

# 1

The search for new physics beyond the Standard Model (SM) is one of the most important goals in the scientific programme of the ATLAS experiment. Among the many candidate extensions of the Standard Model, Supersymmetry (SUSY) is one of the best motivated and studied theories; and many SUSY models predict the production of supersymmetric particles at LHC energy range.

In SUSY models with R-parity conservation, or Universal Extra Dimensions (UED) with K-parity conservation, new particles are produced by pair, mainly via  $gg \rightarrow g\tilde{g}$ ,  $qq \rightarrow q\tilde{q}$  or  $gq \rightarrow g\tilde{q}$  processes; final states contain the LSP (Lightest Supersymmetric Particle, for SUSY) or the LKP (Lightest Kaluza-Klein Particle for UED), which is stable and cannot be caught by the detector. Thus we look for final states containing electrons, muons, jets and missing transverse energy (MET).

The ATLAS SUSY Working Group is studying the reach possibility of different models, looking for an excess from the SM in different channels with 2, 3 or 4 jets, and 0, 1 or 2 leptons.

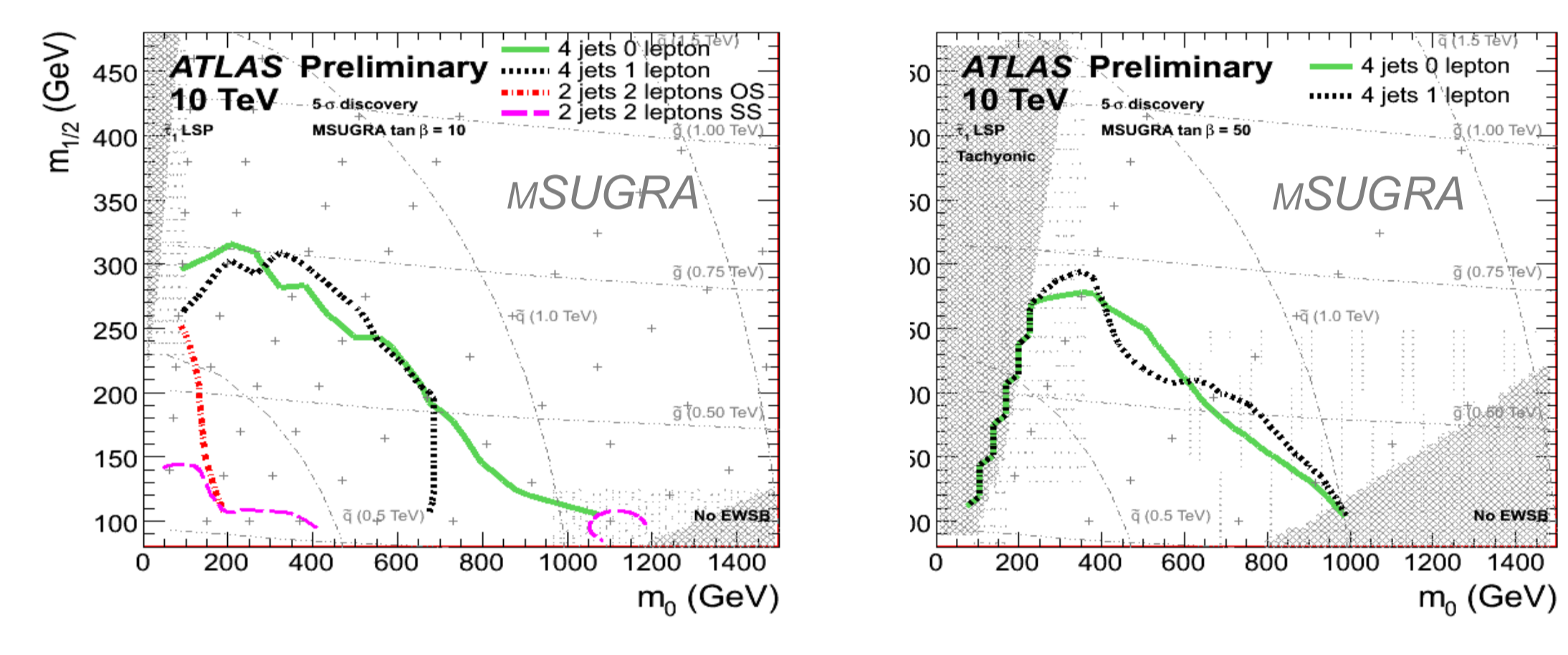
Recent studies focused on a center of mass energy of  $\sqrt{s} = 10$  TeV, and a luminosity of  $200 \text{ pb}^{-1}$ .

**Physics Models:** In order to define search strategies and to cover as many scenarios as possible, within the ATLAS SUSY Working Group analyses are developed scanning the parameter space of three models:

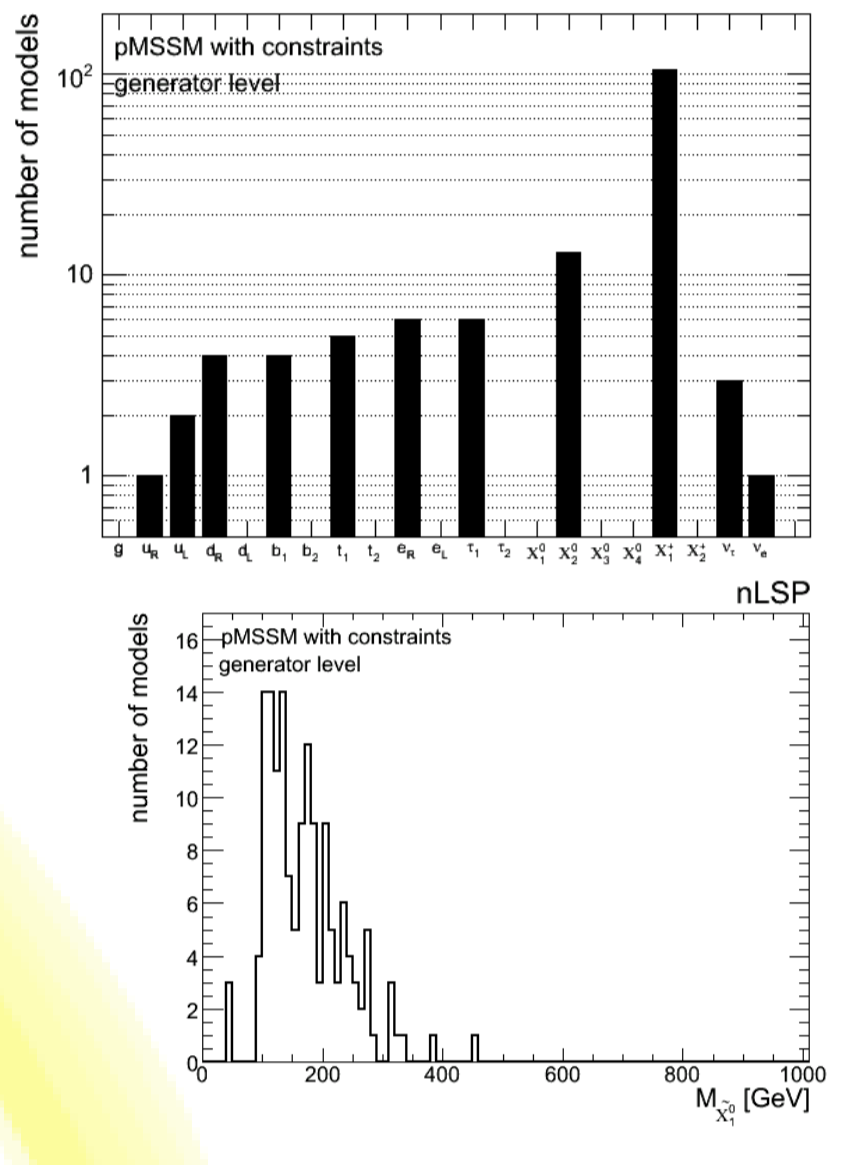
model	Characteristics
pMSSM	<ul style="list-style-type: none"> <li>the model presents 19 free SUSY parameters, sampled with SUSY particle mass scale <math>&lt; 1</math> TeV, and within theoretical bound</li> <li>selected 150 points which satisfy previous experimental bounds (Tevatron, LEP, WMAP, ...)</li> <li>cross section: <math>0.4 &lt; \sigma &lt; 400 \text{ pb}</math></li> <li>[Ref: Berger, Gainer, Hewett, Rizzo; JHEP 02 (2009) 023]</li> </ul>
mSUGRA	<ul style="list-style-type: none"> <li>5 dimension parameter space</li> <li>points are produced along radial lines in <math>(m_0, m_{1/2})</math> plane for <math>\tan \beta = 10, 50</math> with <math>A_0 = 0, \mu &gt; 0, m_{\text{top}} = 172.5 \text{ GeV}</math></li> <li>cross section: <math>0.1 &lt; \sigma &lt; 2900 \text{ pb}</math></li> </ul>
UED	<ul style="list-style-type: none"> <li>4+1 dimensions</li> <li>mass splitting in Kaluza-Klein excitation spectrum</li> <li>determined by <math>\Lambda \cdot R = 20</math></li> <li>produced points: <math>1/R = 300, 400, 500, 600, 700, 800, 900, 1000 \text{ GeV}</math></li> <li>cross section: <math>1.0 &lt; \sigma &lt; 1800 \text{ pb}</math></li> </ul>

# 2

# 5

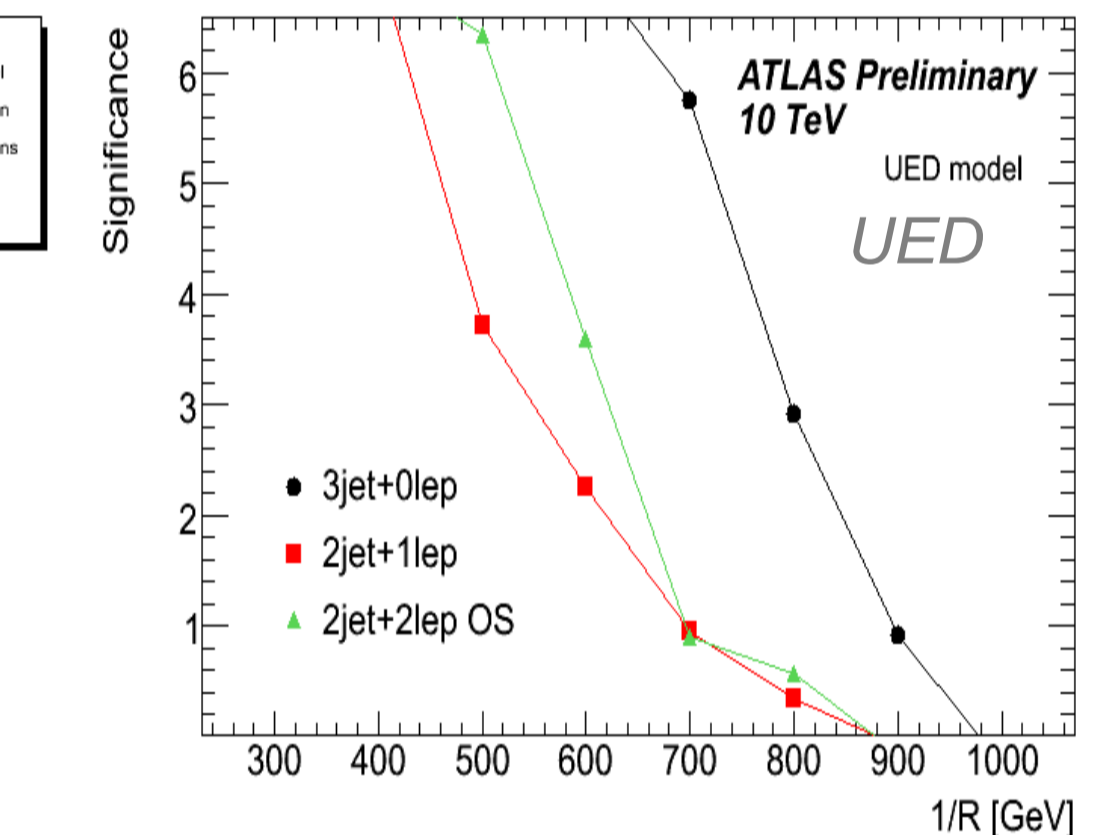
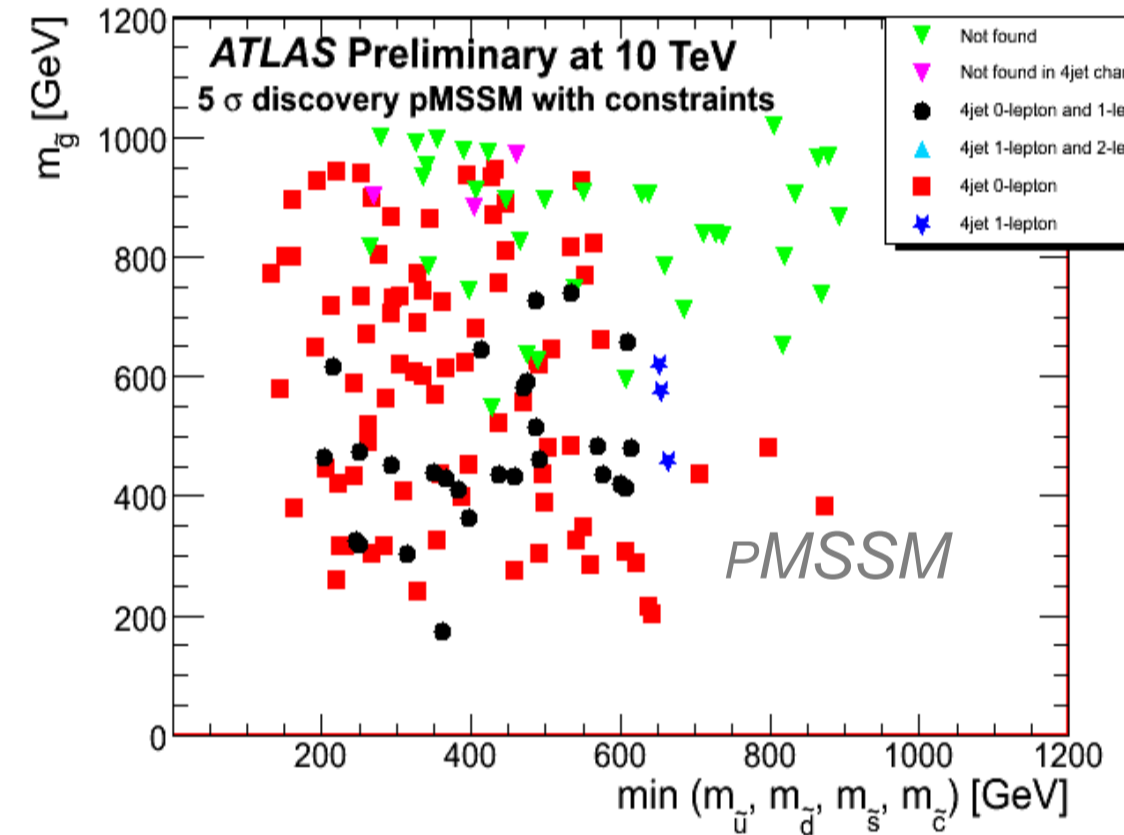
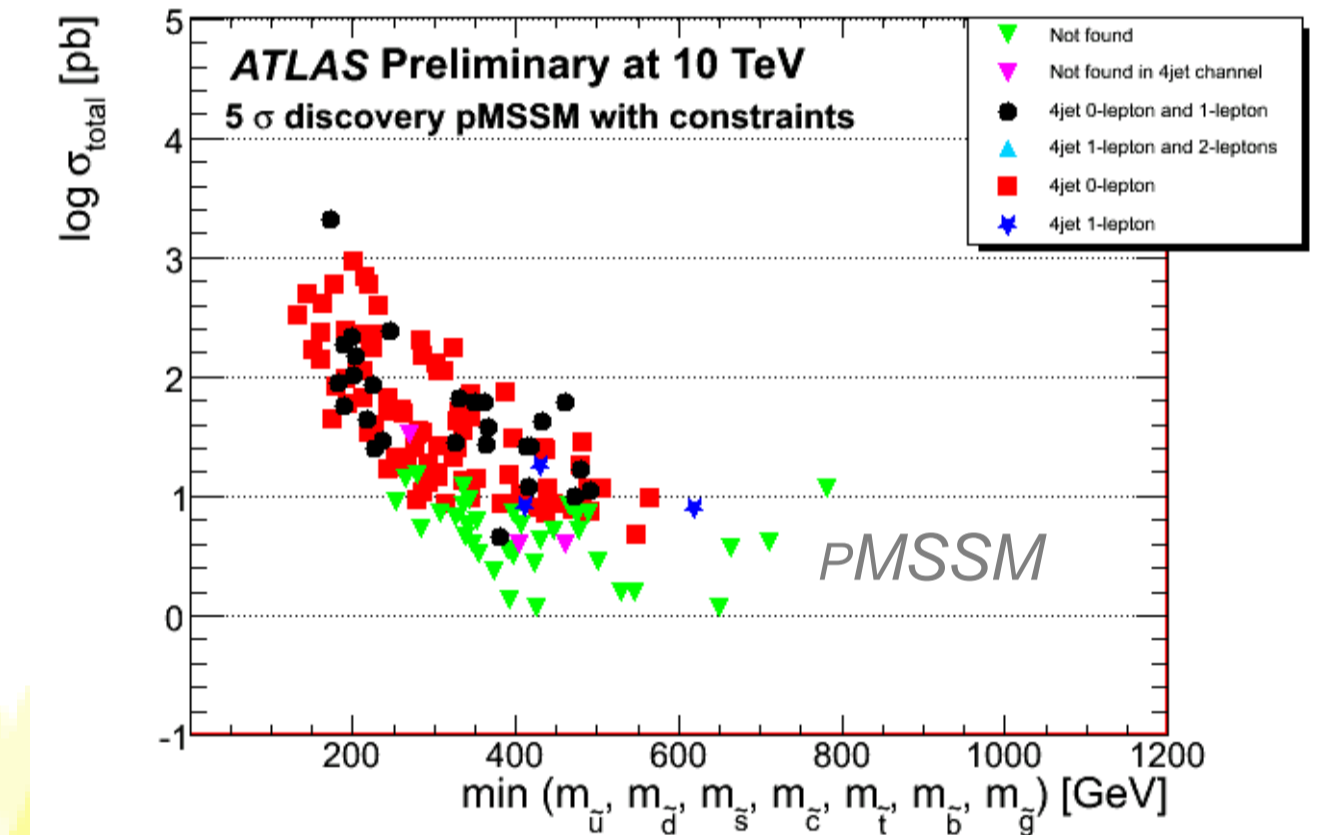


Repartition of pMSSM generated models



**Cut Optimization:** searched the optimal  $M_{\text{eff}}$  cut, in steps of 400 GeV, in order to maximize the significance.

The significance was calculated using a convolution of a Poisson and a Gaussian term to account for a systematic error of 50%.



# 4

## ANALYSES AND BACKGROUND:

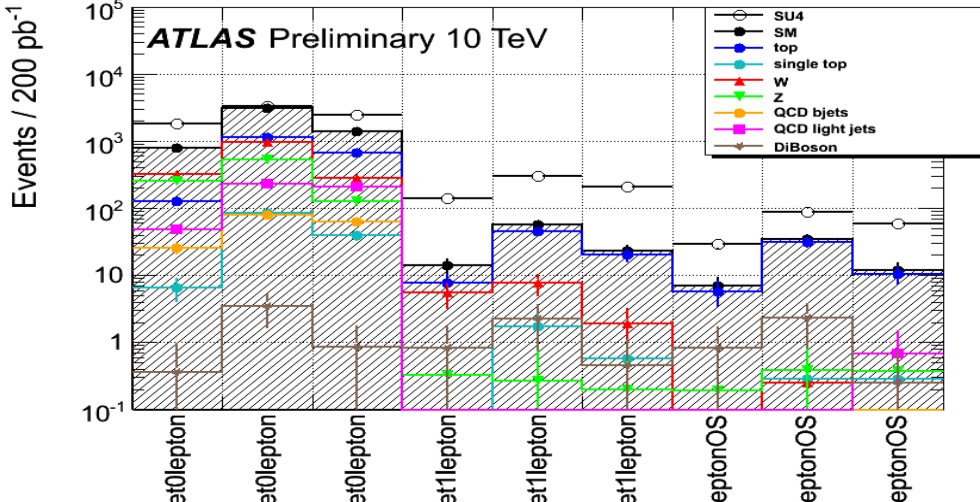
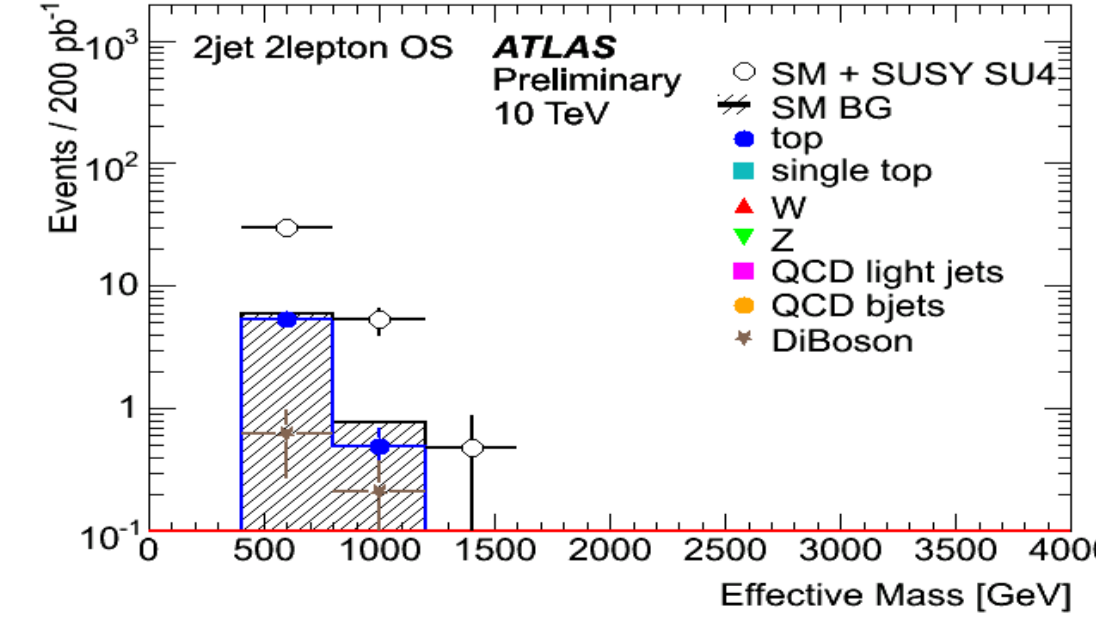
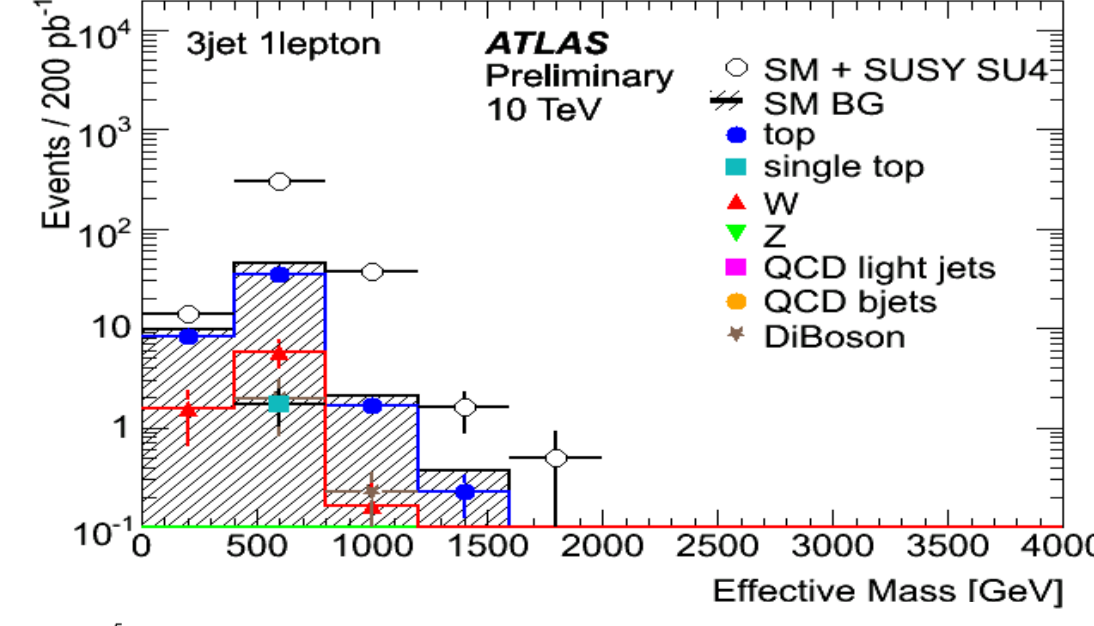
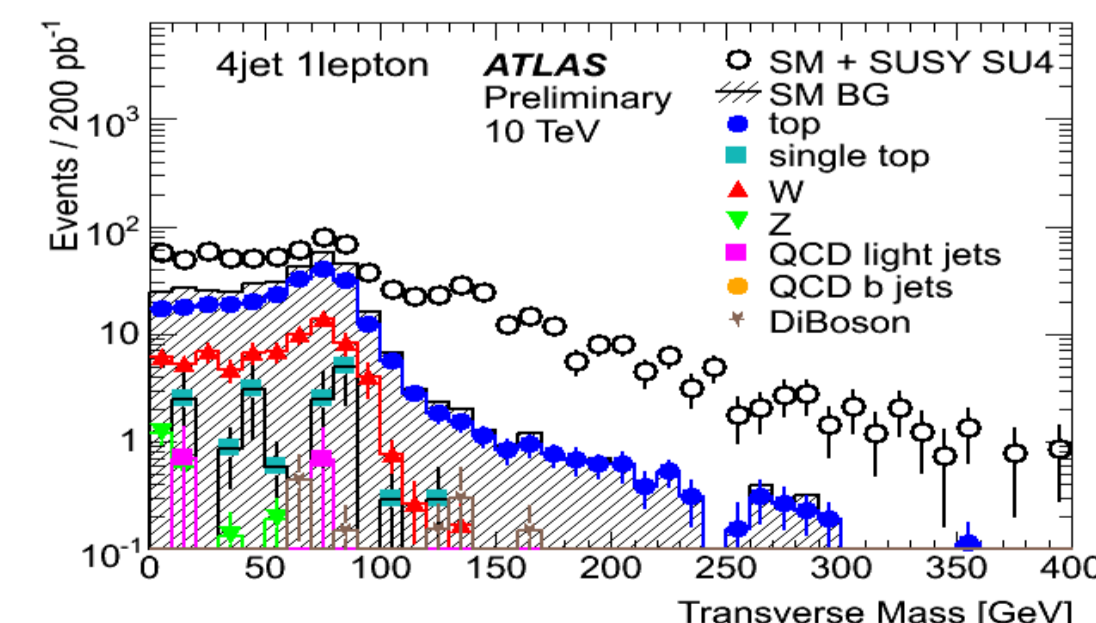
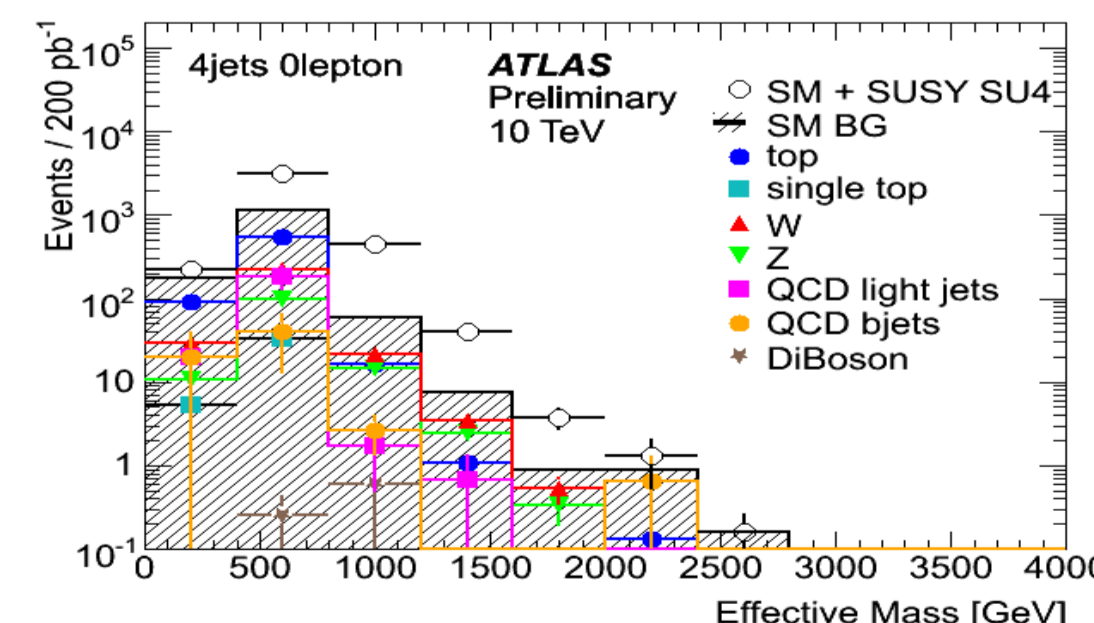
**0 LEPTONS CHANNELS:**

- 2-jets: mainly W and Z.
- 3 and 4 jets: top pair production.
- QCD contribution is present as well.

**1 LEPTON CHANNELS:** mainly top pair production and W + jets backgrounds, effectively reduced by the cut on transverse mass ( $M_T > 100 \text{ GeV}/c$ ).

No QCD contribution. This channel is the cleanest and best understood.

**2 LEPTON CHANNELS:** mainly top pair production.



**SU4 SUSY signal:**  
 $m_0 = 200 \text{ GeV}$   
 $m_{1/2} = 160 \text{ GeV}$   
 $A_0 = -400$   
 $\tan \beta = 10$   
 $\mu > 0$   
 $\sigma = 107.6 \text{ pb}$

## RESULTS:

With and integrated luminosity of  $200 \text{ pb}^{-1}$ , running at  $\sqrt{s} = 10 \text{ TeV}$ , ATLAS can discover signals of R-Parity conserving SUSY with squark and gluino masses less than  $600\text{-}700 \text{ GeV}$  in many scenarios. Signals of Universal Extra Dimensions can be discovered if  $1/R < 700 \text{ GeV}$ .

Reference: ATLAS Note: ATL-PUB-2009-342  
 "Prospects for SUSY and UED discovery based on inclusive searches at 10 TeV centre-of-mass energy with ATLAS detector"

# 3

**VARIABLES:** main variables are Missing  $E_T$  and Effective Mass

$$M_{\text{eff}} = MET + \sum_{i=1}^{N_{\text{jets}}} p_T^{\text{jet},i} + \sum_{j=1}^{N_{\text{leptons}}} p_T^{\text{lepton},j}$$

## EVENT SELECTION CUTS:

<b>0 Leptons</b>	veto on isolated leptons ( $e$ or $\mu$ with $p_T > 20 \text{ GeV}/c$ )
<b>1 Lepton</b>	exactly 1 isolated lepton ( $e$ or $\mu$ ) with $p_T > 20 \text{ GeV}/c$ veto on other leptons ( $e$ or $\mu$ ) with $p_T > 10 \text{ GeV}/c$ transverse mass $M_T(e/\mu, MET) > 100 \text{ GeV}/c$
<b>2 Leptons OS</b>	exactly 2 isolated opposite charge leptons ( $e$ or $\mu$ ) with $p_T > 10 \text{ GeV}/c$
<b>2 Jets</b>	2 jets with $p_T > 180, 50 \text{ GeV}/c$ $MET > 80 \text{ GeV}/c$ and $> 0.3 M_{\text{eff}}$ Transverse Sphericity $> 0.2$
<b>3 Jets</b>	3 jets with $p_T > 100, 40, 40 \text{ GeV}/c$ $MET > 80 \text{ GeV}/c$ and $> 0.25 M_{\text{eff}}$ Transverse Sphericity $> 0.2$
<b>4 Jets</b>	4 jets with $p_T > 100, 40, 40, 40 \text{ GeV}/c$ $MET > 80 \text{ GeV}/c$ and $> 0.2 M_{\text{eff}}$ Transverse Sphericity $> 0.2$
	$\min \Delta\phi(\text{jet}^i, MET) > 0.2, i = 1, 2$
	$\min \Delta\phi(\text{jet}^i, MET) > 0.2, i = 1, 2, 3$