



ATLAS Early SUSY Searches with Photons and Missing Transverse Energy

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On behalf of ATLAS collaboration

SUSY2010, 23rd-28th, Aug 2010 Bonn, Germany

Outline

- Introduction
- Results from Monte Carlo study
- Early data works
- Conclusions

SUSY Scenarios Giving $\gamma + E_{T}^{miss}$





- GMSB model when $\tilde{\chi_1^0}$ is NLSP and \tilde{G} is LSP $\tilde{\chi_1^0} \rightarrow \tilde{G}_{\gamma}$
- Various topologies can be used to search SUSY:

 $\gamma\gamma + E_T^{\text{miss}}, \gamma(\gamma) + \text{lepton(s)} + E_T^{\text{miss}}, \gamma + Z(\rightarrow II) + E_T^{\text{miss}}, \gamma(\gamma) + \text{jets} + E_T^{\text{miss}}$

- Non-pointing photon study: $\tilde{\chi_1^0}$ lifetime measurement

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Monte Carlo Study Signal examples(14TeV):

name	NLO (LO) σ [pb]	Λ [TeV]	M_m [TeV]	C_G	<i>c</i> τ [mm]	$M_{\tilde{\chi}_1^0}$ [GeV]
GMSB1	(7.8 (5.1))	90	500	1.0	1.1	118.8
GMSB2	7.8 (5.1)	90	500	30.0	$9.5 \cdot 10^{2}$	118.8
GMSB3	7.8 (5.1)	90	500	55.0	$3.2 \cdot 10^{3}$	118.8

Backgrounds: QCD jets, W/Z+jets and ttbar

Typical SUSY cuts:

- 1. At least 4 jets must be found with $p_T > 50 \text{GeV}(p_T > 100 \text{GeV} \text{ for the leading jet})$
- 2. Missing transverse energy $E_{T}^{miss} > 100 \text{GeV}$ and $E_{T}^{miss} > 20\% \text{*}M_{eff}$



Different topologies

$\gamma\gamma$ +jets+ E_{T}^{miss} final state have the largest discovery significance

 N_{ossF} : Number of opposite sign same flavor lepton pairs Sig: signal significance. Sig=S/ \sqrt{B}



Numbers for 1fb⁻¹14TeV

Nγ	N _{OSSF}	Signal	\sum Background	Sig	N _W	N _Z	N _{tī}
0	0	1287.4	929.6	42.3	274.4	21.0	632.8
0	1	283.6	73.0	33.2	8.7	1.4	63.0
1	0	902.9	51.7	126.1	19.5	2.0	30.1
1	1	189.1	1.4	161.4	0.2	0.0	1.2
2	0	252.9	0.1	252.9	0.0	0.0	0.1
2	1	37.0	0.0	37.0	0.0	0.0	0.0

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ATLAS Discovery Reach

 5σ discovery potential contour lines for GMSB SUSY in the Λ -tan β plane for different integrated luminosity(14TeV) with $\gamma\gamma$ +jets+ E_{T}^{miss} final state



Tevatron Limits for $\gamma\gamma + E_{T}^{miss}$



> $M = \Lambda/2$, $tan\beta = 15$, $N_5 = 1$, $sign(\mu) = +, C_{grav} = 1$

Only one free parameter: $\boldsymbol{\Lambda}$

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Non pointing photon

GMSB3 point

C_{grav}=55, the NLSP decay length 3m

Only 12.4%(0.6%) of the reconstructed events contain one(two) photons with p_T>20GeV in the detector acceptance region



Numbers for 1fb⁻¹14TeV

Nγ	N _{OSSF}	Signal	\sum Background	Sig	N _W	NZ	N _{tī}
0	0	825.2	929.6	27.1	274.4	21.0	632.8
0	1	265.2	73.0	33.2	8.7	1.4	63.0
1	0	255.8	51.7	35.7	19.5	2.0	30.1
1	1	68.6	1.4	58.6	0.2	0.0	1.2
2	0	12.5	0.1	12.5	0.0	0.0	0.1
2	1	4.7	0.0	4.7	0.0	0.0	0.0

Two methods to measure the lifetime of neutralino 1)projected impact-parameter method

1)projected impact-parameter method

2)Calorimeter timing method

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ATLAS Detector



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Calorimeter



γ Reconstruction & Identification

Reconstruction:

- Seeded by energy cluster
- Track match
 - Without match->photon
 - Matched to track(s) from conversion vertex

->converted photon (~50% of p_T >15GeV photons are converted photons)

Identification:

Cut on shower shape variables

Shower shape variable is powerful to reject $\pi_0 \rightarrow \gamma \gamma$ background

Middle Layer Shower Shape

Strips shower shape

$$E_{ratio} = \frac{E_{max1} - E_{max2}}{E_{max1} + E_{max2}}$$

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$\boldsymbol{\gamma}$ Isolation

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γ Performance

^Dhoton efficiency >80% identification efficiency for p₇>30GeV 0.8 tight photon from 0.6 simulation 0.4 **ATLAS** Preliminary △ Loose 0.2 Simulation trigger efficiency Tight All γ 20 60 80 0 30 40 50 70 90 L1 calorimeter 0.8 E^{true} [GeV] trigger with a 5GeV threshold 0.6 >(99.70±0.04)% trigger **ATLAS** Preliminary 0.4 $\sqrt{s} = 7 \text{ TeV}, \text{ Ldt} = 15.8 \text{ nb}^{-1}$ efficiency for p_{τ} >10GeV Data 2010 tight photon 0.2 Minimum Bias MC 8 10 12 16 18 20 6 14 E^{cluster}_T [GeV] 08/19/10 Dongliang Zhang--SUSY10 15

Photon Purity Estimation

 Correction factors for both assumptions are estimated from MC and applied to the equation in final calculation

 $->(72\pm7)\%$ purity for isolated tight photon with $p_T>20GeV$

 Reverse Isolation cut and cuts on shower shape variables to select 3 background enriched samples

- Assuming:
 - No correlation between Isolation variable and these shower shape variables
 - No signal leak into control regions

E_{τ}^{miss} Performance

E_x^{miss}, E_y^{miss} resolution as function of Sum E_τ

Good agreement between data and Monte Carlo

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Conclusions

- Various topologies based on high p_{τ} isolated $\gamma(s)$ and large $E_{\tau}^{\rm miss}$ are predicted in GMSB SUSY Models
- Monte Carlo study shows the large discovery significance
- ATLAS photon reconstruction and identification perform well

More than 1.5pb⁻¹ data has been collected and is under analysis now Dongliang Zhang--SUSY10 18

Backup

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Prompt Photon Selection

Event selection

- L1_EM5 trigger
- ≥ 1 vertex with at least 3 tracks
- ≻ E_T>10GeV
- > |η|<1.37, 1.52<|η|<2.37</p>
- Non-overlap with non-working cells

