Search for supersymmetry in events with photons, bottom quarks, and missing transverse momentum in proton–proton collisions at a centre-of-mass energy of 7 TeV

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Search for supersymmetry in events with photons, bottom quarks, and missing transverse momentum in proton–proton collisions at a centre-of-mass energy of 7 TeV with the ATLAS detector

ATLAS Collaboration

A search has been performed for the experimental signature of an isolated photon with high transverse momentum, at least one jet identified as originating from a bottom quark, and high missing transverse momentum. Such a final state may originate from supersymmetric models with gauge-mediated supersymmetry breaking in events in which one of a pair of higgsino-like neutralinos decays into a photon and a gravitino while the other decays into a Higgs boson and a gravitino. The search is performed using the full dataset of 7 TeV proton–proton collisions recorded with the ATLAS detector at the LHC in 2011, corresponding to an integrated luminosity of 4.7 fb^{-1}. A total of 7 candidate events are observed while 7.5 ± 2.2 events are expected from the Standard Model background. The results of the search are interpreted in the context of general gauge mediation to exclude certain regions of a benchmark plane for higgsino-like neutralino production.

1. Introduction

Theories of gauge-mediated supersymmetry breaking (GMSB) presume a hidden sector in which supersymmetry is broken and the symmetry breaking is communicated to the visible sectors through Standard Model gauge boson interactions [1–6]. Such theories are attractive because the hypothesis of an intermediate hidden sector suppresses the magnitude of flavour-changing neutral currents. The lightest supersymmetric particle (LSP) in GMSB is the ultra-light gravitino (G), which under certain circumstances is a viable dark matter candidate [7]. The next-to-lightest supersymmetric particle (NLSP) may be the lightest neutralino (χ^0_1), often assumed to be a bino-like particle. The bino is the supersymmetric partner of the U(1) gauge field, coupling to the photon and Z boson with strengths that are determined by the weak mixing angle. This results in the χ^0_1 decaying predominantly to a photon and the LSP. The classical signature of GMSB is, therefore, events with two isolated energetic photons and large missing transverse momentum (E_T^{miss}). Recent extensions of the original GMSB idea, known as general gauge mediation (GGM) [10], evade these limits by allowing decoupled mass scales for strongly-interacting supersymmetric partners of the Standard Model particles.

In the GGM models considered in this Letter, the neutralino has higgsino or neutral wino (supersymmetric partners of the Higgs and neutral W bosons) components instead of being predominantly bino-like, and therefore, in addition to its conventional decay to a gravitino and a photon, it may decay to a gravitino and a Higgs boson or to a gravitino and a Z boson. This GGM signature could be identified as an excess of events with pairs of neutralinos decaying to these bosons, in all combinations, associated with high E_T^{miss} [11]. In particular, for a light Higgs boson (m_h < 130 GeV), which decays predominantly to bb, one final-state signature is the combination of an isolated high transverse momentum (p_T) photon, jets originating from bottom quarks, and high E_T^{miss}. Such a signature arises when one neutralino decays to a gravitino and a photon and the other to a gravitino and a Higgs boson. This decay mode is therefore significant when both branching fractions are large, namely when the bino mass term M_1 approximately equals the higgsino mass parameter −µ [1].

This Letter describes the search for events with a “γ + b + E_T^{miss} topology”, consisting of an isolated high-p_T photon, large E_T^{miss} and at least one jet that contains a b-hadron (“b-tagged jet”), in the full dataset of √s = 7 TeV pp collisions recorded in 2011 with the ATLAS detector at the LHC, corresponding to a total integrated luminosity of 4.7 fb^{-1}. This signature is complementary to searches for diphoton production accompanied by E_T^{miss} [12,13], searches for b-jet production plus E_T^{miss} [14,15], searches for lepton production plus E_T^{miss} [16], and searches for Z bosons accompanied by photons and E_T^{miss} [17]. The γ + b + E_T^{miss} topology has not been
2. ATLAS detector

The ATLAS experiment [18] is a multi-purpose particle physics detector with a forward–backward symmetric cylindrical geometry and nearly 4π coverage in solid angle. The collision point is surrounded by inner tracking devices followed by a superconducting solenoid providing a 2 T magnetic field, a calorimeter system, and a muon spectrometer. The inner tracker provides precision tracking of charged particles for pseudorapidities |η| < 3.2, high-granularity LAr electromagnetic (EM) sampling calorimeters, and silicon microstrip detectors inside the transition radiation tracker. The calorimeter system has liquid argon (LAr) or scintillator tiles as the active media. In the pseudorapidity region |η| < 1.7, the end-cap and forward regions, spanning 1.5 < |η| < 4.9, are instrumented with LAr calorimeters for both EM and hadronic measurements. The muon spectrometer consists of three large superconducting toroids with 24 coils, a system of trigger chambers, and precision tracking chambers, which provide triggering and tracking capabilities in the ranges |η| < 2.4 and |η| < 2.7, respectively.

3. Simulated samples

Standard Model processes that constitute the background to this search are simulated using several different generator programs. Events with single- or pair-production of top quarks are simulated using the MC@NLO [19] generator with the CT10 [20] PDF sets used for those calculations. The PDF sets used for those calculations are CTEQ6.6M [39] and MSTW2008NLO [40]. Multijet background (“QCD jet”) events are generated using the PYTHIA [29] generator. Diboson background events (WW, WZ, and ZZ) are simulated using HERWIG. Events with vector bosons accompanied by bb or light jets are simulated using ALPGEN [30] and HERWIG [21].

The production of signal events is simulated in two separate two-dimensional benchmark grids of points defined by specific GGM model parameters. The first grid has various gluino and neutralino masses (m_g, m_0), while the second grid has varying squark and neutralino masses (m_{s}, m_{0}). The fundamental parameters M_{1} and μ together determine the lightest neutralino mass and are adjusted in such a way that the following branching ratios of the \chi_{1}^{0} are approximately constant: BR(\chi_{1}^{0} → h + G) ≃ 56%, BR(\chi_{1}^{0} → γ + G) ≃ 33%, and BR(\chi_{1}^{0} → Z + G) ≃ 11%. These numbers vary by ±2% throughout the grids. The value of μ is chosen to be negative in order to make the branching ratio of the \chi_{1}^{0} to the lightest Higgs boson greater than that to the Z boson. Masses of the sleptons and coloured supersymmetric particles not to make the grid are set to 2.5 TeV, and the lightest Higgs boson is in the decoupled regime with m_{h} = 2 TeV and m_{h} = 115 GeV, which results in a branching ratio BR(h → bb) = 74%. Other parameters are the wino mass M_{2} = 2.5 TeV, the ratio of Higgs doublet vacuum expectation values tan β = 1.5, and the neutralino decay length ct < 0.25 mm. The small effect of a different choice of Higgs boson mass, m_{h} = 125 GeV, is discussed in Section 9. More generally, different choices of these parameters can modify slightly the relevant branching ratios but do not affect significantly the overall sensitivity reach for models of gauge mediation. The full mass spectrum and decay widths are calculated using SUSPECT, SDECAY, and HDECAY with the SUSY-HIT interface [31]. Events are generated with Herwig [32].

The signal production rate is dominated at high neutralino masses by strong production of gluinos and squarks, but at low neutralino masses the direct production of charginos and neutralinos is greatly enhanced. Signal cross sections are calculated to next-to-leading order in the strong coupling constant (NLO) using PROSPINO2 [33]. The nominal cross section and its uncertainty are taken from an envelope of cross-section predictions using different PDF sets and factorization and renormalization scales, as described in Ref. [38]. The PDF sets used for those calculations are CTEQ6.6M [39] and MSTW2008NLO [40].

Monte Carlo simulated event samples are generated with multiple pp interactions (pile-up) and are re-weighted by matching the distribution of the number of interactions per bunch crossing to that observed in the data. The samples are passed through the GEANT4 [41,42] simulation of the ATLAS detector and the same reconstruction software used for the data.

4. Event reconstruction

Jets are reconstructed from calibrated clustered energy deposits in the calorimeter using the anti-kt jet clustering algorithm [43] with radius parameter R = 0.4. Clusters of calorimeter cells are seeded by cells with energy significantly above the measured noise. Jet energies are corrected for the effects of calorimeter non-compensation and inhomogeneities using pT- and \eta-dependent calibration factors based on Monte Carlo simulations validated with extensive test-beam and collision-data studies [44]. Reconstructed jets with pT > 20 GeV and |η| < 2.8 are used in this analysis.

A multivariate b-tagging algorithm that exploits both impact parameter and secondary vertex information is used to identify jets with |η| < 2.5 containing a b-hadron [45]. The working point used in this analysis has a 60% efficiency on a sample of b-jets from simulated tt events, with typical misidentification rates of 12% for c-jets and less than 0.2% for light-quark/gluon jets with pT > 20 GeV and |η| < 2.5.

A photon candidate must have transverse momentum p_{T} > 20 GeV and must fulfill a set of “tight” identification requirements [46]. Moreover, the cluster associated with the photon should have |η| < 2.37 and should not be in the transition region between the barrel and end-cap calorimeters (1.37 < |η| < 1.52). An isolation criterion is applied in order to suppress the background from photons originating inside jets: the total calorimeter energy deposit, not including the photon candidate, inside a cone of ΔR = \sqrt{(Δη)^2 + (Δφ)^2} = 0.2 around the photon direction is required to be less than 5 GeV. Photon candidates identified from

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1 ATLAS uses a right-handed coordinate system with its origin at the nominal interaction point (IP) in the centre of the detector and the z-axis along the beam pipe. The x-axis points from the IP to the centre of the LHC ring, and the y-axis points upward. Cylindrical coordinates (r, φ) are used in the transverse plane, φ being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle θ as \eta = −ln(tan(θ/2)).

2 The addition of the resummation of soft gluon emission at next-to-leading-logarithmic accuracy (NLL) [33–37] is performed in the case of strong SUSY pair-production.
conversions are included, but, in order to suppress the background from primary electrons misidentified as photons, the tracks of converted photon candidates are required to have no hits in the pixel detector.

Electron candidates are clustered energy deposits in the electromagnetic calorimeter matched to a track in the inner detector. They are required to have $p_T > 20$ GeV and $|\eta| < 2.47$, and must satisfy the “medium” electron shower shape and track selection criteria described in Ref. [49]. As for photons, electron candidates in the calorimeter transition region are vetoed.

Muon candidates with $|\eta| < 2.4$, reconstructed by combining tracks in the inner detector and tracks in the muon spectrometer, are required to have $p_T > 10$ GeV and also to pass muon quality requirements [48].

The measurement of the missing transverse momentum, including its magnitude $E_T^{\text{miss}}$, is based on the vector sum of the reconstructed transverse momenta in the event. Objects included in the sum are muons and electrons with $p_T > 10$ GeV, photons with $p_T > 20$ GeV, jets with $p_T > 20$ GeV, and calibrated calorimeter clusters that are not associated with any object with $|\eta| < 4.9$, as described in Ref. [49].

Any jet candidate lying within a distance $\Delta R < 0.2$ from an electron or photon is discarded. Also, in order to ensure that selected leptons and photons are not purely the result of hadronic activity, electrons and photons with distances $0.2 < \Delta R < 0.4$ from a jet are rejected, as are muons within $\Delta R < 0.4$ of a jet. The difference in requirements reflects the fact that only photons and electrons can potentially be reconstructed as jets. Since one of the main backgrounds in this analysis is due to electrons misidentified as photons, a preliminary suppression of the background is achieved by labelling an object an electron whenever an electron or photon is discarded. Also, in order to suppress dileptonic and semileptonic backgrounds in which a jet or lepton is misidentified as a photon, the tracks of conversions are included, but, in order to suppress the background from primary electrons misidentified as photons, the tracks of converted photon candidates are required to have no hits in the pixel detector.

The main selection requirements are summarized in Table 1. The lepton requirement strongly suppresses the multijet events in which the measured $E_T^{\text{miss}}$ leading jets must be greater than 0.4. This condition suppresses dileptonic and semileptonic $t\bar{t}$ events with a prompt photon or with a jet misidentified as a photon, and dileptonic events with an electron or a $t\bar{t}$ lepton misidentified as a photon. Finally, events with a second photon with $p_T > 50$ GeV are rejected. The main selection requirements are summarized in Table 1.

### 5. Event selection

The data sample is collected with a trigger requiring at least one photon passing “loose” identification requirements [46] with $p_T > 80$ GeV; this trigger is fully efficient for the selection described below. The following selection criteria were optimized to maximize the sensitivity to the GGM scenarios considered, especially gluino/squark production: a candidate event should contain a photon with $p_T > 125$ GeV, at least two jets with $p_T > 20$ GeV, at least one of which is $b$-tagged, and $E_T^{\text{miss}} > 150$ GeV. The transverse mass of the photon and the missing transverse momentum $m_T(y', E_T^{\text{miss}}) = \sqrt{2E_T^{\text{miss}}p_T'(1 - \cos \phi)}$, where $\phi$ is the azimuthal angle between the missing transverse momentum and the photon, is required to be greater than 100 GeV. This criterion removes events in which electrons or decay products of $t\bar{t}$ leptons, originating from $W$ decay, are misidentified as photons. The minimum azimuthal angle between the $E_T^{\text{miss}}$ direction and each of the two leading jets must be greater than 0.4. This condition suppresses multijet events in which the measured $E_T^{\text{miss}}$ is due mostly to jet mismeasurement effects. Events with an identified electron or muon satisfying the criteria given in Section 4 are vetoed. This veto suppresses dileptonic and semileptonic $t\bar{t}$ events with a prompt photon or with a jet misidentified as a photon, and dileptonic events with an electron or a $t\bar{t}$ lepton misidentified as a photon. Finally, events with a second photon with $p_T > 50$ GeV are rejected. The main selection requirements are summarized in Table 1.

### 6. Background estimation

Events from $t\bar{t}$ production with a $W$ boson decaying into leptons in the final state (leptonic $t\bar{t}$ background) contain a pair of $b$-jets and genuine $E_T^{\text{miss}}$. These events may survive the signal selection procedure if an isolated high-$p_T$ photon candidate is also present. Such a photon may be the result of the misidentification of an electron produced in the leptonic $W$ decay, a genuine prompt photon, or a $\tau$ decay product or jet misidentified as a photon. All processes that give rise to final states $W(\to \ell\nu) + X$, including leptonic $t\bar{t}$, diboson, and single top backgrounds, are estimated using data-driven methods. Another large background estimated with data-driven methods is from multijet events. Finally, the small contribution from $Z(\to \ell\ell) +$ jets background is estimated using Monte Carlo simulation.

A control sample (CS) is defined by selecting events according to the criteria described in Section 5 but replacing the photon selection by requiring the presence of an electron. Once the probability of an electron being misidentified as a photon (the “$e \to \gamma$ misidentification rate”) is known, the number of events in the signal region with misidentified electrons can be deduced from this CS. The $e \to \gamma$ misidentification rate for different $\eta$ regions is measured by selecting events with a photon and an electron in which the $e\gamma$ invariant mass is less than 20 GeV from the nominal $Z$ boson mass of 91.2 GeV. The electron is required to pass the “tight” identification criteria [46], and the photon is required to pass the quality requirements of the signal region. The number of $e\gamma$ events is then divided by the number of $e^+e^-$ pairs with one tight and one medium electron, and the ratio is taken to be the misidentification rate. The average misidentification rate for photons with $p_T > 100$ GeV is 1.8%. When this technique is applied to the data, $1.1 \pm 0.1$ (stat.) background events with electrons misidentified as photons are predicted in the signal region.

The prompt photon background cannot be separated from the backgrounds in which a jet or $\tau$ lepton is misidentified as a photon. Therefore, a single CS is used to estimate these backgrounds. The “lepton control region” is defined by requiring the presence of a lepton, in addition to the photon, and relaxing the $E_T^{\text{miss}}$ cut to $80 < E_T^{\text{miss}} < 150$ GeV while keeping all the other selection criteria of Section 5. The lepton requirement strongly suppresses the multijet contamination, making it possible to use a lower $E_T^{\text{miss}}$ threshold in order to increase the number of selected events and hence reduce the uncertainty on the background estimate. The lower $E_T^{\text{miss}}$ threshold is chosen to be 80 GeV to ensure that the $t\bar{t}$ background remains the dominant contribution in the lepton control region. The results of the method for the signal region and the lepton control region are shown in Table 2. In order to prevent double counting, the background with electrons misidentified as photons is subtracted, leaving 10.1 events in the CS. Multiplying the 10.1 events observed in the CS by the simulation-based scale factor of

### Table 1

<table>
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<th>Summary of event selection requirements.</th>
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<td>1 photon ($p_T &gt; 125$ GeV)</td>
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<tr>
<td>$\geq 2$ jets ($p_T &gt; 20$ GeV)</td>
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<tr>
<td>$\geq 1$ b-tagged jet</td>
</tr>
<tr>
<td>$E_T^{\text{miss}} &gt; 150$ GeV</td>
</tr>
<tr>
<td>$m_T(y', E_T^{\text{miss}}) &gt; 100$ GeV</td>
</tr>
<tr>
<td>$\Delta \phi(E_T^{\text{miss}}, \text{jet}) &gt; 0.4$</td>
</tr>
<tr>
<td>veto $e/\mu$</td>
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<td>veto second photon</td>
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### Table 2

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<th>Sample</th>
<th>Signal region</th>
<th>Lepton control region</th>
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<tr>
<td>$t\bar{t}$ MC@NLO</td>
<td>0.3 ± 0.2</td>
<td>0.5 ± 0.3</td>
</tr>
<tr>
<td>$t\bar{t}$ WHIZARD</td>
<td>2.5 ± 0.2</td>
<td>7.9 ± 0.4</td>
</tr>
<tr>
<td>Total</td>
<td>2.8 ± 0.3</td>
<td>8.4 ± 0.5</td>
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<tr>
<td>Data</td>
<td>10.1 ± 3.5</td>
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nal region (SR), control regions (CRs) are defined with events that fail the b-tag requirement or the $E_T^{miss}$ requirement (see Table 3).

The CR3 data sample is contaminated by $t\bar{t}$, single top, and $W/Z +$ jets events that have genuine $E_T^{miss}$, and this contamination must be removed. This contamination $N_{\text{MC, multijet}}^{\text{CR3}}$ is estimated from the Monte Carlo simulation and accounts for approximately 45% of the events in the CR3. A scale factor between the tagged and untagged samples is calculated in the low $E_T^{miss} < 100$ GeV control regions ($N_{\text{CR1}}^{\text{Data}}/N_{\text{CR2}}^{\text{Data}}$), and this scale factor is subsequently applied to the high-$E_T^{miss}$ region of the untagged CS to obtain the prediction for the signal region:

$$N_{\text{SR}}^{\text{Pred}} = \left( N_{\text{Data}}^{\text{CR3}}/N_{\text{CR2}}^{\text{MC, multijet}} \right) \times \left[ N_{\text{Data}}^{\text{CR1}}/N_{\text{CR1}}^{\text{Data}} \right].$$

In order to check the accuracy of this method, the background estimate is calculated after all selection requirements and then repeated without the $m_T(g, E_T^{miss}) > 100$ GeV requirement, which is expected to have little effect on the multijet background. The two calculations yield predictions of $3.3 \pm 0.6$ (stat.) events before the $m_T(g, E_T^{miss})$ requirement and $2.7 \pm 0.7$ (stat.) events after all requirements, with uncertainty due only to limited statistics in the CRs. The difference of 0.6 events is used as a systematic uncertainty associated with this method. The number of expected QCD multijet events in the signal region is therefore $2.7 \pm 1.1$ events.

Finally, the $Z(\rightarrow \nu\bar{\nu}) +$ jets process is estimated, from studies of simulated events, to contribute $0.3 \pm 0.3$ events in the signal region. The background from other sources is estimated to be negligible.

### 7. Systematic uncertainties on the background

The main source of systematic uncertainties on the background is the scale factor derived from simulation for prompt photon and misidentified jet/ $E_T^{miss}$ in the signal region. The uncertainty on this factor is dominated by the theoretical uncertainties on the $t\bar{t}$ processes. Uncertainties such as Monte Carlo modelling and different initial- and final-state radiation models are evaluated by comparing Ac-}

erMC (LO) [50], MC@NLO (NLO), and POWHEG (NLO) $t\bar{t}$ simulations. The impact of using different fragmentation and hadroniza-

To verify that the event characteristics used in this method are well modelled in the lepton control region, the $E_T^{miss}$ and $p_T^\gamma$ distributions in the data and simulation are shown in Fig. 1. The distributions agree within uncertainties.

Multijet events, another source of background, may contain genuine photons or misidentified jets that hadronize to an isolated $p_T^\gamma$. High $E_T^{miss}$ is rare in multijet events but can be realized by mismeasured jets or by heavy-flavour quark jets decaying semileptonically. To estimate the multijet contribution in the sig-

![Fig. 1](image-url)
in the event selection, is estimated to be 6%. The impact of the luminosity uncertainty is less than 1% because only the small contribution from Z(→ℓ+ℓ−)+jets background is normalized using the integrated luminosity.

### 8. Signal efficiencies and systematic uncertainties

The combined product of acceptance and efficiency of the event selection is calculated with simulated events for each point in the GGM benchmark grids. Low m˜b values typically result in gravitinos with relatively low pT, which translates to lower efficiency for the EmissT requirement relative to high-m˜b points. A typical efficiency for high-mass gluino points (mG = 900 GeV, m˜b = 450 GeV) is 10%, including the branching ratio for all Higgs boson decays and the contribution from neutralino decays to Z bosons that subsequently decay to bb. Uncertainties on the signal cross section due to PDFs, renormalization and factorization scales, and the strong coupling constant αs are calculated separately for each production process as described in Ref. [38] and combined into an overall uncertainty that varies significantly for different signal points. Most of the signal points have a combined cross-section uncertainty of 2–5% but the total uncertainty can reach 50% for the points with very large gluino masses. The uncertainties on the signal acceptance include an uncertainty ranging from 3% to 16% due to the limited number of simulated events at each benchmark grid point. The uncertainty on the jet energy scale and jet energy resolution, b-tagging efficiency, photon and lepton identification, luminosity, and pile-up are evaluated as in Section 7. The uncertainties on the jet energy scale and jet energy resolution vary from 1% to 10% across the different signal points. The relative uncertainty on the signal selection efficiency due to the uncertainty in the b-tagging efficiency varies between 1% and 16% throughout the signal grid. The systematic uncertainty on the photon identification is less than 6%. The systematic uncertainty on lepton identification is 3%. Scaling the number of pile-up events in simulation gives rise to variations of up to 6% throughout the grid. The systematic uncertainty on luminosity is evaluated to be 4% [52,53]. All the sources of described background and signal systematic uncertainties are summarized in Table 4.

### 9. Results

Table 5 summarizes the expected number of Standard Model events in the signal region and the number of events observed in the data. The systematic and statistical uncertainties, both included, are of the same order.

![Figure 2](image-url)  
**Fig. 2.** The EmissT distribution after all selection criteria except the EmissT cut (top) and the pT distribution after all selection criteria except those on mT(γ, EmissT) and Δφ(EmissT, jet) (bottom), along with the distribution of pT after all requirements except those on mT(γ, EmissT) and Δφ(EmissT, jet). The distribution of mT(γ, EmissT) after all requirements except that on Δφ(EmissT, jet) and the distribution of Δφ(EmissT, jet) after all requirements except that on mT(γ, EmissT) are shown in Fig. 3. The observed data agree with the background-only predictions.

Since no excess is observed above the background-only prediction, the main result of the search is to constrain contributions from physics beyond the Standard Model. The profile likelihood is used with an asymptotic approximation and the CLs method to calculate confidence limits [54,55]. From the number of observed and expected events, a 95% confidence level upper limit on the visible...
cross section, defined by the product of production cross section times efficiency times acceptance, is derived. The expected 95% confidence limit is 8.1 events, corresponding to an upper limit on the visible cross section of $1.7 \text{ fb}$. The observed limit is 7.4 events, corresponding to a visible cross section of $1.6 \text{ fb}$.

The calculated acceptances for the simulated signal events and their cross sections are used in the framework of the specific GGM models described in Section 1 to map the excluded signal region. For each point in the benchmark plane observed upper limits on the signal strength are calculated, including both strong production of squarks and gluinos and weak production of neutralinos and charginos. Observed and expected limits for the combined production processes are shown in Fig. 4. The grey lower-right regions, corresponding to models with gluino or squark NLSP, are not considered.

If a Higgs boson mass $m_h = 125 \text{ GeV}$ is used instead of $115 \text{ GeV}$, the branching ratio to $b \bar{b}$ is reduced, and the exclusion is weakened. The important differences in excluded cross section for supersymmetric particle production, at high gluino mass and moderately high neutralino mass, are about 10%. In this relevant region, a 10% change in cross section corresponds to a 10 GeV reduction in the 900 GeV gluino mass exclusion.

10. Conclusions

A search for supersymmetry with a signature consisting of an isolated high transverse momentum photon, a $b$-tagged jet, and high missing transverse momentum is performed using 4.7 fb$^{-1}$ of $\sqrt{s} = 7 \text{ TeV} pp$ collision data recorded with the ATLAS detector at the LHC. Seven events are observed, consistent with the expected Standard Model background of 7.5 ± 2.2 events. A model-independent 95% confidence level upper limit of 1.6 fb is set on the visible cross section of events passing the selection. The cross-section limits are used to constrain higgsino-like neutralino production for a typical GGM model in two benchmark planes. These
are the first direct experimental constraints on this signature. For neutralino masses greater than 220 GeV, this search excludes gluino masses less than 900 GeV and squark masses less than 1020 GeV in the gluino–neutralino and squark–neutralino benchmark planes, respectively.

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References


16 Department of Physics, Humboldt University, Berlin, Germany
17 Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland
18 School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom
19 (a) Department of Physics, Bogazici University, Istanbul; (b) Division of Physics, Dogus University, Istanbul; (c) Department of Physics Engineering, Gaziantep University, Gaziantep;
20 (d) Department of Physics, Istanbul Technical University, Istanbul, Turkey
21 (a) INFN Sezione di Bologna; (b) Dipartimento di Fisica, Università di Bologna, Bologna, Italy
22 Physikalisches Institut, Universität Bonn, Bonn, Germany
23 Department of Physics, Boston University, Boston, MA, United States
24 Department of Physics, Brandeis University, Waltham, MA, United States
25 (a) Universidade Federal do Rio De Janeiro COPEE/EE/F, Rio de Janeiro; (b) Federal University of Juiz de Fora (UFJF), Juiz de Fora; (c) Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei, (d) Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil
26 Physics Department, Brookhaven National Laboratory, Upton, NY, United States
27 (a) National Institute of Physics and Nuclear Engineering, Bucharest; (b) University Politehnica Bucharest, Bucharest; (c) West University in Timisoara, Timisoara, Romania
28 Departamento de Fisica, Universidad de Buenos Aires, Buenos Aires, Argentina
29 Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom
30 Department of Physics, Carleton University, Ottawa, ON, Canada
31 CERN, Geneva, Switzerland
32 Enrico Fermi Institute, University of Chicago, Chicago, IL, United States
33 (a) Departamento de Fisica, Pontificia Universidad Catolica de Chile, Santiago; (b) Departamento de Fisica, Universidad Técnica Federico Santa María, Valparaíso, Chile
34 Institute of High Energy Physics, Chinese Academy of Sciences, Beijing; (a) Department of Modern Physics, University of Science and Technology of China, Hefei; (b) Department of Physics, Nanjing University, Jiangsu; (c) School of Physics, Shandong University, Shandong; (d) Physics Department, Shanghai Jiao Tong University, Shanghai, China
35 Laboratoire de Physique Corpusculaire, Clermont Université and CNRS/IN2P3, Clermont-Ferrand, France
36 Nevis Laboratory, Columbia University, Irvington, NY, United States
37 Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark
38 INFN Gruppo Collegato di Cosenza; (a) Dipartimento di Fisica, Università della Calabria, Arcavacata di Rende, Italy
39 ACT2002 University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland
40 The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland
41 Physics Department, Southern Methodist University, Dallas, TX, United States
42 Physics Department, University of Texas at Dallas, Richardson, TX, United States
43 DESY, Hamburg and Zeuthen, Germany
44 Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany
45 Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany
46 Department of Physics, Duke University, Durham, NC, United States
47 SUPA – School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom
48 INFN Laboratori Nazionali di Frascati, Frascati, Italy
49 Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg, Germany
50 Section de Physique, Université de Genève, Geneva, Switzerland
51 (a) INFN Sezione di Genova; (b) Dipartimento di Fisica, Università di Genova, Genova, Italy
52 (a) E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi; (b) High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia
53 II Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany
54 SUPA – School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom
55 INFN Laboratori Nazionali di Frascati, Frascati, Italy
56 Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg; (b) Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg; (c) ZITI Institut für technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany
57 Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan
58 Department of Physics, Indiana University, Bloomington, IN, United States
59 Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
60 University of Iowa, Iowa City, IA, United States
61 Department of Physics and Astronomy, Iowa State University, Ames, IA, United States
62 Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia
63 KEK, High Energy Accelerator Research Organization, Tsukuba, Japan
64 Graduate School of Science, Kobe University, Kobe, Japan
65 Faculty of Science, Kyoto University, Kyoto, Japan
66 Kyoto University of Education, Kyoto, Japan
67 Department of Physics, Kyushu University, Fukuoka, Japan
68 Instituto de Fisica La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina
69 Physics Department, Lancaster University, Lancaster, United Kingdom
70 INFN Sezione di Lecce; (a) Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy
71 Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom
72 Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia
73 School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom
74 Department of Physics, Royal Holloway University of London, Egham, Surrey, United Kingdom
75 Department of Physics and Astronomy, University College London, London, United Kingdom
76 Laboratoire de Physique Nucléaire et de Hautes Energies, LPCP, Université Paris-Diderot and CNRS/IN2P3, Paris, France
77 Fysiska institutionen, Lunds universitet, Lund, Sweden
78 Departamento de Física Teórica C-15, Universidad Autonoma de Madrid, Madrid, Spain
79 Institut für Physik, Universität Mainz, Mainz, Germany
80 School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom
81 CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
82 Department of Physics, University of Massachusetts, Amherst, MA, United States
83 Department of Physics, McGill University, Montreal, QC, Canada
84 School of Physics, University of Melbourne, Victoria, Australia
85 (a) Department of Physics, The University of Michigan, Ann Arbor, MI, United States
86 Department of Physics and Astronomy, Michigan State University, East Lansing, MI, United States
87 (a) INFN Sezione di Milano; (b) Dipartimento di Fisica, Università di Milano, Milano, Italy
88 B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Belarus
166 Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden
167 Instituto de Física Corpuscular (IFIC) and Departamento de Física Atómica, Molecular y Nuclear and Departamento de Ingeniería Electrónica and Instituto de Microelectrónica de Barcelona (IMB-CNM), University of Valencia and CSIC, Valencia, Spain
168 Department of Physics, University of British Columbia, Vancouver, BC, Canada
169 Department of Physics and Astronomy, University of Victoria, Victoria, BC, Canada
170 Department of Physics, University of Warwick, Coventry, United Kingdom
171 Waseda University, Tokyo, Japan
172 Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel
173 Department of Physics, University of Wisconsin, Madison, WI, United States
174 Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany
175 Department of Physics, Yale University, New Haven, CT, United States
176 Yerevan Physics Institute, Yerevan, Armenia
177 Centre de Calcul de l’Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), Villeurbanne, France

a Also at Department of Physics, King’s College London, London, United Kingdom.
b Also at Laboratory of Instrumentacao e Fisica Experimental de Partículas – LIP, Lisboa, Portugal.
c Also at Faculdade de Ciencias and CEFITEC, Universidade de Lisboa, Lisboa, Portugal.
d Also at Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom.
e Also at Department of Physics, University of Johannesburg, Johannesburg, South Africa.
f Also at TRIUMF, Vancouver, BC, Canada.
g Also at Department of Physics, California State University, Fresno, CA, United States.
h Also at Novosibirsk State University, Novosibirsk, Russia.
i Also at Department of Physics, University of Coimbra, Coimbra, Portugal.
j Also at Department of Physics, UASLP, San Luis Potosi, Mexico.
k Also at Università di Napoli Parthenope, Napoli, Italy.
l Also at Institute of Particle Physics (IPP), Canada.
m Also at Department of Physics, Middle East Technical University, Ankara, Turkey.
n Also at Louisiana Tech University, Ruston, LA, United States.
o Also at Department of Physics, University of Cape Town, Cape Town, South Africa.
p Also at Institute of Physics, Jagiellonian University, Krakow, Poland.
q Also at School of Physics, Shandong University, Shandong, China.
r Also at DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l’Univers), CEA Saclay (Commissariat à l’Energie Atomique et aux Energies Alternatives), Gif-sur-Yvette, France.
s Also at Section de Physique, Université de Genève, Geneva, Switzerland.
t Also at Department de Physique, Universidade de Minho, Braga, Portugal.
u Also at Department of Physics, The University of Texas at Austin, Austin, TX, United States.
w Also at Department of Physics and Astronomy, University of South Carolina, Columbia, SC, United States.
x Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary.
y Also at California Institute of Technology, Pasadena, CA, United States.
z Also at Institute of Physics, Jagiellonian University, Krakow, Poland.
a Also at LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France.
b Also at Nevis Laboratory, Columbia University, Irvington, NY, United States.
c Also at Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom.
d Also at Department of Physics, Oxford University, Oxford, United Kingdom.
e Also at Department of Physics, The University of Michigan, Ann Arbor, MI, United States.
f Also at Discipline of Physics, University of KwaZulu-Natal, Durban, South Africa.
g Deceased.