

LHCC Poster Session - CERN, 13 March 2013

SUSY search with two same-sign leptons and jets with the ATLAS detector using 21 fb⁻¹ of pp collisions at 8TeV

Abstract

A search for the production of supersymmetric particles decaying into final states with jets, b-jets, missing transverse momentum and two isolated leptons, e or μ , with the same electric charge (same-sign leptons) is presented. The analysis uses a data sample collected during 2012, which corresponds to a total integrated luminosity of 20.7 fb⁻¹ of $\sqrt{s} = 8$ TeV proton-proton collisions recorded with the ATLAS detector at the Large Hadron Collider. No deviation from the Standard Model expectation is observed. Exclusion limits are derived for a mSUGRA/CMSSM model, for which the parameters are chosen in such a way that the Higgs mass is compatible with the recent discovery of a Higgs-like particle at the LHC, and for a wide variety of simplified models of supersymmetry. The result significantly extends previous exclusion limits from several searches for Supersymmetry.

Introduction

Focus on strong production: look at squark / gluino decays with two same-sign leptons in the final state.

Motivation:

- gluinos are Majorana fermions : allows for same-sign lepton pair production.
- ≥ 3 leptons can occur during cascade decays.
- Standard Model background is very low.

Event selection:

- E_T^{miss} only triggers if $E_T^{\text{miss}} > 150$ GeV, single lepton triggers if leading lepton $p_T > 40$ GeV (muons) or $p_T > 70$ GeV (electrons) and dilepton triggers otherwise.
- Jets with $p_T > 25$ GeV and $|\eta| < 2.8$; if b-tagging is required the threshold p_T is lowered to 20 GeV.
- Signal leptons: isolated electrons with $p_T > 20$ GeV and $|\eta| < 2.47$ must satisfy the "tight++" selection criteria; isolated muons with $p_T > 20$ GeV and $|\eta| < 2.4$.

Standard Model background

Three event categories can be considered, depending on number of b-jets identified in the final state: 0, ≥ 1 , ≥ 3 b-jets.

Irreducible:

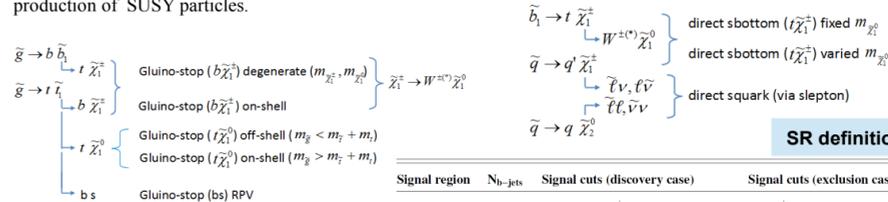
- signal regions with at least one b-jets : $t\bar{t}$ production with a vector boson, W or Z, decaying leptonically.
- signal region with a b-jet veto: diboson production (WZ / ZZ plus jets).
- these backgrounds are estimated from Monte-Carlo simulations.

Reducible:

- can be divided in charge mis-measurement, fake leptons.
- with the requirements imposed in the signal regions the only significant contribution is from $t\bar{t}$.
- **charge mis-measurement** → the probability of one electron to have a wrong charge.
- **fake leptons** stem from the weak b-hadron decay.
- these background are estimated using fully data-driven methods.

SUSY models

The results are interpreted in minimal supergravity (mSUGRA/CMSSM) and simplified models with strong pair production of SUSY particles.



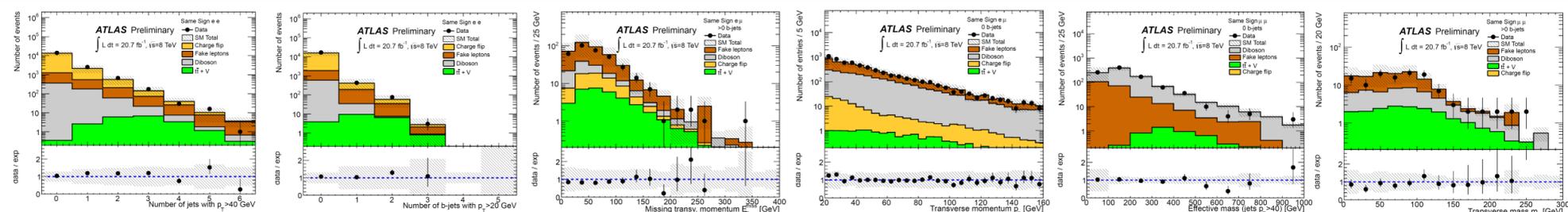
SR definitions

Signal region	N _{b-jets}	Signal cuts (discovery case)	Signal cuts (exclusion case)
SR0b	0	$N_{\text{jets}} \geq 3, E_T^{\text{miss}} > 150$ GeV $m_T > 100$ GeV, $m_{\text{eff}} > 400$ GeV	$N_{\text{jets}} \geq 3, E_T^{\text{miss}} > 150$ GeV, $m_T > 100$ GeV, binned shape fit in m_{eff}
SR1b	≥ 1	$N_{\text{jets}} \geq 3, E_T^{\text{miss}} > 150$ GeV $m_T > 100$ GeV, $m_{\text{eff}} > 700$ GeV	$N_{\text{jets}} \geq 3, E_T^{\text{miss}} > 150$ GeV, $m_T > 100$ GeV, binned shape fit in m_{eff}
SR3b	≥ 3	$N_{\text{jets}} \geq 4$	$N_{\text{jets}} \geq 5$, ($E_T^{\text{miss}} < 150$ GeV or $m_T < 100$ GeV)

Validation regions

Event classes	VR-diboson	VR-ttW	VR-ttZ
Observed events	54	9	4
Expected background events	74 ± 13	4.2 ± 1.9	8.0 ± 2.0
Expected tt+V events	1.6 ± 0.8	2.7 ± 1.5	3.2 ± 1.1
Expected diboson events	60 ± 7	0.4 ± 0.1	3.9 ± 1.3
Expected fake lepton events	12 ± 11	1.1 ± 1.1	0.9 ± 0.5
Expected charge mis-meas. events	0	0	0

Data and expected background comparison



Background estimates are checked in e-e, e- μ and μ - μ channels, for several discriminating variables: good agreement, within estimated systematic uncertainty, is obtained.

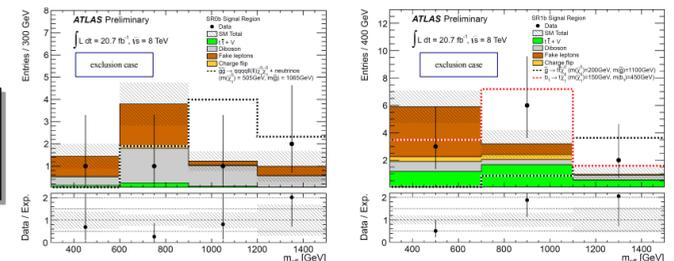
Results

Number of observed events and expected background events in the three signal regions for the discovery case.

A) Discovery case	SR0b	SR1b	SR3b
Observed events	5	8	4
Expected background events	7.5 ± 3.3	3.7 ± 1.6	3.1 ± 1.6
Expected tt+V events	0.5 ± 0.4	2.2 ± 1.0	1.7 ± 0.8
Expected diboson events	3.4 ± 1.0	0.7 ± 0.4	0.1 ± 0.1
Expected fake lepton events	3.4 ± 3.1	0.3 ^{+1.1} _{-0.3}	0.9 ^{+1.4} _{-0.9}
Expected charge mis-measurement events	0.1 ± 0.1	0.5 ± 0.2	0.4 ± 0.1
p_0	0.50	0.11	0.36

Dominant source of systematic uncertainty:

- **SR0b**: systematic uncertainty on fake rate, JES, b-tagging identification
- **SR1b**: JES, systematic uncertainty on fake rate, ttV cross-section
- **SR3b**: systematic uncertainty on fake rate, ttV cross-section



Interpretations, model-dependent limits

