PROCEEDINGS OF SCIENCE

Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS experiment in 20.3 fb^{-1} of $\sqrt{s}$=8 TeV proton-proton collisions

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This proceeding presents a search for squarks and gluinos in final states containing jets, missing transverse momentum and no electrons or muons with high transverse momentum. The data were recorded in 2012 by the ATLAS experiment in $\sqrt{s}$=8 TeV proton-proton collisions at the Large Hadron Collider, and corresponds to a total luminosity of 20.3 fb^{-1}. No significant excess above the Standard Model expectation is observed. Results are interpreted by setting limits on complex supersymmetric models like mSUGRA/CMSSM and on phenomenological supersymmetric models with a simplified mass spectrum.

The European Physical Society Conference on High Energy Physics -EPS-HEP2013
18-24 July 2013,
Stockholm, Sweden

PoS(EPS-HEP 2013)051

1. Introduction and Motivation

In supersymmetric (SUSY) theories where R-parity conservation is assumed, squarks and gluinos decay in cascades, producing standard model particles and lighter SUSY particles, until the lightest supersymmetric particle (LSP) is produced. The LSP is stable and weakly interacting and is expected to leave the detector without interaction, producing a signature of missing transverse momentum ($E_{\mathrm{T}}^{\mathrm{miss}}$). This proceeding presents some of the most recent results in the search for squarks and gluinos. The search is made in final states with jets and missing transverse momentum without any isolated electrons or muons with high transverse momentum (p_T), using 20.3 fb^{-1} of data collected by the ATLAS detector in proton-proton collision at 8 TeV at the LHC [1].

2. Event Selection and Background Determination

Requirement	Channel									
	A (2-jets)		B (3-jets)		C (4-jets)		D (5-jets)	E (6-jets)		
	L	M	M	T	M	T	–	L	M	T
$E_{\mathrm{T}}^{\mathrm{miss}}$[GeV] >	160									
$p_T(j_1)$ [GeV] >	130									
$p_T(j_{2-6})$ [GeV] >	60 for each additional jet, according to the channel jet multiplicity									
$\Delta\phi(\mathrm{jet}_i, \mathbf{E}_{\mathrm{T}}^{\mathrm{miss}})_{\mathrm{min}}$ >	0.4 ($i = \{1,2,(3\,\mathrm{if}\,p_T(j_3) > 40\,\mathrm{GeV})\}$)				0.4 ($i = \{1,2,3\}$), 0.2 ($p_T > 40$ GeV jets)					
$E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}}(n_j)$ >	0.2	[a]	0.3	0.4	0.25	0.25	0.2	0.15	0.2	0.25
m_{eff}(incl.) [GeV] >	1000	1600	1800	2200	1200	2200	1600	1000	1200	1500

(a) For SR A-medium the requirement is $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}} > 15$ GeV$^{1/2}$, where $H_T = m_{\mathrm{eff}}(n_j) - E_{\mathrm{T}}^{\mathrm{miss}}$

Table 1: Selection criteria used to define channels in the analysis. Each channel is divided into up to three signal regions on the basis of the requirements listed in the bottom two rows. The signal regions in the third row indicate the 'loose' (L), 'medium' (M) and 'tight' (T) cut on m_{eff}(incl.).

The analysis consists of 5 channels defined according to the inclusive jet multiplicity, from 2 up to 6 jets, respectively labeled A to E. The event selection is based on a $jet + E_{\mathrm{T}}^{\mathrm{miss}}$ trigger which is fully efficient in events with at least one jet with a transverse momentum (p_T) above 160 GeV and $E_{\mathrm{T}}^{\mathrm{miss}}$ above 130 GeV. The complete event selection is shown in Table 1. In addition, an event has to contain at least n-jets with p_T larger then 60 GeV in order to enter the n-jet selection. A cut on the angular separation between jets and the missing transverse momentum is subsequently applied in order to reject multi-jet events where the $E_{\mathrm{T}}^{\mathrm{miss}}$ comes from miss-measurement of a jet energy. The final selection that defines the separation between the signal regions consists of 2 cuts. The first cut is on the ratio between the $E_{\mathrm{T}}^{\mathrm{miss}}$ and the *effective mass* (m_{eff}), defined as the scalar sum of the p_T of the leading n-jets in the n-jet channel and $E_{\mathrm{T}}^{\mathrm{miss}}$. The second cut is applied on a modified version of the effective mass, which to the contrary of the previous definition, uses all jets with a transverse momentum above 40 GeV.

After this selection the main background processes from the standard model are: $Z + jets$ where Z decays into neutrinos, $W + jets$ where the lepton is faking a jet and $t\bar{t} + jets$. All these backgrounds are estimated using semi-data driven methods, with the exception of the multi-jet

background which is less then 1% of the total background and is taken from data. Other minor backgrounds are estimated directly from the Monte Carlo simulation.

3. Results and Interpretation

For each signal region the number of SM events is estimated using a likelihood fit . No statistically significant excess is observed in any of the signal regions. The results are interpreted by setting limits on the parameter space of a number SUSY models. For each signal point the signal region (SR) with the best expected sensitivity is used. The 95 % CL exclusion regions are derived using a log-likelihood ratio test in the combination with the CLs prescription.

Observed 95% CL exclusion limits for a simplified set of phenomenological MSSM (Minimal Supersymmetric extension of the SM), using strong production of $\tilde{g}$ and first- and second-generation $\tilde{q}$ with direct decays into lightest $\tilde{\chi}_1^0$, are presented in the Figure 1. The results are also interpreted also in 2 sets of simplified models where a pair of gluinos or a pair or squarks is produced. In the first set they decay directly into quark and the lightest neutralino ($\tilde{\chi}_1^0$), while in the second set they first decay into quark and $\tilde{\chi}_1^\pm$ and the chargino decays producing a $W^\pm$ and $\tilde{\chi}_1^0$.

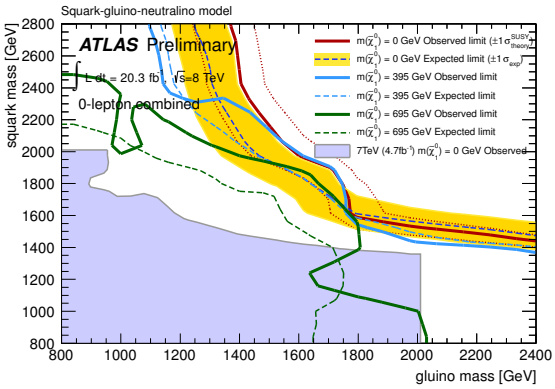

Figure 1: Combined exclusion limits for a simplified phenomenological MSSM scenario. Three values of the lightest neutralino mass are considered: $m_{\tilde{\chi}_1^0} = 0$, 395 and 695 GeV. Exclusion limits are obtained by using the signal region with the best expected sensitivity at each point. The dashed lines show the expected limits at 95% CL, with the light (yellow) band indicating the 1σ experimental and background-theory uncertainties on the $m_{\tilde{\chi}_1^0} = 0$ limit. Observed limits are indicated by solid curves. Previous results for $m_{\tilde{\chi}_1^0} = 0$ from ATLAS at 7 TeV [2] are represented by the shaded (light blue) area.

4. Conclusion

The search for new physics with a dataset of 20.3 fb^{-1} collected by the ATLAS detector in the year 2012, using final states with large missing transverse momentum, high-p$_t$ jets, and no electrons or muons is presented. Good agreement between the number of events in the data and the number predicted by the standard model has been observed. No significant excess of data in any of the signal regions has been observed and results were interpreted in a number of SUSY models.

References

[1] *Search for squarks and gluinos with the ATLAS detector in final states with jets and missing transverse momentum and 20.3 fb^{-1} of $\sqrt{s} = 8$ TeV proton-proton collision data*, Tech. Rep. ATLAS-CONF-2013-047, CERN, Geneva, May, 2013. http://cds.cern.ch/record/1547563.

[2] ATLAS Collaboration, *Search for squarks and gluinos with the ATLAS detector in final states with jets and missing transverse momentum using 4.7 fb^{-1} of $\sqrt{s} = 7$ TeV proton-proton collision data*, Phys.Rev. **D87** (2013) 012008, arXiv:1208.0949 [hep-ex].