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

Takashi Yamanaka on behalf of ATLAS collaboration
Department of Physics
Graduate School of Science, The University of Tokyo
113-0033 Tokyo, JAPAN

1 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 $\tilde{q}_{\mathrm{R}}$ and $\tilde{q}_{\mathrm{L}}$ 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 results in complex final states consisting of $E_{\mathrm{T}}^{\mathrm{miss}}$, 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} [1].

2 Event Selection

Events were required to have at least one jet with $p_{\mathrm{T}} > 120$ GeV, two additional jets with $p_{\mathrm{T}} > 30$ GeV and $E_{\mathrm{T}}^{\mathrm{miss}} > 100$ GeV. At least one jet was required to be identified as b-jet (b-tagged jet) using an algorithm that reconstructs displaced vertex from the primary one and associated with the jet. Events containing identified electron or muon candidates were rejected.

The effective mass, m_{eff}, was used as discriminating observable, and is defined as the scalar sum of $E_{\mathrm{T}}^{\mathrm{miss}}$ and the transverse momentum of the highest p_{T} jets (up to a maximum of four). Events were required to have $E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}} > 0.2$. In addition, the smallest azimuthal separation between the $E_{\mathrm{T}}^{\mathrm{miss}}$ direction and the three leading jets, $\Delta\phi_{\mathrm{min}}$, was required to be larger than 0.4.

Further cut on $m_{\mathrm{eff}} > 600$ GeV was applied to maximize the sensitivity to sbottom production via gluino decay $\tilde{g} \to \tilde{b}_1 b$.

3 Results and Interpretation

The dominant source of SM backgrounds is $t\bar{t}$ production due to the presence of jets, $E_{\mathrm{T}}^{\mathrm{miss}}$ and b-quarks in the final state. The non-QCD backgrounds including $t\bar{t}$ were estimated using Monte Carlo simulation. The total uncertainty on this prediction was estimated to be $\pm 35\%$ after the final selection. It is dominated by the uncertainties on the jet energy scale, the theoretical prediction of $t\bar{t}$ and determination of b-tagging efficiency.

The QCD background was estimated by normalizing the PYTHIA Monte Carlo prediction to data in QCD-enriched control region defined by $\Delta\phi_{\mathrm{min}} < 0.4$. The Monte Carlo was then used to evaluated the ratio between the number of events in this control region and the signal region ($\Delta\phi_{\mathrm{min}} > 0.4$).

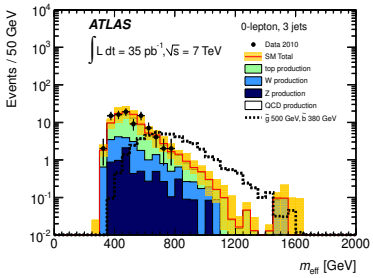

Figure 1: Distribution of the effective mass

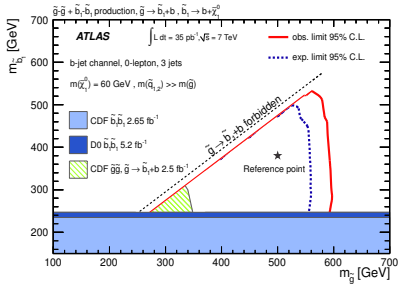

Figure 2: Observed and expected 95% CL exclusion limits in the $(m_{\tilde{g}}, m_{\tilde{b}_1})$ plane.

The predicted number of events for $t\bar{t}$ and single top was 12.2 ± 5.0, for W and Z was 6.0 ± 2.0, for QCD was 1.4 ± 1.0 and for SM total was 19.6 ± 6.9. The observed number of events was 15. In Figure 1, the distribution of m_{eff} after the application of all cuts, except for the m_{eff} cut, is shown.

The data are in agreement with the Standard Model predictions within uncertainties and no excess was found. The results were used to exclude parameter regions in several R-parity conserving SUSY models. In particular, for the hypothesis that the lightest squark $\tilde{b}_1$ is produced via gluino-mediated or direct pair production and decays exclusively via $\tilde{b}_1 \to b\chi_1^0$, gluino masses below 590 GeV are excluded for sbottom masses up to 500 GeV with 95% CL as shown in Figure 2.

References

[1] ATLAS Collaboration, Phys. Lett. B 701 (2011) 398, arXiv:1103.4344 (2011).