



- In the R-Parity conserving models considered the lightest neutralino is assumed to be (collider) stable so passes through the detector undetected.
- Signatures therefore involve jets, missing transverse energy ($E_{\mathrm{T}}^{\mathrm{miss}}$) and possibly leptons (inc. τs) from cascade decays (and, additionally, possibly photons).
- Here I am looking in the fully hadronic jets+$E_{\mathrm{T}}^{\mathrm{miss}}$ channel.

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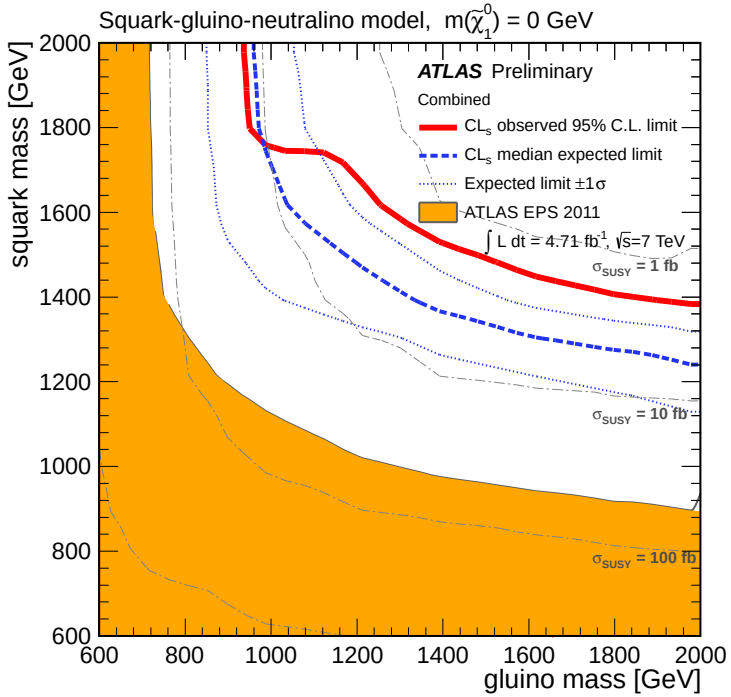
Introduction II

- ATLAS searches have been performed looking for these most obvious direct decays involving hard jets and large missing momentum.
- No evidence for SUSY has been found and limits have been set on the masses of $\tilde{q}$s and $\tilde{g}$s.(below)(ATLAS-CONF-2012-033)
- When the decay chain is longer the jets are generally softer and the $E_{\mathrm{T}}^{\mathrm{miss}}$ lower.
- Here I will present an analysis looking for these signatures by requiring a large number of jets and some $E_{\mathrm{T}}^{\mathrm{miss}}$.(ATLAS-CONF-2012-037)



0-lepton High Multiplicity Analysis

0-lepton High Multiplicity Analysis

- Update of previous 1.34fb^{-1} analysis (arXiv: 1110.2299) with increased number of signal regions and increased luminosity.
- Released as a CONF note at Moriond QCD 2012 - ATLAS-CONF-2012-037 (Hunt for new phenomena using large jet multiplicities and missing transverse momentum with ATLAS in L = 4.7 fb^{-1} of $\sqrt{s} = 7$ TeV proton-proton collisions)
- Updated procedures and more detailed study allowed removal of the $\Delta R(\mathrm{jet,jet})$ cut present in the previous version.
- Large increase in signal acceptance.
- 6 signal regions defined.

Signal region	**7j55**	**8j55**	**9j55**	**6j80**	**7j80**	**8j80**
Isolated Leptons (e, μ)	$=0$					
Jet p_T	$> 55\,\mathrm{GeV}$			$> 80\,\mathrm{GeV}$		
Jet $\lvert\eta\rvert$	< 2.8					
Number of jets	≥ 7	≥ 8	≥ 9	≥ 6	≥ 7	≥ 8
$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_T}$	$> 4\ \mathrm{GeV}^{1/2}$					

0-lepton High Multiplicity Analysis: Backgrounds

- Due to the softer $E_{\mathrm{T}}^{\mathrm{miss}}$ requirements and lack of $\Delta\phi(j_i, E_{\mathrm{T}}^{\mathrm{miss}})$ cuts, jet miss-measurement is a primary background in this search.
- The cuts are designed to allow a robust estimation of this background.
- The $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$ distribution is observed to be stable under changes in nJet.
- This is due to the jet resolution dependence of the ATLAS detector.
- Shape is taken from lower multiplicity (after subtracting other backgrounds) and normalised at low $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$.
- Primary systematics are; closure at lower multiplicity/lower $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$, the varying amounts of heavy flavour jets at different nJet and the subtraction of the other backgrounds in forming the template.

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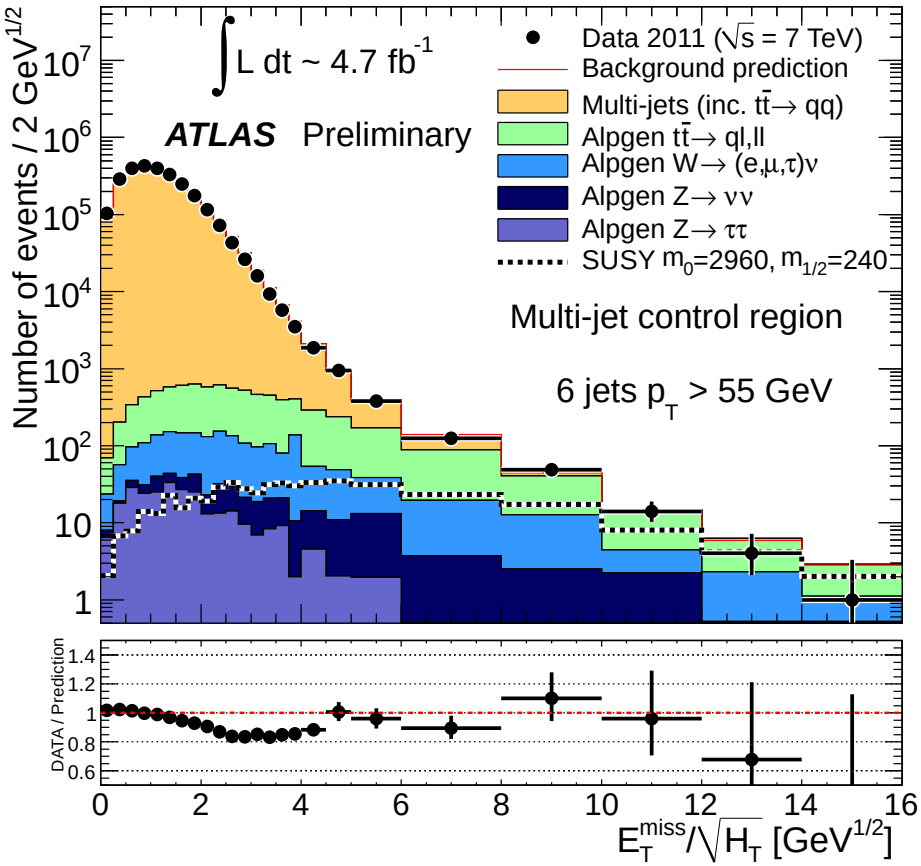
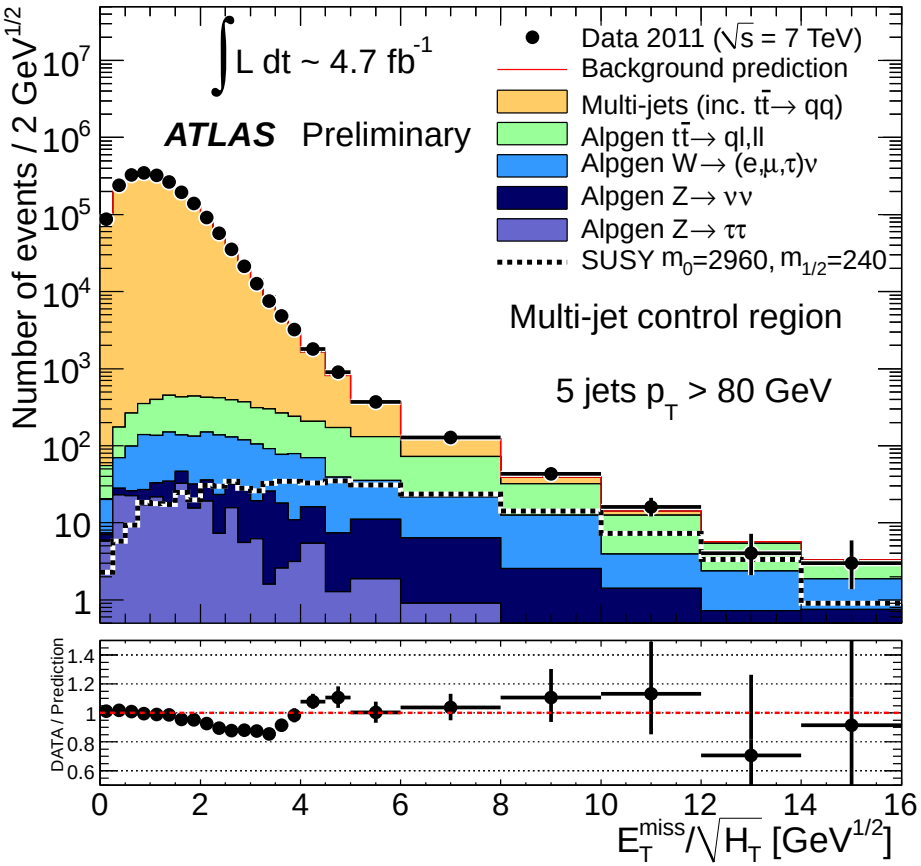
0-lepton High Multiplicity Analysis: Backgrounds





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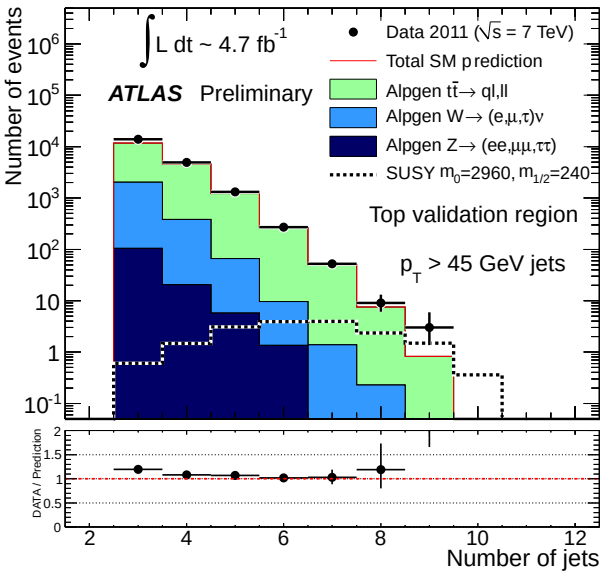
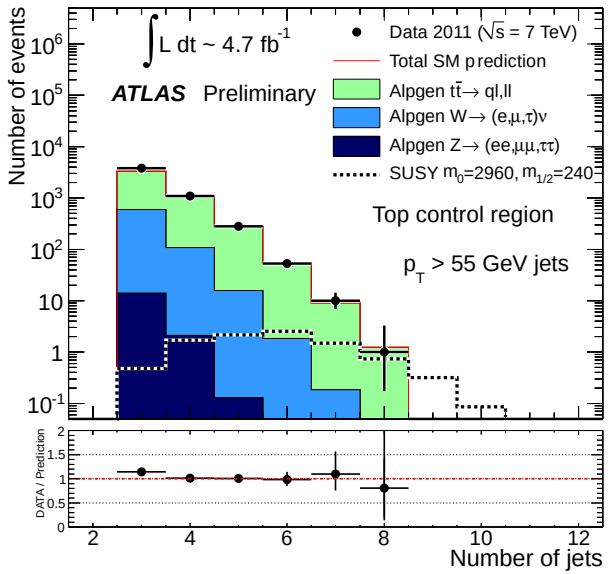
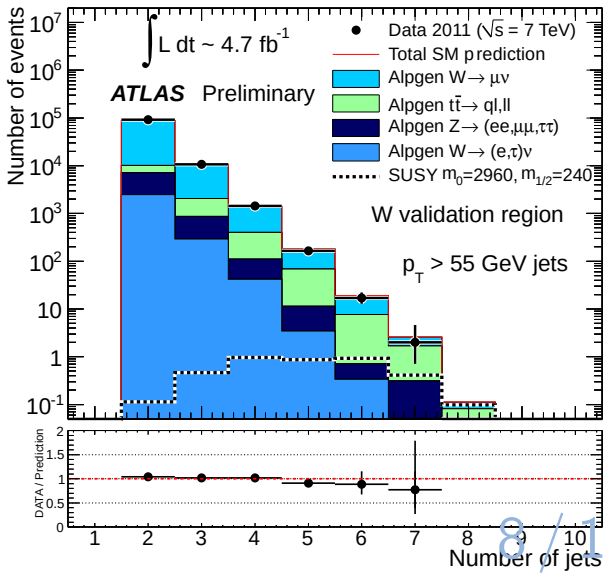
0-lepton High Multiplicity Analysis: Backgrounds

- $t\bar{t}$, W+jets and Z+jets backgrounds follow a similar approach to the 0-lepton m_{eff} analysis.
- Validation regions are formed requiring muons.
- Control regions are defined applying SR cuts and treating the muon as a jet (for W and $t\bar{t}$) or adding them to the $E_{\mathrm{T}}^{\mathrm{miss}}$ (for Z).
- Transfer factors are used when adequate CR statistics are present, otherwise Monte-Carlo estimations are used.
- Monte-Carlo is validated at high multiplicity by looking at jet multiplicity distributions with reduced jet p_{T} cuts.





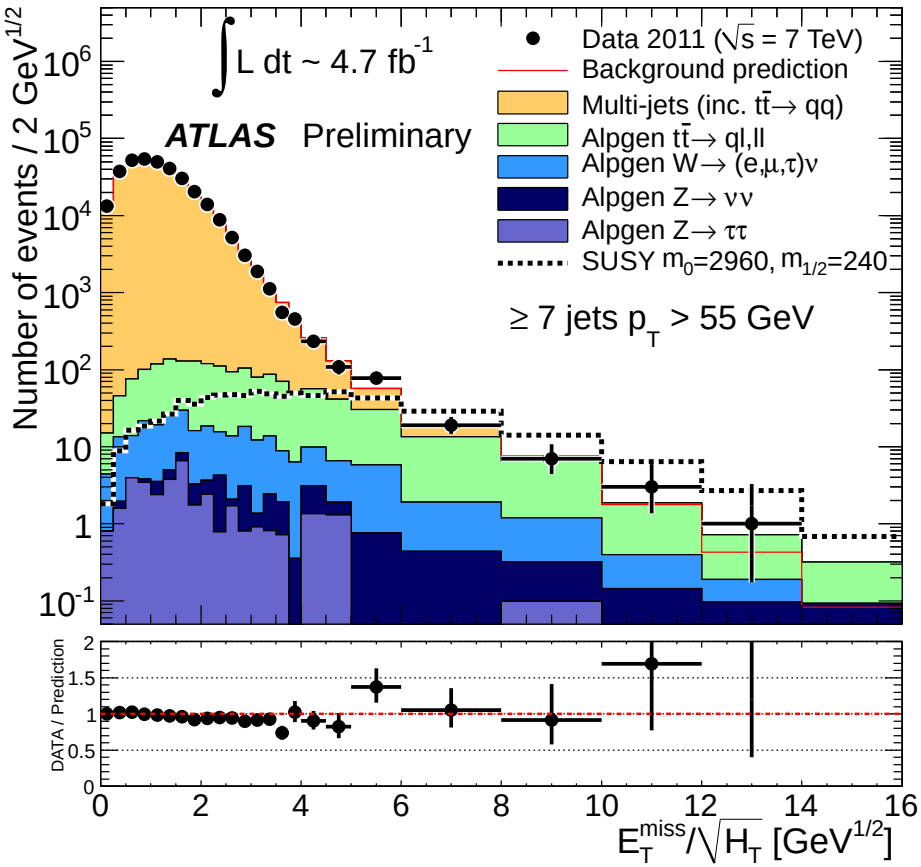


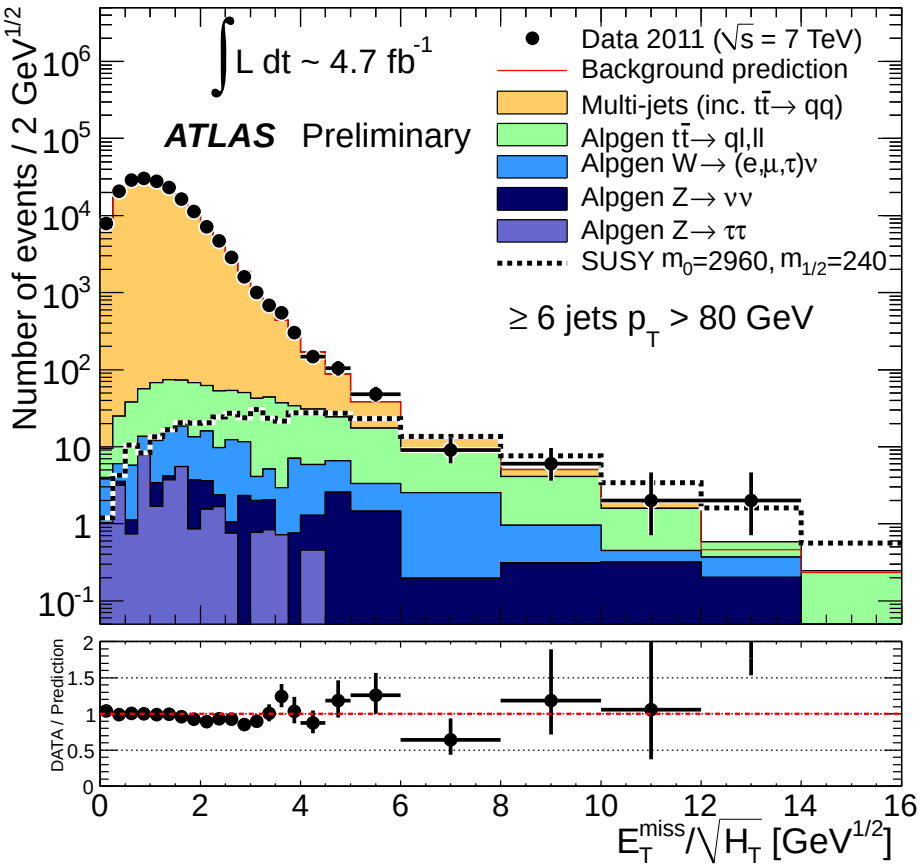
0-lepton High Multiplicity Analysis: Results

- No significant excess is observed in any of the six signal regions.

Signal region	**7j55**	**8j55**	**9j55**	**6j80**	**7j80**	**8j80**
Multi-jets	91±20	10±3	1.2±0.4	67±12	5.4±1.7	0.42±0.16
$t\bar{t} \to q\ell, \ell\ell$	55±18	5.7±6.0	0.70±0.72	24±13	2.8±1.8	0.38±0.40
W + jets	18±11	0.81±0.72	0+0.13	13±10	0.34±0.21	0+0.06
Z + jets	2.7±1.6	0.05±0.19	0+0.12	2.7±2.9	0.10±0.17	0+0.13
Total Standard Model	**167±34**	**17±7**	**1.9±0.8**	**107±21**	**8.6±2.5**	**0.80±0.45**
Data	**154**	**22**	**3**	**106**	**15**	**1**
p_{SM}	0.64	0.27	0.28	0.52	0.07	0.43

0-lepton High Multiplicity Analysis: Results





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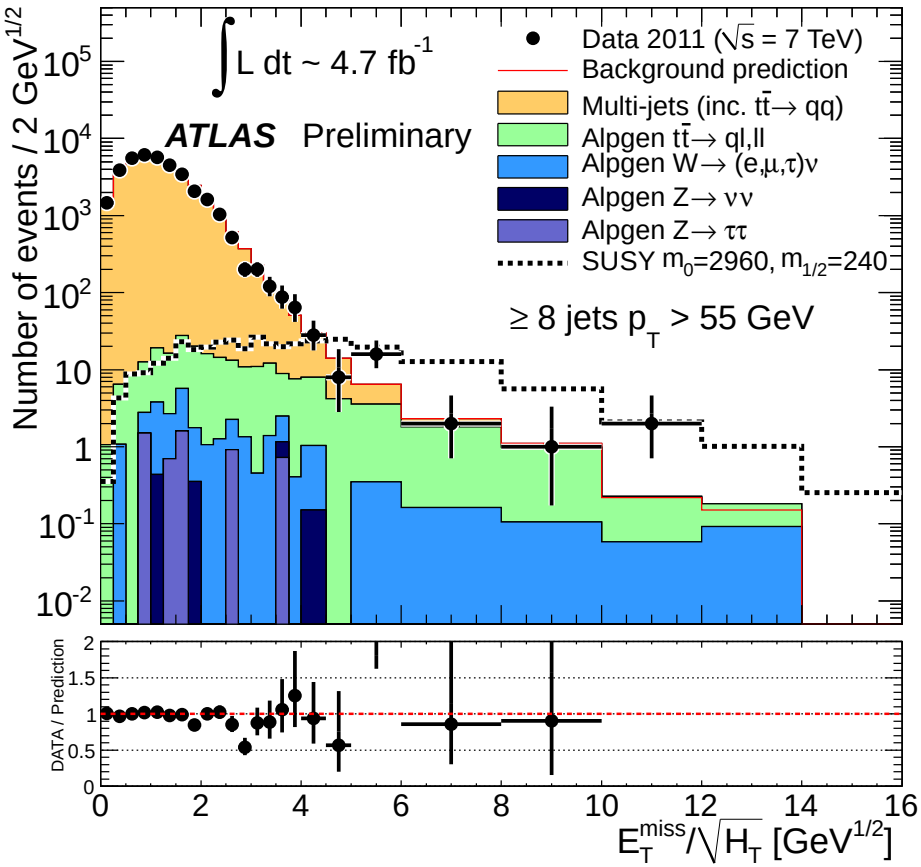

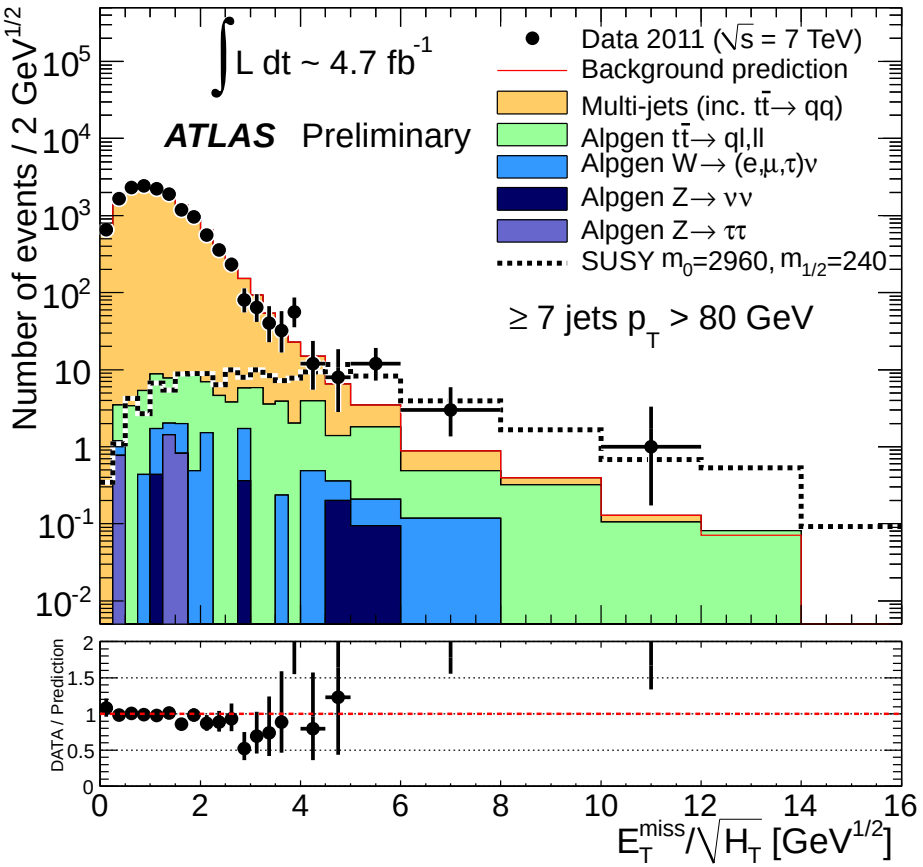

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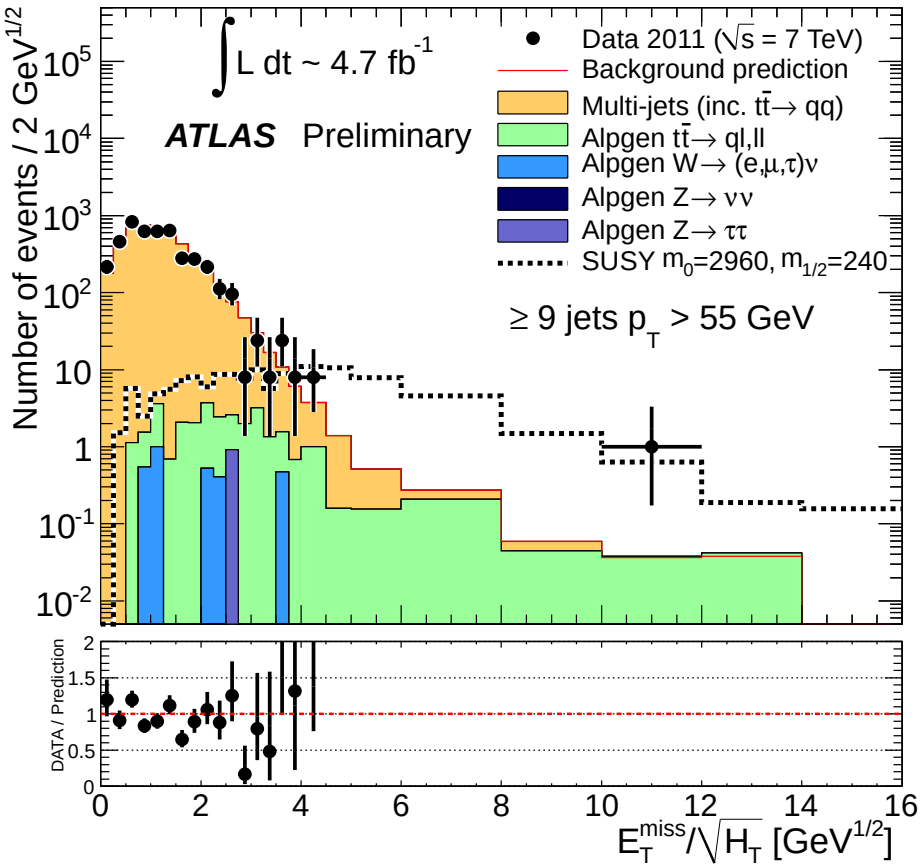

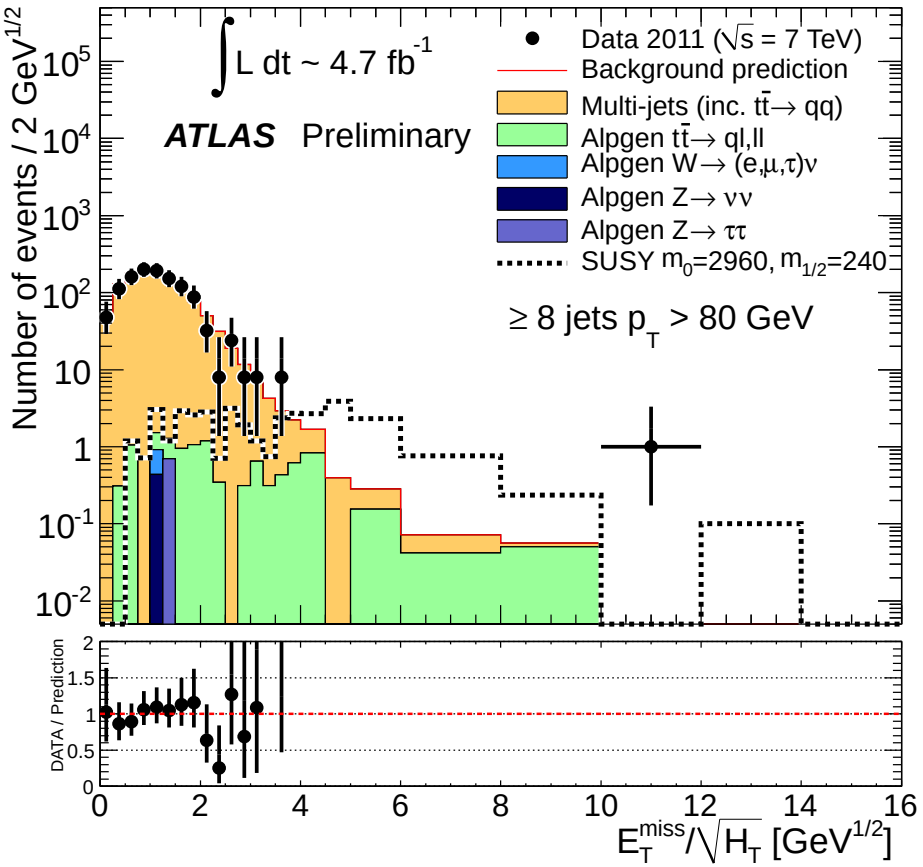

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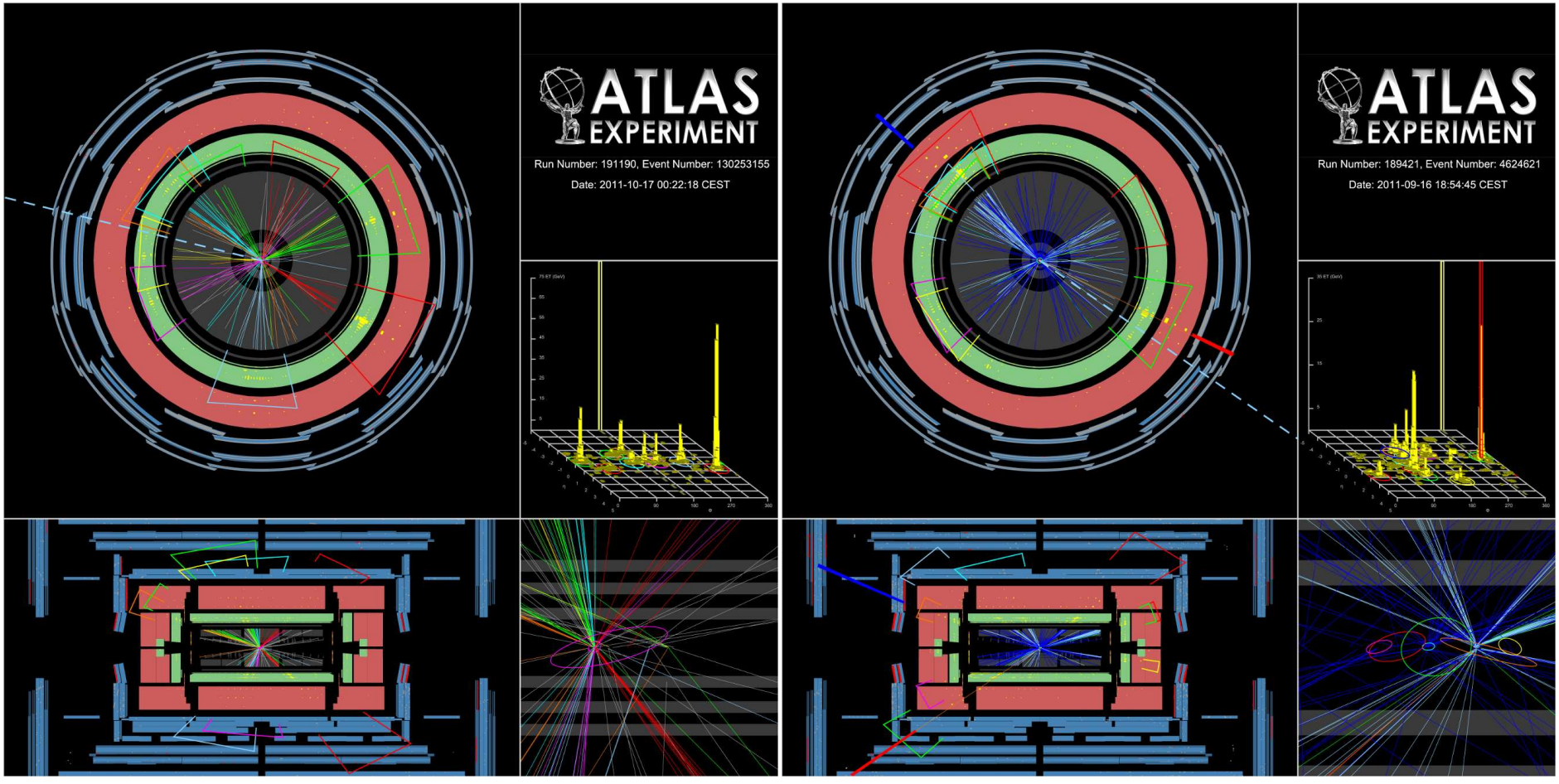
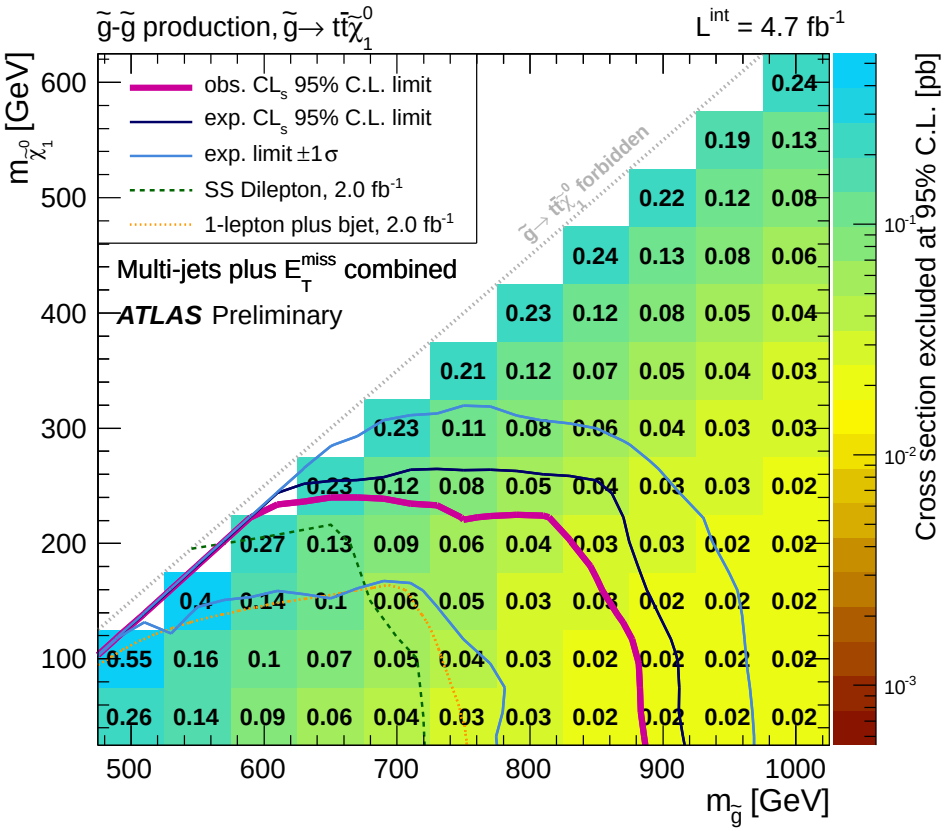
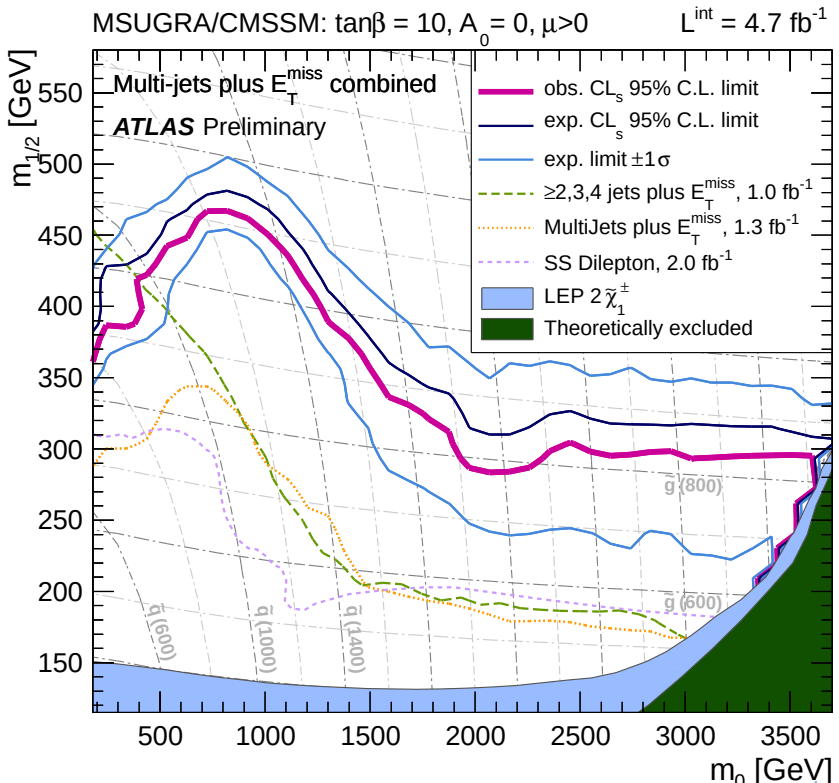
0-lepton High Multiplicity Analysis: Results



0-lepton High Multiplicity Analysis: Limits

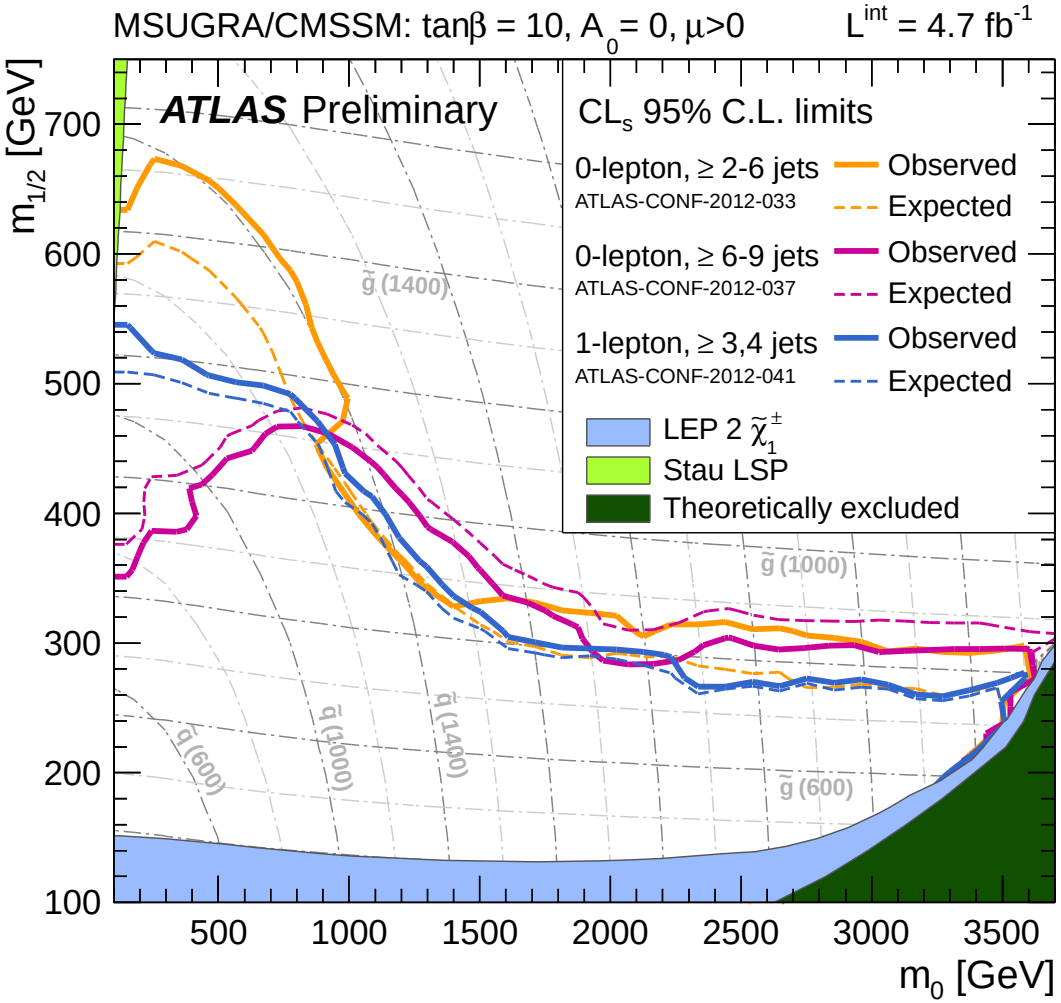
- Having observed no significant excess we set limits.
- Limits are set in a simplified model with a gluino octet which decays to a $t\bar{t}$ pair and $\tilde{\chi}_1^0$ (4 tops in final state + $E_{\mathrm{T}}^{\mathrm{miss}}$), and in the MSUGRA/CMSSM plane with $\tan\beta = 10$; $A_0 = 0$; $\mu > 0$.





Conclusions

- A hunt for SUSY has been presented.
- 4.7fb^{-1} of 7 TeV data analyzed.
- No excess above the Standard Model expectation was observed.
- Limits were set in MSUGRA/CMSSM and a simplified models.
- Search was designed to be generic $\rightarrow$ should cover many other models.
- We look forward to 8 TeV running this year.
- Are there any questions?



Back-Up Slides

0-lepton High Multiplicity Analysis: $t\bar{t}$ Control and Validation Plots