European Physical Society Conference on High Energy Physics 2013

Search for pair produced top squarks decaying into a charm quark and the lightest neutralinos in *pp* collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector at the LHC*

Roger Caminal Armadans, on behalf of the ATLAS Collaboration

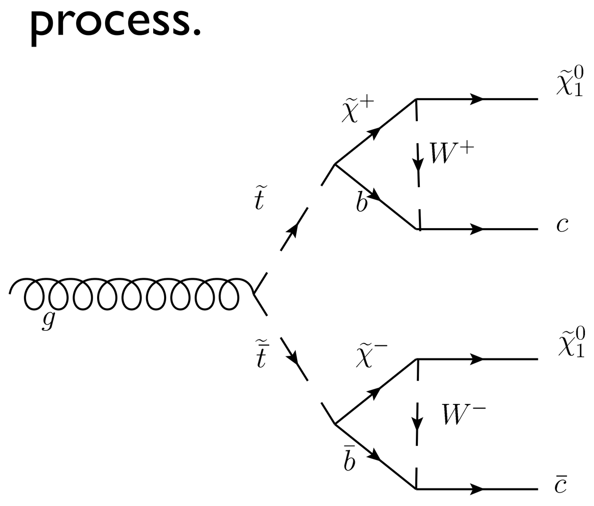
IFAE - Barcelona

*The results shown in this poster have been documented as ATLAS-CONF-2013-068 available at http://atlas.web.cern.ch/

Introduction

Supersymmetry (SUSY) is a theoretical favored candidate for physics beyond the Standard Model (SM) which naturally solves the hierarchy problem and provides a possible candidate for dark matter in the Universe.

In scenarios for which $\Delta m = m_{\tilde{t}} - m_{\tilde{\chi}_1^0} < m_b + m_W$, the stop decay into a charm quark and the lightest supersymmetric particle, $\tilde{t} \to c + \tilde{\chi}_1^0$, may be the dominant decay process.

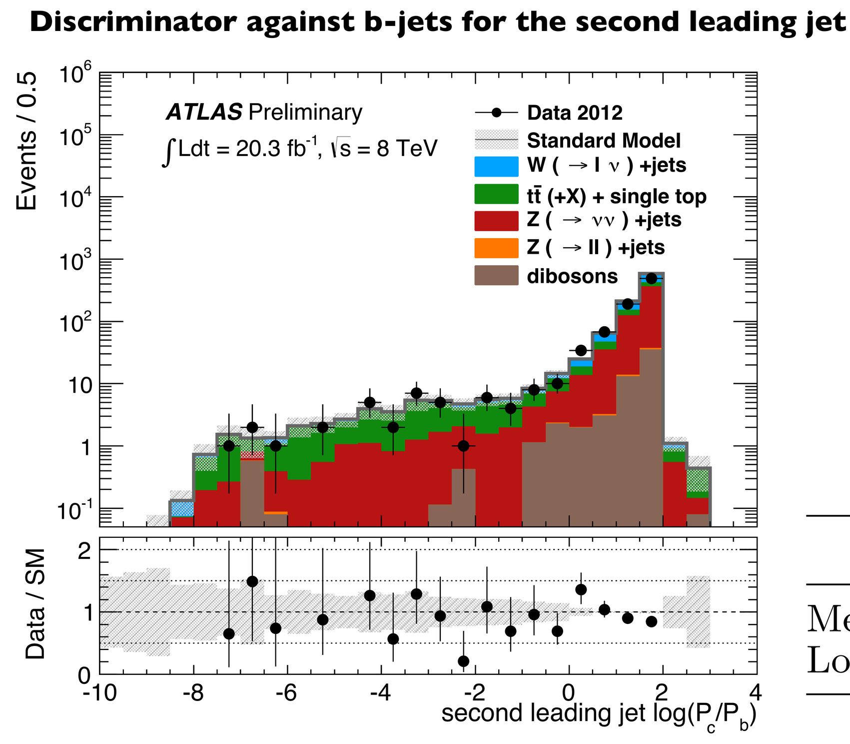


Two different approaches are used depending on Δm:

- For **small Δm**, the transverse momenta of the two charm jets is too low to be reconstructed. A monojet analysis strategy is followed, making use of the presence of initial-state radiation jets to identify signal events.
- For **moderate Δm** the charm jets receive a large enough boost to be detected. Therefore charm tagging is used to enhance the SUSY signal.

Charm tagging

Discriminator against b-jets for the second leading jet



Jets are identified as originating from the hadronization of a charm quark via a dedicated algorithm using **multivariate techniques**. The algorithm provides three weights, one for light-flavor quarks and gluon jets, one for charm jets and one for b-jets, from which the anti-b, $log(P_c/P_b)$, and anti-u, $log(P_c/P_u)$, discriminators are calculated. Two operating points are used:

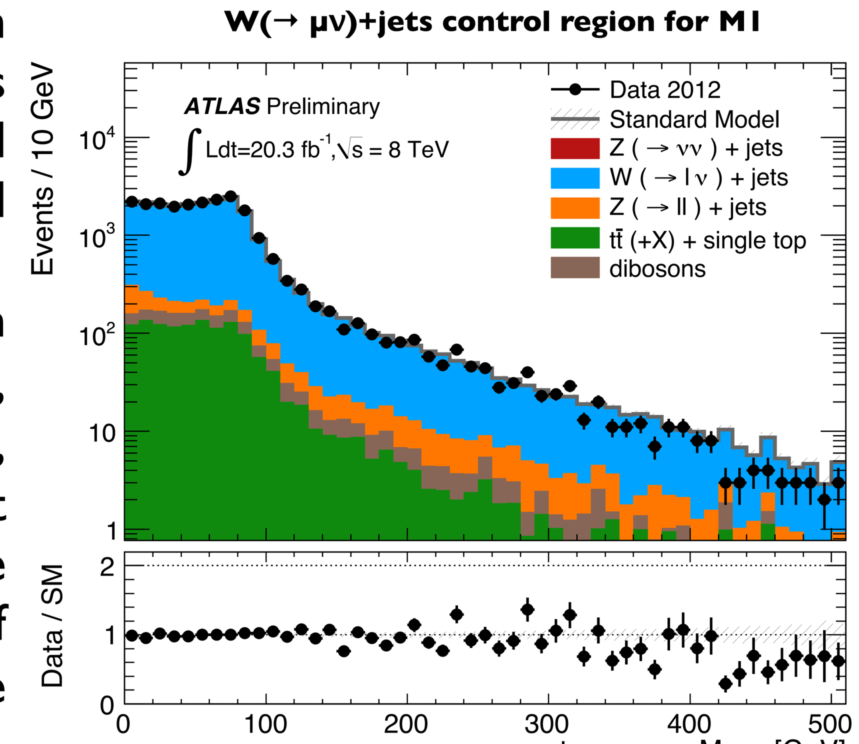
	c-tag eff.	b-rejection	light-rejection	τ-rejection
Medium	20%	5	140	10
Loose (as b-veto)	95%	2	-	-

Electro-weak background

The production of Z and W bosons in association with jets is the main source of background. Its contribution to the total background is 94% and 63% for the monojet-like and charm-tagged analyses respectively.

Samples of SHERPA MC events are normalized with data-driven scale factors retrieved in W(→eν)+jets, W(→μν)+jets and Z(→μμ)+jets control samples, defined separately to normalize the different background processes. As an example, the figure shows the distribution of the transverse mass of the W boson in the W(→ μν)+jets control sample for the M1 selection.

W(→ μν)+jets control region for M1



Systematic uncertainties

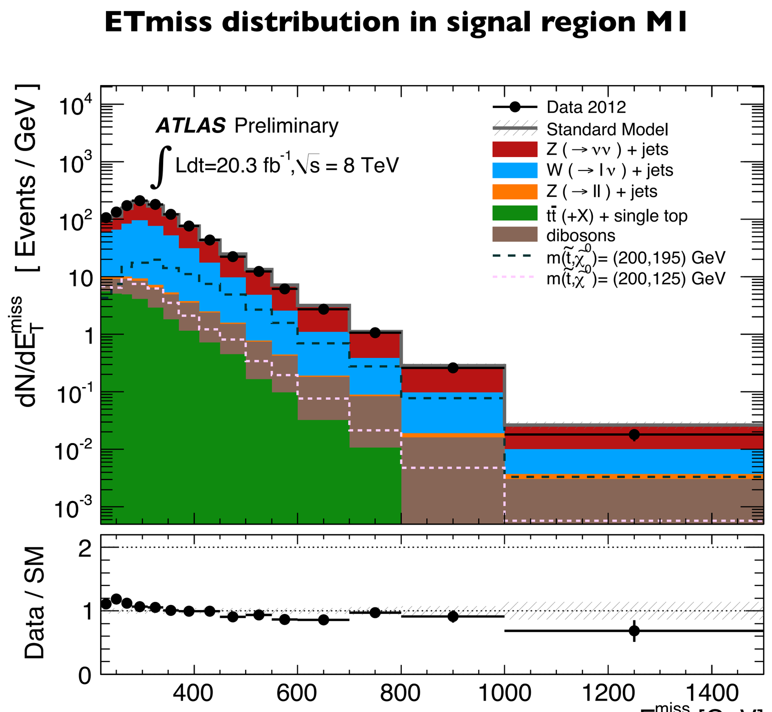
Different sources of systematic uncertainties are considered in the analysis: the absolute jet pT and the ETmiss energy scale and resolution, the pileup corrections, the lepton identification efficiencies, the modeling of parton showers and hadronization in the simulation, the b-veto and medium c-tag efficiencies (only in the c-tagged analysis), and the uncertainties on the control samples used to constrain the W/Z + jets contributions. This leads to a total systematic uncertainty of 3.2% for the monojet-like analysis and a 24% uncertainty for the c-tagged analysis.

Results

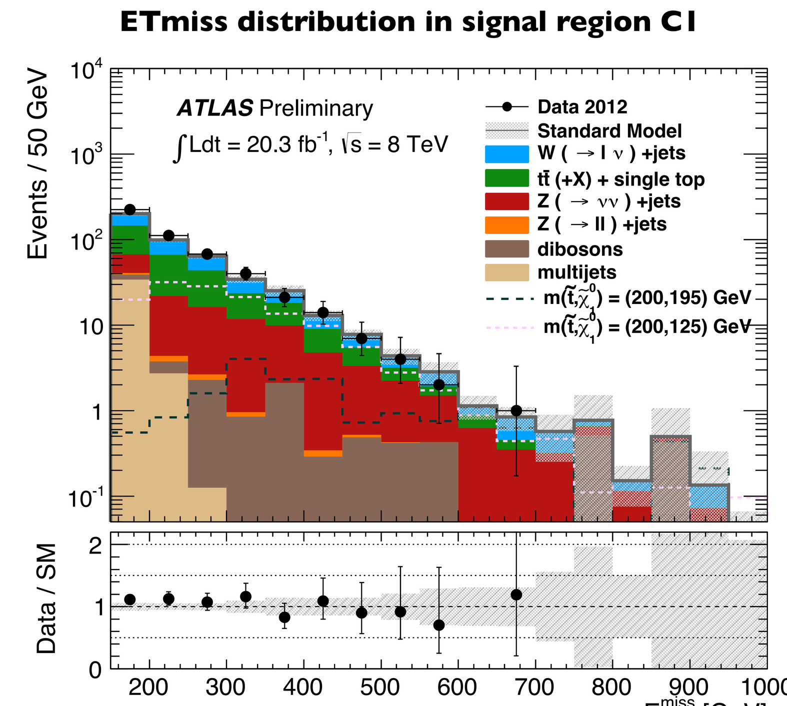
Good agreement is observed between the data and the Standard Model prediction.

Signal Region	M1	C1
Observed events (20.3 fb^{-1})	30793	25
SM prediction	29800 ± 900	29 ± 7

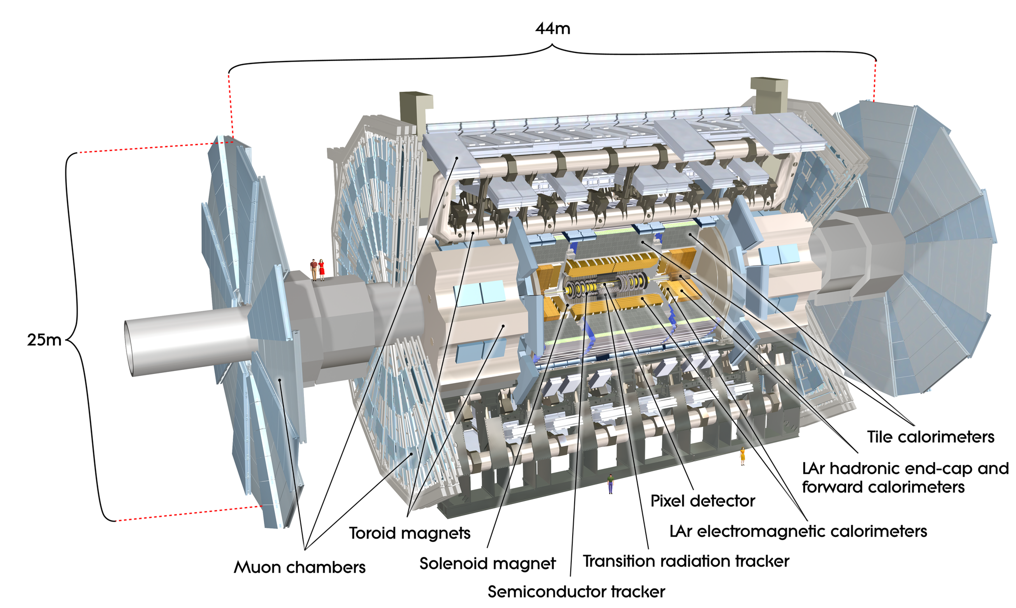
ETmiss distribution in signal region M1



ETmiss distribution in signal region C1



ATLAS detector



Event selection

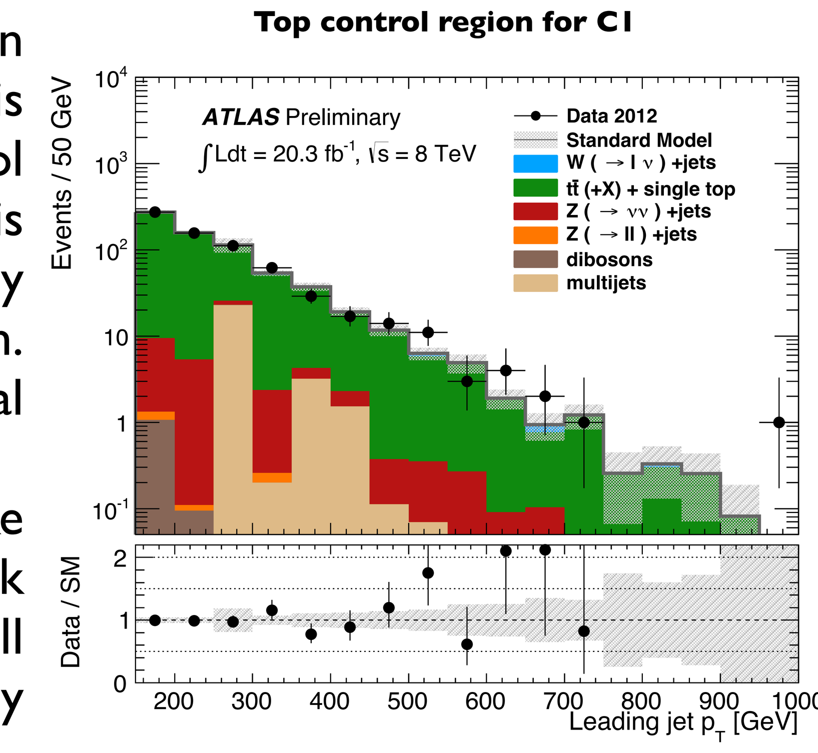
Selection criteria			
Monojet-like selection M1		Charm-tagged selection C1	
Primary vertex, jet quality requirements and lepton vetoes		Primary vertex, jet quality requirements and lepton vetoes	
At most three jets with $p_T > 30$ GeV and $\lvert\eta\rvert < 2.8$		At least three jets with $p_T > 30$ GeV and $\lvert\eta\rvert < 2.5$ (in addition to the leading jet) *b-veto* for second and third jet *medium c*-tag for fourth jet	
$\Delta\phi(\text{jet}, p_T^{\text{miss}}) > 0.4$		$\Delta\phi(\text{jet}, p_T^{\text{miss}}) > 0.4$	
minimum leading jet p_T (GeV)	280	270	
minimum E_T^{miss} (GeV)	220	410	

Top background

The top quark background in the charm-tagged analysis is estimated in a separate control region in which c-tagging is replaced by b-tagging by inverting the b-veto criterion. It's contribution to the total background is 24%.

In the case of the monojet-like analysis, the top quark production process is small (about 2%) and is entirely determined from MC.

Top control region for C1



Other backgrounds

- The **multijet background** is estimated in a data-driven way. It constitutes less than 1% of the total background in the monojet-like selection and it is negligible in the charm-tagged case.
- The **dibosons** contribution to the total background is 3% and 7% for the monojet-like and the charm-tagged analyses, respectively, and is determined from MC.
- The **non-collision background** is estimated in a data-driven way and it's found to be negligible in both selections.

Limits

The results are translated into 95% CL limits on the SUSY stop pair production as a function of the stop mass for different neutralino masses.

Experimental uncertainties on the signal vary between 2% and 10% in the monojet-like selection, and between 8% and 29% in the charm-tagged selection, depending on the stop and neutralino masses.

Renormalization and factorization scales, PDF uncertainties and variations in α_s result in a theory uncertainty between 14% and 16%.

Masses for the stop up to 200 GeV are excluded at 95% CL for arbitrary neutralino masses, while for neutralino masses of about 200 GeV, stop masses below 230 GeV are excluded at 95% CL.