Search for New Physics at $\sqrt{s}$ = 7 TeV in Hadronic Final States with $\not{E}_T$ and Heavy Flavor

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Physics in Collision
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$\tilde{g} \rightarrow \tilde{b} + b, \tilde{b} \rightarrow b + \tilde{\chi}^0$

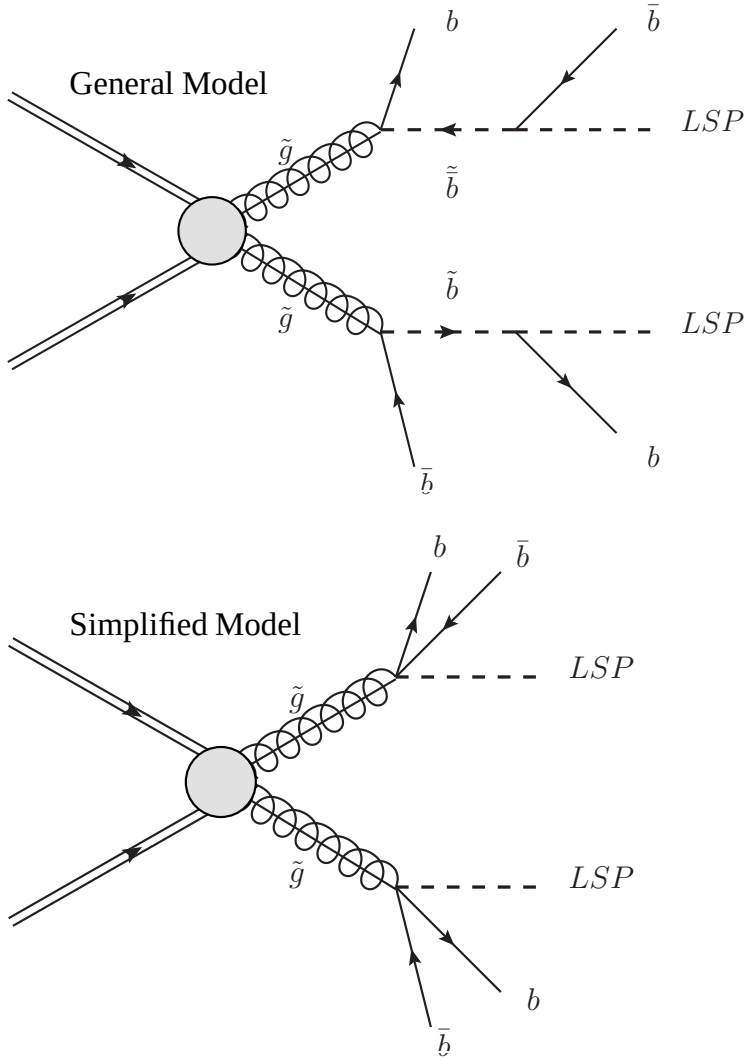
The general SUSY process we are looking for is gluino pair production and subsequent decay via sbottom to 4 b-jets and 2 $\tilde{\chi}^0$ (the LSP), resulting in a 4b + $\not{E}_T$ final state signature. In this phenomenological model, there are 3 parameters: $m_{\tilde{g}}$, $m_{\tilde{b}}$, and $m_{\tilde{\chi}^0}$.

We also explore the following special case:

- $m_{\tilde{b}} >> m_{\tilde{g}} > m_{\tilde{\chi}^0}$

In this limit, the squark mass spectrum is decoupled and the model kinematics are, to first order, determined by a single parameter: $m_{\tilde{g}} - m_{\tilde{\chi}^0}$.

This simplified model is used to optimize the analysis sensitivity **broadly** over the phase space of this topological signature.
Cross-checks are performed to ensure the optimization derived for the simplified case ensures sensitivity in the general case as well.



Optimization Procedure and Signal Regions

Baseline selections on jets and $\not{E}_T$ and lepton vetos were applied for trigger thresholds, QCD rejection, data quality, and signal enhancement. Further signal region optimization was done with the following procedure:

1. Evaluate kinematic variables for signal/background separation power: $\not{E}_T$, H_T, M_{eff} ($\not{E}_T$ +H_T), jet multiplicity, b-tagged jet multiplicity, etc.
2. Choose best variable set, create n-dimensional cut grid
3. Evaluate systematic-corrected significance at each cut grid point for each signal grid point to create a set of "optimal" kinematic cuts
4. Reduce number of selections to a manageable number while ensuring broad sensitivity.

Signal Regions

	$M_{eff} > 500$ GeV	$M_{eff} > 700$ GeV
$\geq$1 b-tag	Region 1	Region 2
$\geq$2 b-tag	Region 3	Region 4

Monte Carlo Background Estimation

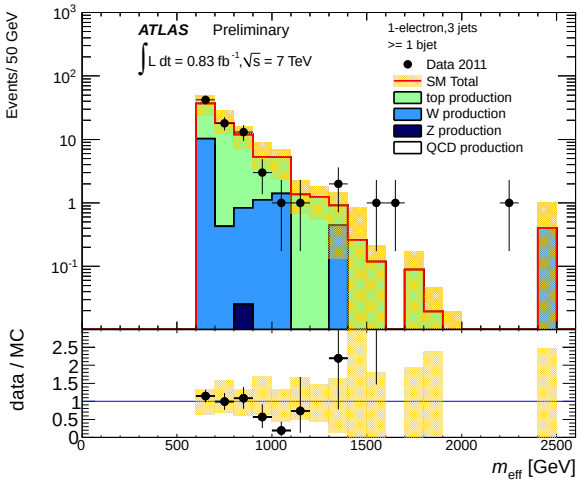
Non-QCD background estimates were taken from Monte Carlo simulation, and in the $t\bar{t}$ case validated using a 1-lepton (e or μ) control region. $t\bar{t}$ makes up the largest background component in all signal regions.

The 1-lepton control region uses the same kinematic cuts as the 0-lepton signal region except that 1 lepton with $p_T > 20$ GeV, $M_{eff} >$ 600 GeV and 40 GeV $< M_T <$ 100 GeV are required.

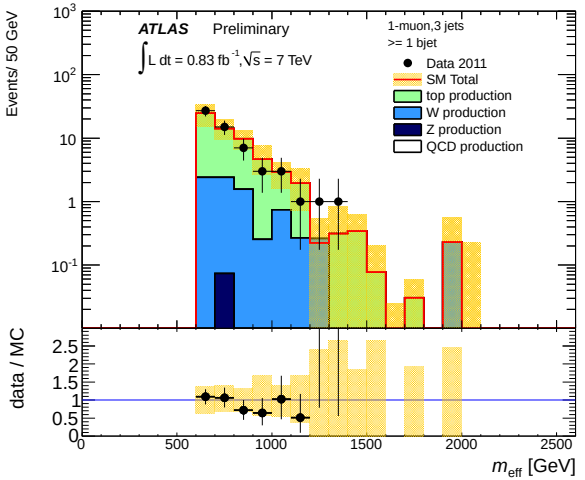
M_T = transverse mass of lepton and $\not{E}_T$

Physics process	$\sigma \cdot$ BR [nb]
$W \rightarrow \ell\nu$ (+jets)	31.4±1.6
$Z/\gamma^* \rightarrow \ell\ell$ (+jets)	3.20±0.16
$Z \rightarrow \nu\nu$ (+jets)	5.82±0.29
$t\bar{t}$	$0.165^{+0.011}_{-0.016}$
Single top	0.085±0.003

1e $t\bar{t}$ estimate validation



1μ $t\bar{t}$ estimate validation



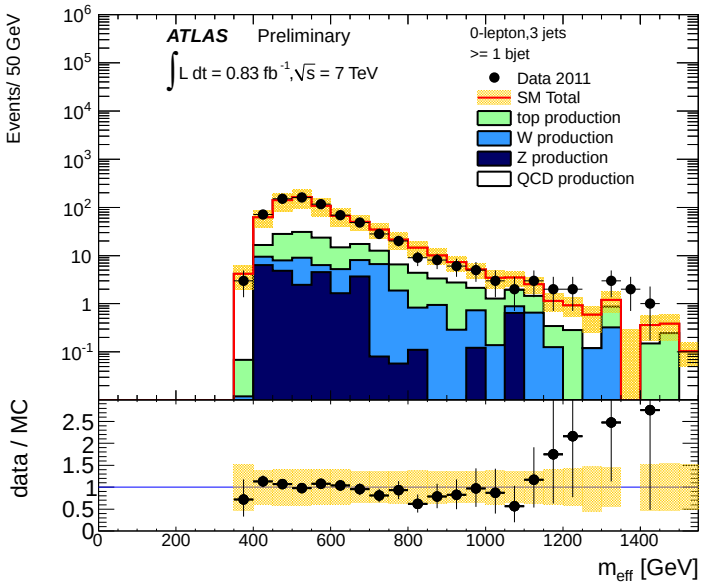
Data-driven QCD Estimation

The QCD background estimate in the signal region was estimated from data, as leading-order Monte Carlo was not sufficient to provide a reliable estimate.

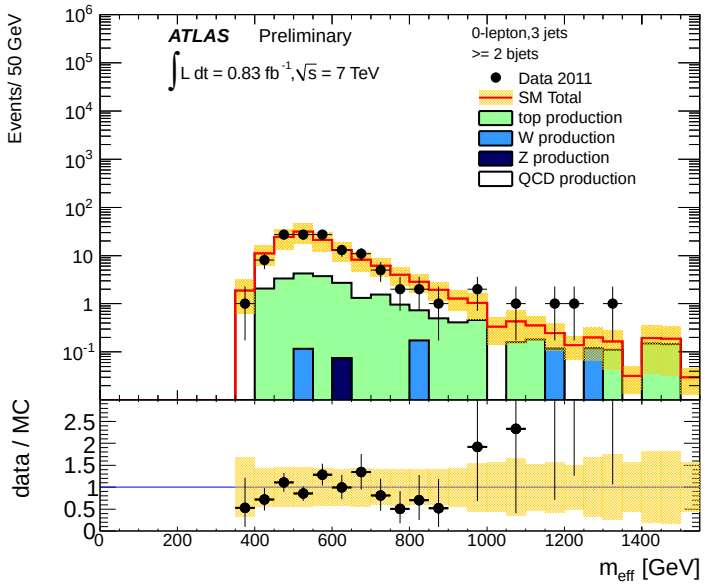
Fundamental Assumption: $\not{E}_T$ in QCD multi-jet background due to mis-measured jets

- Jet momenta in data events with low $\not{E}_T$ significance smeared with a jet response function to generate pseudoevents with large $\not{E}_T$.
- Validated by comparing data and pseudoevent distributions in QCD-enriched ($\Delta\phi(jet, \not{E}_T) < 0.4$) control regions.

$\geq$1 *b*-tags



$\geq$2 *b*-tags

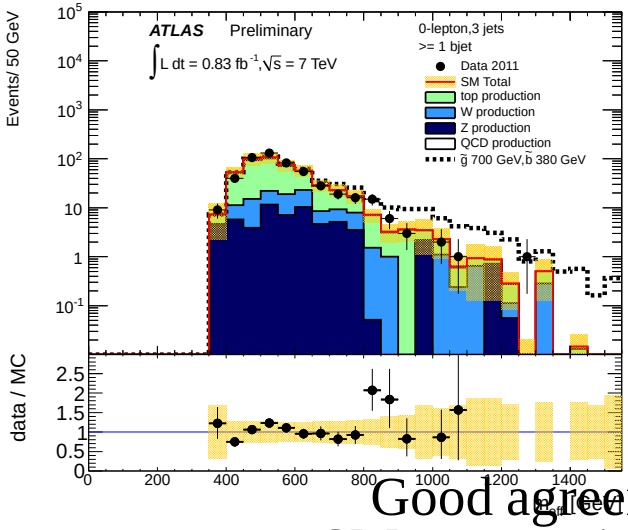


M_{eff} distributions in QCD control regions
QCD estimate derived from data events with smeared jets

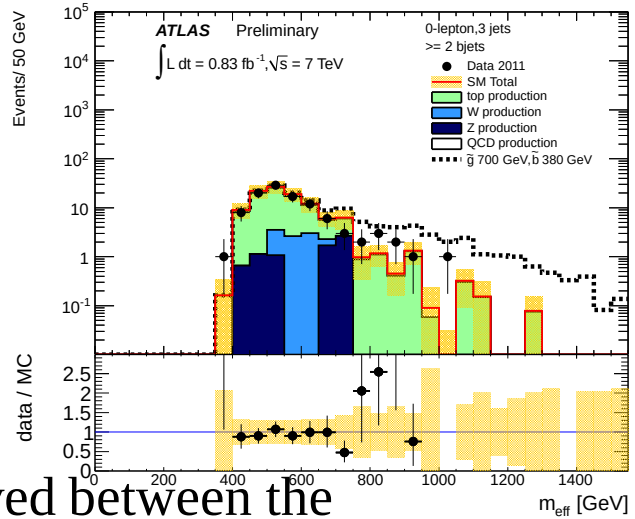
Signal Region Data/Standard Model Comparisons

$\geq$1 *b*-tag

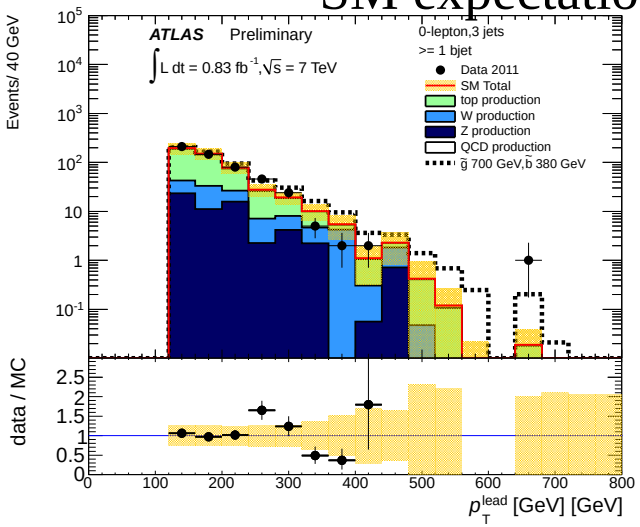
$\geq$2 *b*-tags



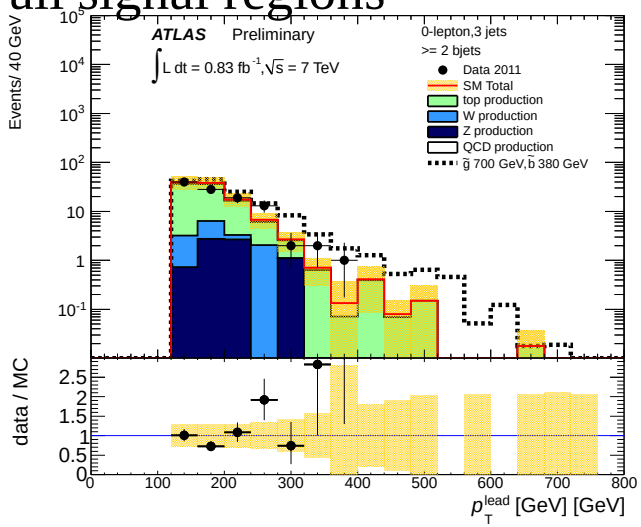
M_{eff}



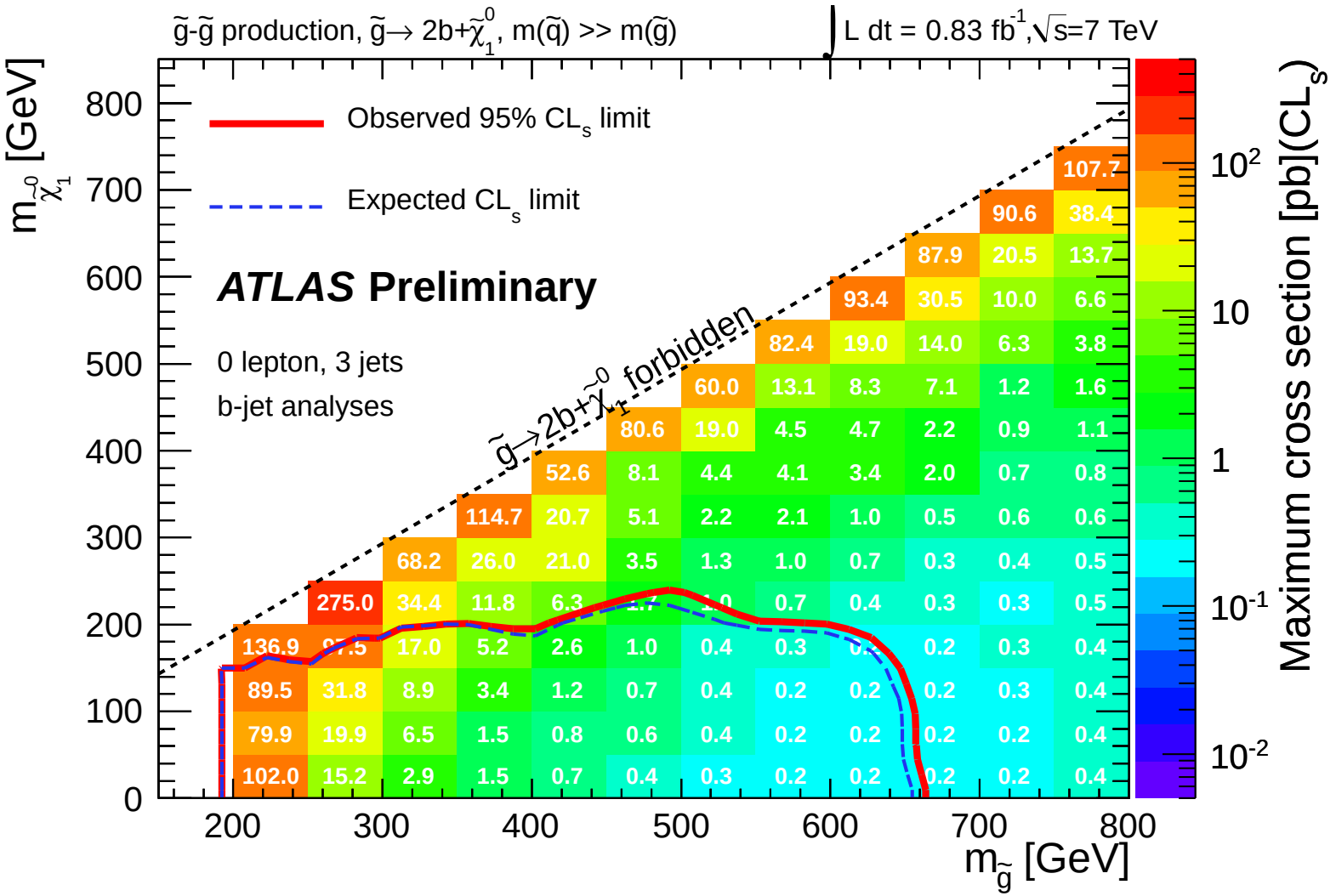
Good agreement is observed between the SM expectation and data for all signal regions



p_T^{lead}



Limits on $\tilde{g} \rightarrow b\bar{b} + \tilde{\chi}^0$ Simplified Models



LSP masses below 200-250 GeV are excluded for gluino masses in the range 200-660 GeV, if $m_{\tilde{g}} - m_{\tilde{\chi}^0} > 100$ GeV