Search for supersymmetry in events with large missing transverse momentum and at least one b-jet candidate in 7 TeV pp collisions with the ATLAS detector [1]
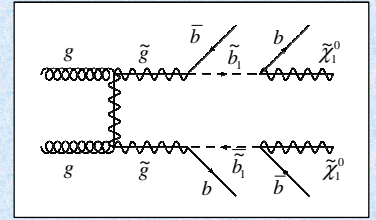
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Introduction

Supersymmetry (SUSY) is one of the most compelling theories to describe physics beyond the Standard Model (SM). In the framework of R-parity conserving minimal extension of the SM (MSSM), SUSY particles are produced in pairs and the lightest supersymmetric particle is stable. Due to the mixing of $\tilde{q}_R$ and $\tilde{q}_L$ and the strong Yukawa coupling, sbottom ($\tilde{b}_1$) and stop ($\tilde{t}_1$) can be lighter than the other squarks. If kinematically allowed, $\tilde{b}_1$ and $\tilde{t}_1$ could be produced via direct pair production or through $\tilde{g}\tilde{g}$ production with subsequent $\tilde{g} \to \tilde{b}_1 b$ or $\tilde{t}_1 t$ decays. This result in complex final states consisting of E_T^{miss}, several jets, among which b-quark jets.

To enhance the sensitivity to SUSY events involving sbottom, isolated leptons (e or μ) are vetoed. We use pp collision data at sqrt(s)=7 TeV recorded by the ATLAS experiment at the LHC in 2010 with the total integrated luminosity of 35 pb^{-1}.

Event Selection

jet : reconstructed from anti-k_t jet clustering algorithm, distance parameter R=0.4, $|\eta| < 2.5$
b-tagged jet : $p_T > 30$ GeV, signed decay length significance with 50% b-tagging efficiency, (light jet rejection : 220)
$\Delta\varphi_{min}$: minimum $\Delta\varphi$ between any of three leading p_T jets and the E_T^{miss}
m_{eff} $= \Sigma_{i \leq 4}(p_T^{jet})_i + E_T^{miss}$

0-lepton ($p_T > 20$ GeV)
jet $p_T >$ 120, 30, 30 GeV
$E_T^{miss} > 100$ GeV
$\geq$ 1 b-tagged jet
$E_T^{miss}/m_{eff} > 0.2$
$\Delta\varphi_{min} > 0.4$ rad
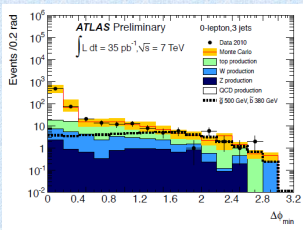$m_{eff} > 600$ GeV

• Higher E_T^{miss} and multi-jet topologies are selected for SUSY signals.
• Large QCD background remaining in 0-lepton channel is removed by E_T^{miss}/m_{eff} and $\Delta\varphi_{min}$ cuts effectively.
• To see enhancement of b-jet final states, at least 1 b-tagged jet is required.
• Finally to maximize sensitivity to SUSY signals, high m_{eff} region is selected.
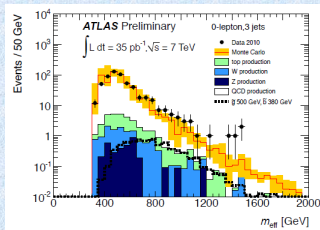
Background Estimation

QCD

Estimated by reversed $\Delta\varphi$ cut control region (CR) from the following equation,

$$N_{QCD, DATA}^{SR} = (N_{DATA}^{CR} - N_{nonQCD, MC}^{CR})F_{MC}\int_{600 GeV}^{\infty} f_{QCD}(m_{eff})dm_{eff}$$

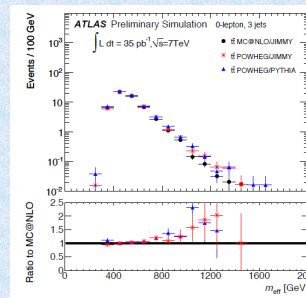$\Delta\varphi_{min}$ distribution without $\Delta\varphi_{min}$ and m_{eff} cuts
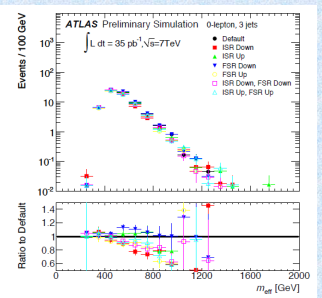

m_{eff} distribution for $\Delta\varphi_{min} < 0.4$ rad region

non-QCD

Estimated from Monte Carlo (MC) simulation.

m_{eff} distribution of tt with MC generators

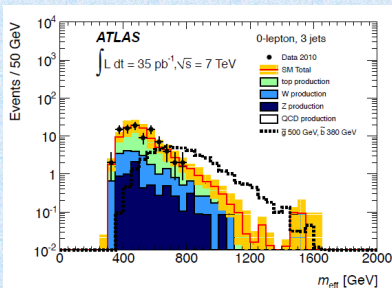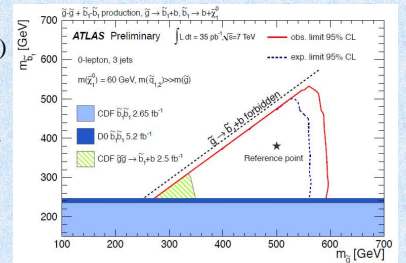m_{eff} distribution of tt with different ISR/FSR parameters

Results

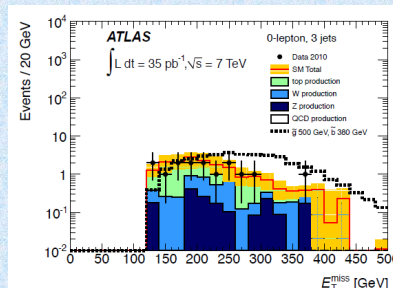|	Number of Events
tt and single top	12.2±5.0
W and Z	6.0±2.6
QCD	1.4±1.0
Total SM	19.6±6.9
Data	15

Conclusion

No excess above the expectations from Standard Model processes was found. The results were used to exclude parameter regions in various R-parity conserving SUSY models.

Observed and expected 95% C.L. exclusion limit in ($m_{\tilde{g}}$, $m_{\tilde{b}}$) plane, for the hypothesis that $\tilde{b}_1$ is produced via $\tilde{g} \to \tilde{b}_1 b$ and decays exclusively $\tilde{b}_1 \to b\tilde{\chi}_1^0$. $\tilde{\chi}_1^0$ is assumed to be 60GeV. **m($\tilde{g}$) < 590 GeV is excluded for m($\tilde{b}_1$) < 530 GeV**

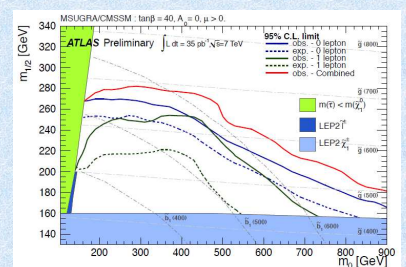m_{eff} distribution without $m_{eff} >$600GeV cut

E_T^{miss} distribution after all selections

Observed and expected 95% C.L. exclusion limit in (m_0, $m_{1/2}$) plane, on MSGURA/CMSSM scenario with tanβ=0, A$_0$=0, μ>0.

Reference

[1] ATLAS Collaboration, arXiv:1103.4344 (2011). Submitted to Phys. Lett. B