BSM: Experimental Results

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UNLP-IFLP

PHENOEXP2018 9 -11 May 2018



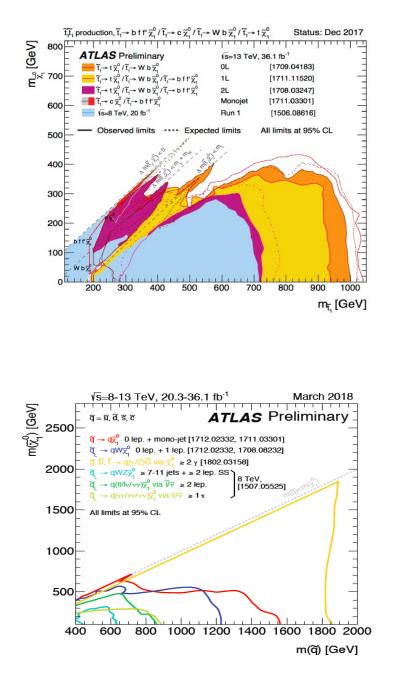


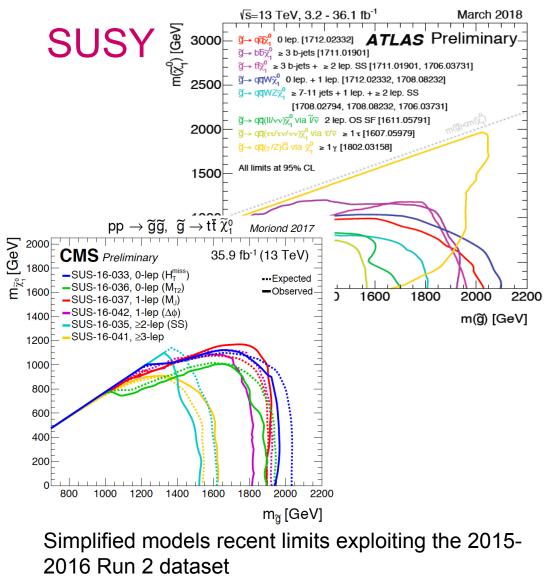
Run II results 2015-2016 data

SUSY

- Standard searches
- RPC \rightarrow RPV
- Long-lived
- Disappearing tracks
- Exotics
 - 🔸 Z' & W'
 - New heavy vector boson in diboson final states
 - Di-jet final states
 - Vector like quarks
- Dark Mater
 - Mono X

Will not include dedicated BSM Higgs searches Most of the results shown form ATLAS experiment



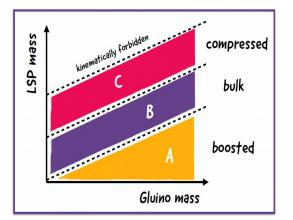


- 1.5-2 TeV exclusion for gluinos at low LSP mass, up to 1.5 TeV for squarks (8-fold degeneracy)
- Some scenarios excluding 1 TeV stops

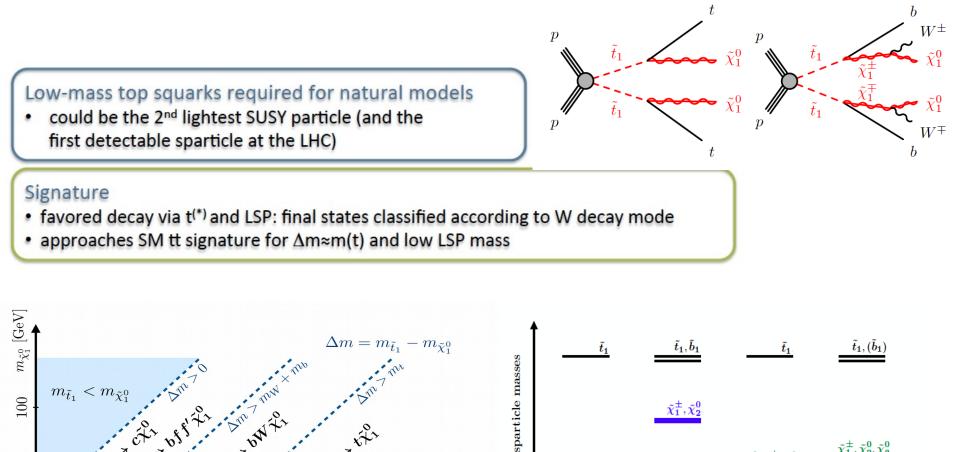
SUSY: Paradigm Shift

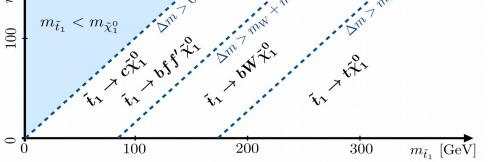
Having found no SUSY so far in "standard" channels (strong production, large mass splittings), the searches are shifting in the following directions:

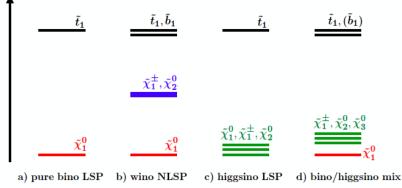
- Compressed spectrum scenarios (e.g, stop nearly degenerate with top quark + neutralino masses)
 - use ISR as an important tool to boost compressed system
- Search for EW production of SUSY particles
- Sensitivity for Higgsino pair production rapidly increasing the reach
- Search for SUSY via Higgs boson in decay chains
 - just started to be sensitive
- Go beyond the R-parity conserving models

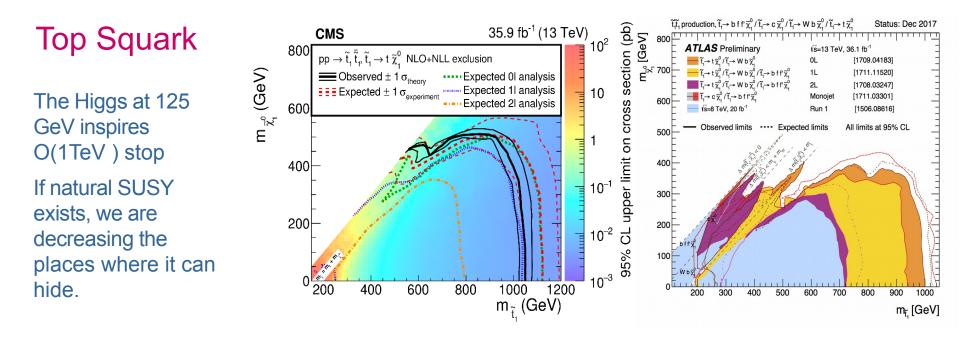


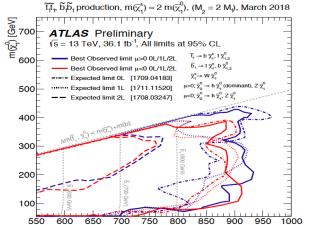
Direct pair production of top squark



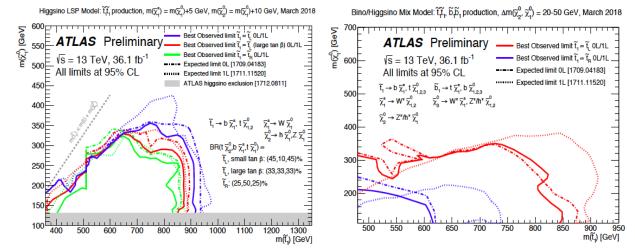








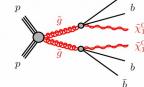
m(t̃,) [GeV]



Note that these plots overlay contours belonging to different stop decay channels, different sparticle mass hierarchies, and simplified decay scenarios. Care must be taken when interpreting them.

gluinos decaying via third generation off-shel squarks to the lightest neutralino

Multi b jets

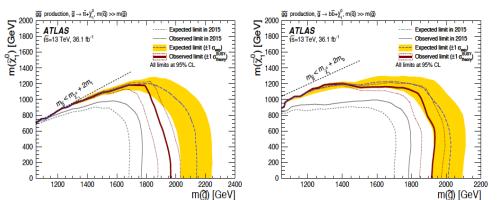


Exclusion stream uses meff shape & jet multiplicity information to perform a multi-bin fit. All search regions dominated by ttbar + heavy flavour events.

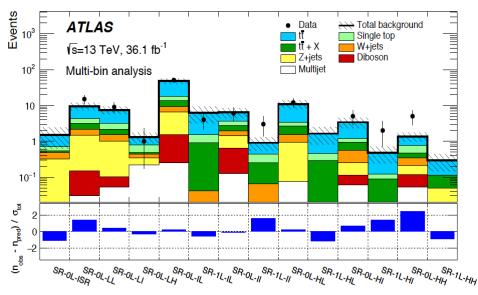
$$H_{\rm T} = \sum_{\rm visible} |p_{\rm T}| \quad m_{\rm eff} = H_{\rm T} + E_{\rm T}^{\rm miss}$$

Largest uncertainties:

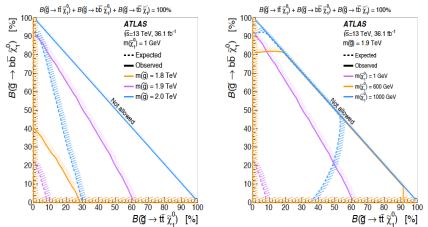
- Flavour tagging, JES/JER: 3-24%.
- ttbar modelling (RadHi/RadLo, MC Generator, Parton Shower): 5-76%.



All the regions of the multi-bin analysis are statistically combined to set model-dependent upper limits. Observed constraints on gluino masses reach 1.9 (1.95) TeV for Gbb (Gtt) simplified models.



Most significant deviation from expectation in multibin SR-0L-HH (High meff and Δm): ~2.5sig local.



Limits also interpreted as a function of the gluino BR to Gtt / Gbb / Gtb!

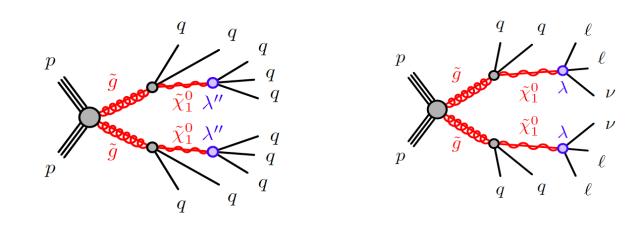
arXiv:1711.01901 [hep-ex]

RPV

$$\mathcal{W}_{\text{RPV}} = \frac{\lambda_{ijk}}{2} L_i L_j \bar{E}_k + \lambda'_{ijk} L_i Q_j \bar{D}_k + \frac{\lambda''_{ijk}}{2} \bar{U}_i \bar{D}_j \bar{D}_k + \kappa_i L_i H_u$$

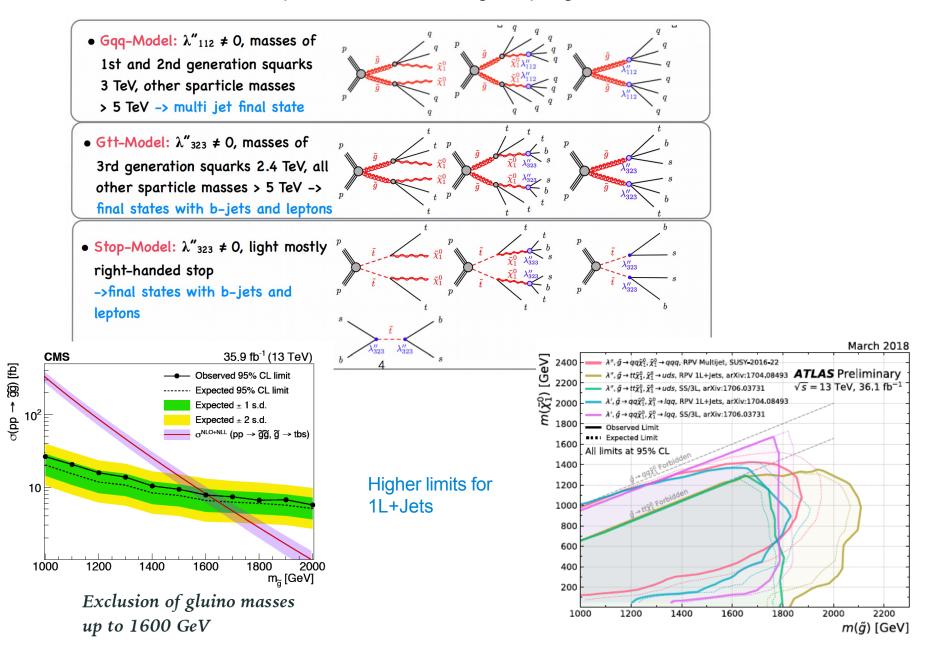
General RPV superpotential in MSSM

- If RPV couplings weaker than the gauge/Higgs couplings, SUSY particles cascade to LSP which then decays to SM particles
- $\kappa,\,\lambda,\,\lambda'$ all give rise to final states with some amount of MET from neutrinos
- λ " gives rise to quark-y final states



Hadronic RPV

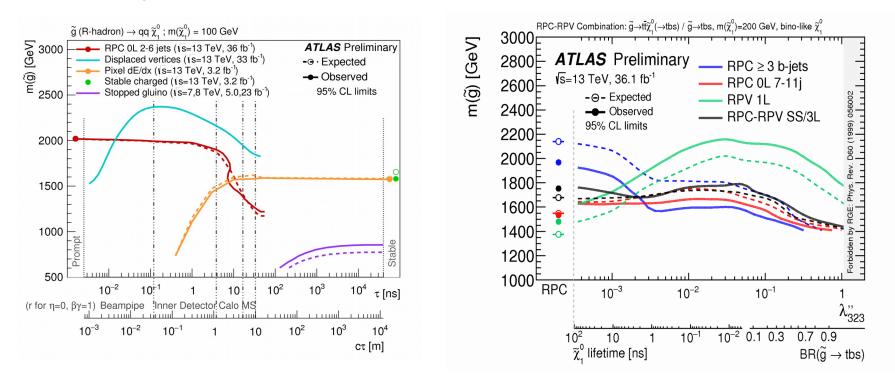
Non-zero baryon-number-violating RPV λ " couplings assumed, while Lepton-number-violating couplings, λ , λ ' are set to zero.



RPC meets RPV

Reinterpretation of searches for supersymmetry in models with variable R-parity-violating coupling strength and long-lived R-hadrons

Most RPV searches focus on maximal violation of R-parity. The LSP lifetime depends on the strength of the coupling. Scaling the coupling allows to search for SUSY final states in different regimes



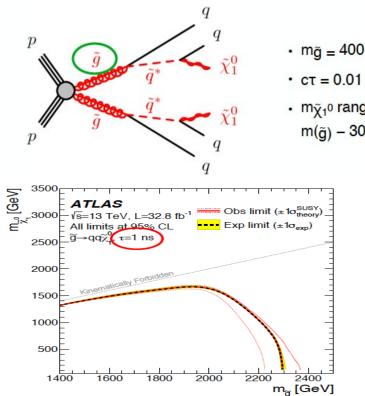
Gluino mass up to ~ 2 TeV can be excluded

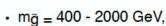
Search for long-lived massive particles

Events with displaced vertices

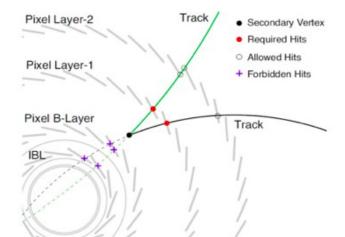
Long lifetimes in BSM models:

- R-parity violating models
- R-Hadrons: Split SUSY decays via a highly virtual intermediate state

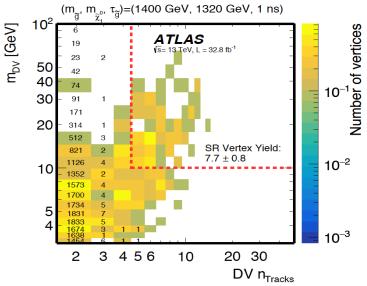




- cτ = 0.01 50 ns,
- m_{¥10} ranges from 100 GeV to m(ã) - 30 GeV.



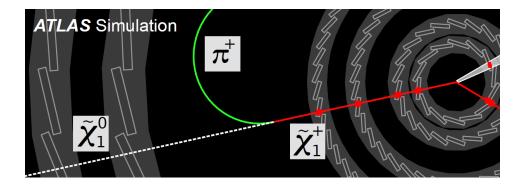
LLP decays occurring at 4 mm < r < 300 mm from the PV

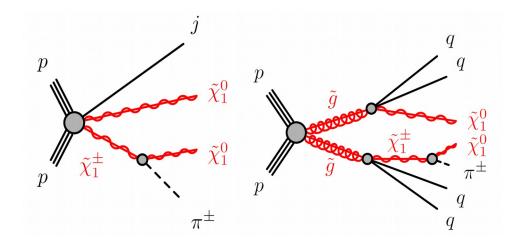


One of the highest gluino mass exclusion amongst all SUSY searches thanks to zero background

Search for disappearing tracks

Search for long-lived charged particles (charginos) leading to disappearing track + MET Pixel-only trackless with IBL reduce minimum track length to 12 cm (from 30 cm in Run-I)

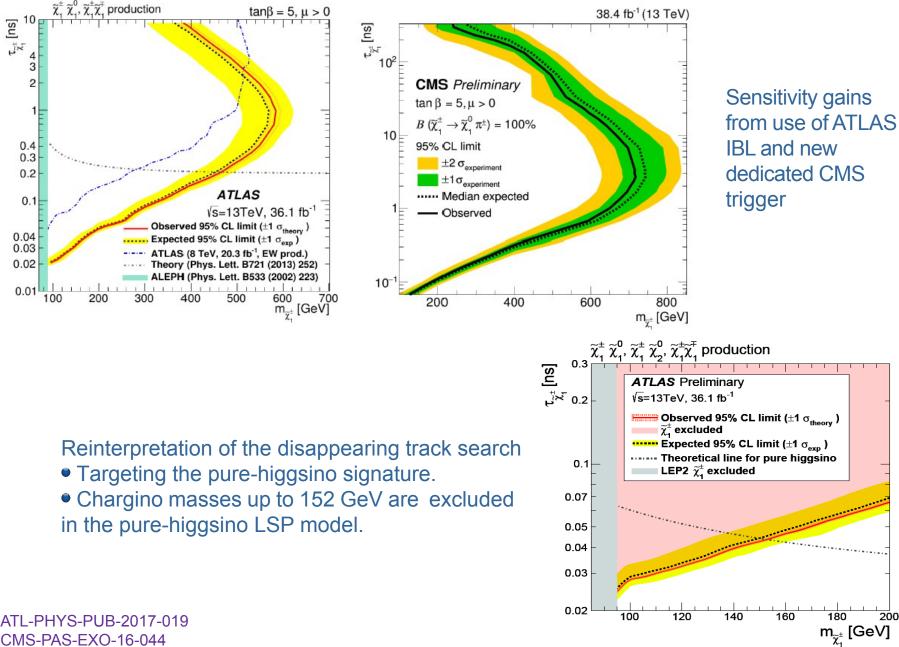




Signature: Chargino track disappears when decays, into MET and low momentum pion track (~0.1 GeV) that is hard to reconstruct. Challenge to identify the legitimate real tracklets (non-fake) using only a few measurement tracks

Almost pure wino LSP scenario

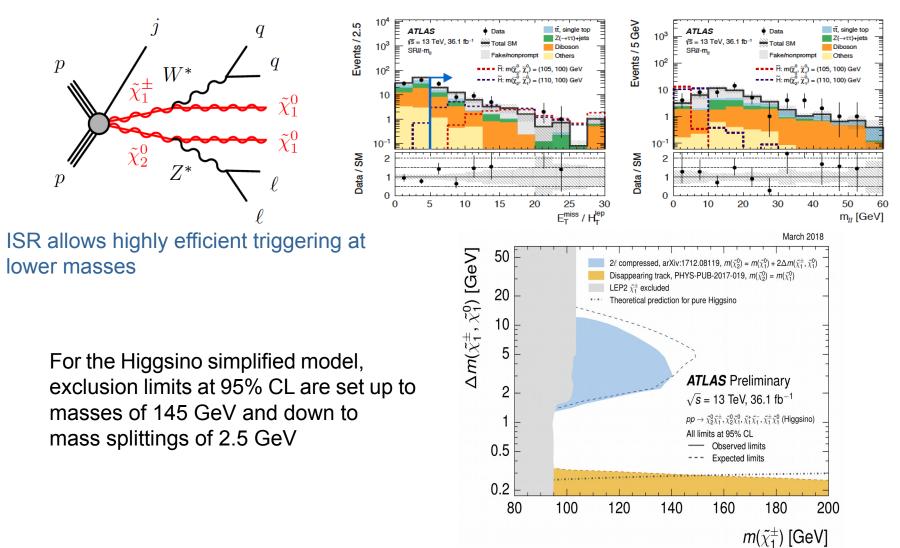
Search for disappearing tracks



ATL-PHYS-PUB-2017-019 CMS-PAS-EXO-16-044

Higgsino searches

Motivated by naturalness arguments Higgsino mass parameter μ is near the weak scale, while the bino and wino mass parameters, M1 and M2, can be significantly larger $|\mu| \ll |M1|, |M2|$. Compressed scenarios.

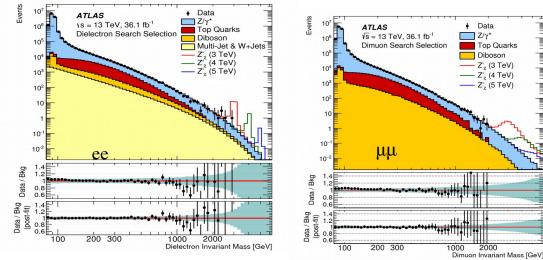




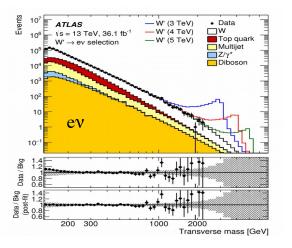
Search Z' / W' in lepton decays

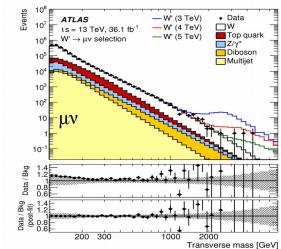
new heavy gauge boson

Search for resonant Z' and non-resonant excesses in dilepton LFC and LFV Search of resonant W'in lepton + MET



Highest invariant mass at ~2.1 TeV for all combinations





A pair of e/µ with pT > 30 GeV Fully reconstructed, high signal-selection efficiency, small & well-understood Backgrounds (DY)

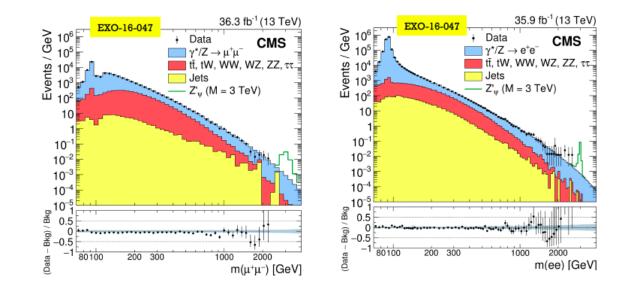
Signature A well define e/μ with pT > 55/65 GeV MeT > 55/65 GeV Dominant background • W \rightarrow ly

• ttbar + single top

No excess found Z' limit at 3.8TeV W' limit at 5.1TeV

$$m_{\rm T} = \sqrt{2p_{\rm T}^{\ell}E_{\rm T}^{\rm miss}\left(1 - \cos\Delta\phi_{\ell,E_{\rm T}^{\rm miss}}\right)}$$

Search Z' / W' in lepton decays

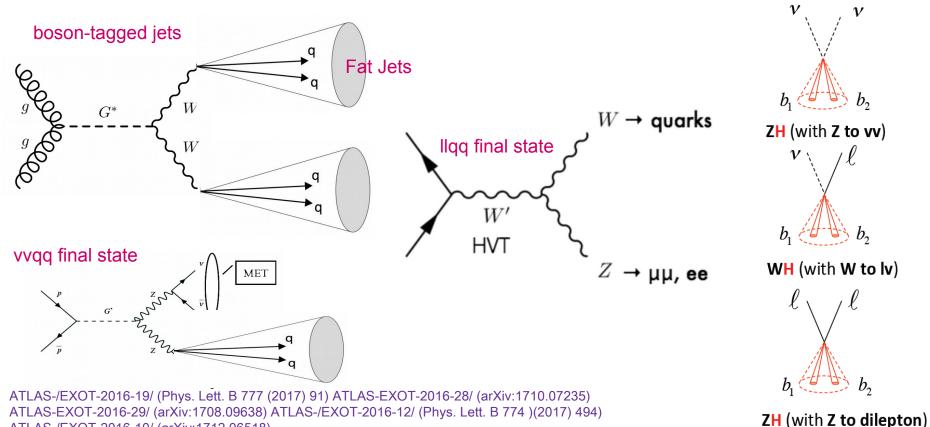


Process	New physics	Lower Mass Exclusion (TeV)	Lumi (fb ⁻¹)	Publication
X → ee/μμ	Boson spin 1 (Z') Graviton DM mediator	From 3.9 to 4.5 From 2.1 to 4.25	35.9	EXO-16-047 Submitted to JHEP
X > ee	Boson spin 1 (Z')	From 4.1 to 4.7	41.4 + 35.9	EXO-18-006 (PAS only)
X → eµ	Boson spin 1 (Ζ') τ sneutrino Quantum black-hole	4.4 1.7 From 3.6 to 5.6	35.9	EXO-16-058 CERN-EP-2018-001
$l+X \rightarrow l+W1 \rightarrow 3l+\nu$	Heavy Neutral Lepton	Upper limit on the mixing matrix element	35.9	EXO-17-012 CERN-EP-2018-006
W/Z/H \rightarrow l/ ν +W \rightarrow l ν	Heavy fermions	0.85	35.9	EXO-17-006 PhysRevLett.119.221802

Searches in diboson final state

Extensions of the SM predict the existence of new particles decaying into vector-boson pairs:

- Heavy neutral Higgs H (spin-0) → ZZ
- Heavy Vector triplet (HVT) W' (spin-1) → WZ
- Bulk Randal-Sundrum Graviton G^{*} (spin-2) \rightarrow ZZ

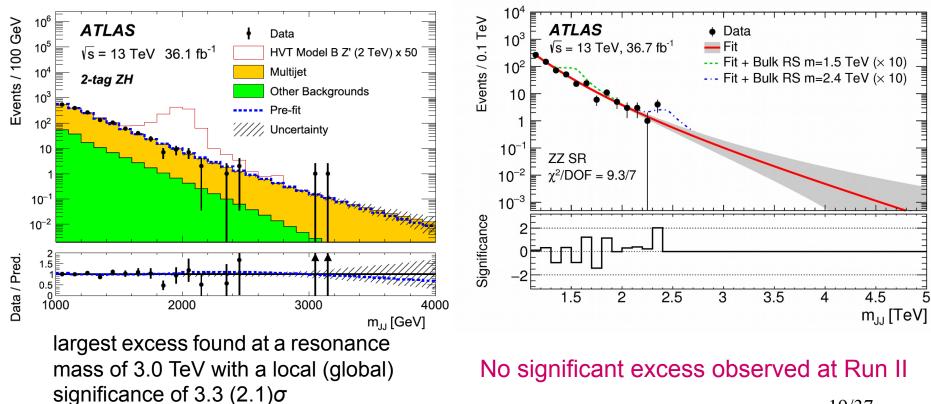


ATLAS-/EXOT-2016-10/ (arXiv:1712.06518)

Fully hadronic diboson-tagged jets (JJ) decays

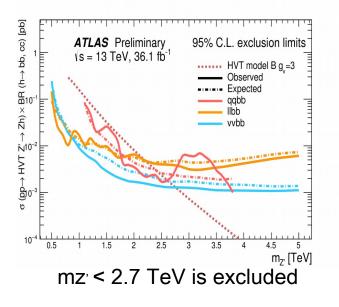
Reconstructed large-R jet substructure used to discriminate W/Z jet against multi-jets: mass, D2 (ratios of the energy correlation functions)

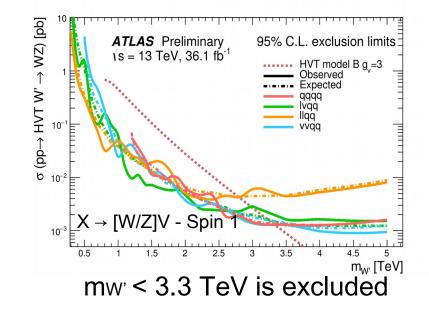
Background: di-jet, multijet shapes and normalisation are data-driven Systematic uncertainties: large-R jet energy scale and resolution

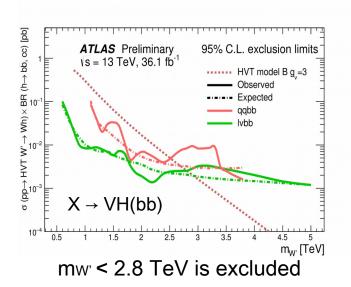


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Diboson limit summary







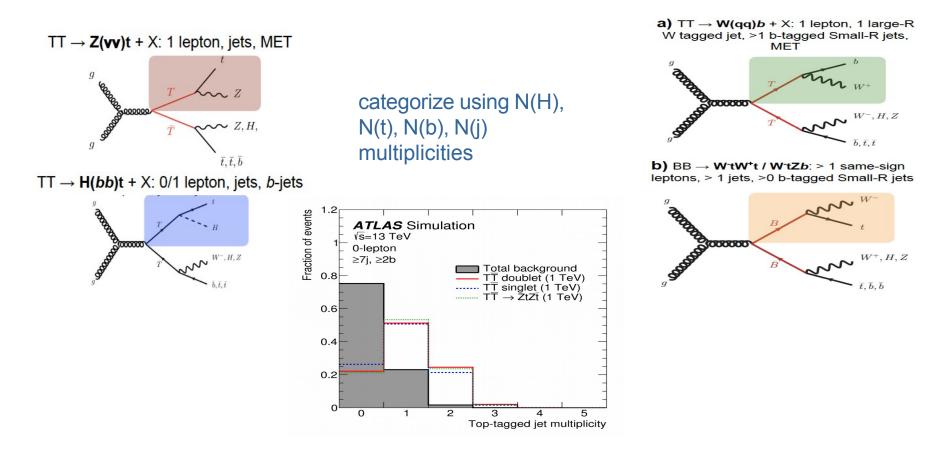
Process	New physics	Lower limit exclusion	Lumi (fb ⁻¹)	Publication
$X \rightarrow ZZ \rightarrow 41$	Graviton	From 0.8 to 1.35 TeV	35.9	B2G-16-023 THEP03(2018)003
$X \rightarrow HH \rightarrow 4$ jets	Graviton	From 0.97 to 1.4 TeV	35.9	B2G-16-026 Submitted to PLB <u>CERN-EP-2017-238</u>
$\begin{array}{l} X \rightarrow Z + W \rightarrow 2\nu + qq \\ X \rightarrow Z + Z \rightarrow 2\nu + qq \end{array}$	Spin 1 resonance (W') Graviton	3.1-3.4 TeV 0.5 and 40 fb ⁻¹	35.9	B2G-17-005 Submitted to JHEP CERN-EP-2018-023
$\begin{array}{ccc} X & \Rightarrow & Z+W \Rightarrow 2l+qq \\ X & \Rightarrow & Z+Z & \Rightarrow & 2l+qq \end{array}$	Spin 1 resonance (W') Graviton	$3-3000 \text{ fb}^{-1}$ 1.5-400 fb ⁻¹	35.9	B2G-17-013
$X \rightarrow W+W \rightarrow 2l + qq$ $X \rightarrow W+Z \rightarrow 2l + qq$	Graviton Spin 1 resonance (W')	l TeV 3 TeV	35.9	B2G-16-029 Submitted to JHEP <u>CERN-EP-2018-015</u>
$\begin{array}{l} X \rightarrow H + H \rightarrow \tau \ \tau \ + bb \\ X \rightarrow HZ/HW \rightarrow \tau \ \tau \ + qq \end{array}$	Resonances: spin 0, spin 1 and spin 2	2.4 TeV (for S=0 and W') 1.8 TeV (Z')	35.9	B2G-17-006

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/ A. Florent – Aspen 2018

Vector like quarks

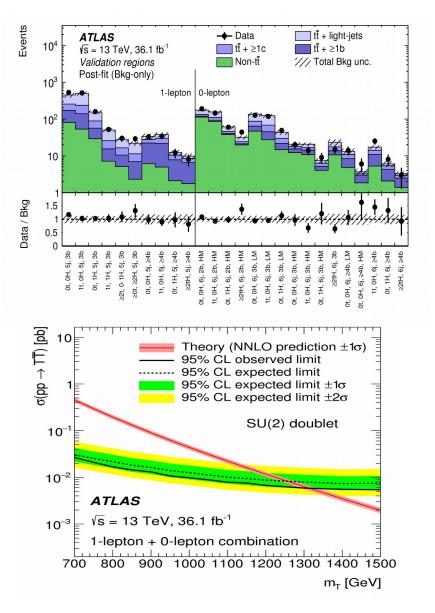
Color-triplet spin-¹/₂ fermions, left-handed and right-handed components transform in a same way under the SM gauge group

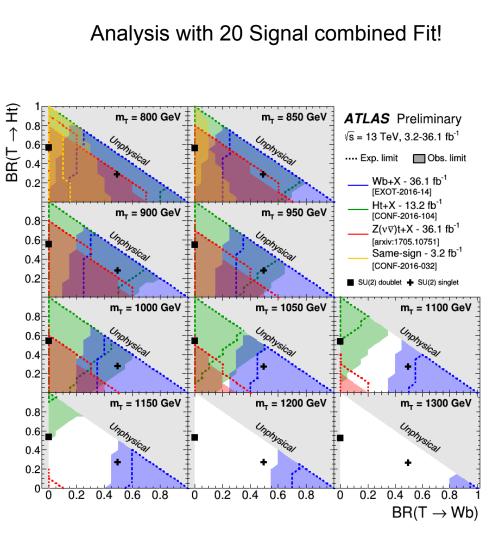
Masses of the VLQ are not generated by a Yukawa coupling, not excluded by existing Higgs Measurements. The VLQs couple preferentially to 3rd-generation quarks



ATLAS-CONF-2016-104/ (Phys. Lett. B 774)(2017) 494) ATLAS-EXOT-2016-15/ (ATLAS-CONF-2017-055)

Vector like quarks



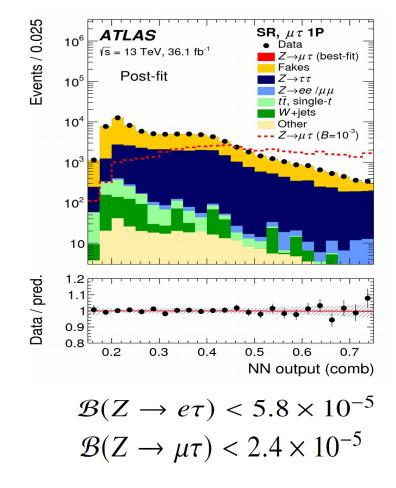


95% CL exclusion in the plane of different BRs for different values of the vectorlike T quark mass ATLAS-EXOT-2016-30

$V + \gamma$ Zy basses ntrk YES Baseline **BTAG** & double b-tagging Selection & mass window cut? NO passes ntrk < 30 YES D2 & $D_2^{(\beta=1)}$ substructure & mass window NO passes YES VMASS mass window cut? Flowcharts for the categorization of NO the events ELSE Events / 40 GeV Data 10^{2} Background Fit $\pm 1 \sigma$ $m_x=1$ TeV (σ B=248 fb) $m_x=2 \text{ TeV} (\sigma B=21 \text{ fb})$ 10^{-1} 10⁻² ATLAS √s = 13TeV, 36.1 fb⁻¹ \rightarrow X \rightarrow Z γ , Spin(X)=0, BTAG category 10⁻³ Significance 2 0 1.5 2 2.5 3 m_{Jv} [TeV]

ATLAS-EXOT-2016-36 arXiv:1804.09568

Events accepted in the SR are classified using neural networks (NNs) trained to discriminate signal from main backgrounds



In the near future, searching for smaller signals in larger data sets will required new computational and statistics techniques to face the challenge.

Others

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Dark Matter

ATLAS-CMS Dark Matter Forum

arXiv:1507.00966v

Define benchmark models for kinematically distinct signals for the so called Run-2 searches

- Simplified Models
- Provide basis for re-interpretations (distinct kinematics)
- Collected by LHC DM forum
- Dirac-fermionic WIMPs

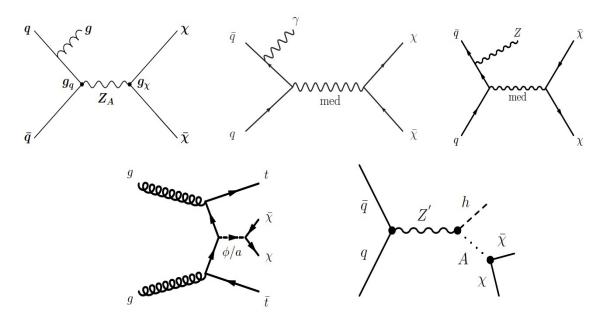
Mostly 4 parameters:

- mediator mass ($M_{_{Med}}$)
- WIMP mass (m_v)
- 2 couplings (g_q, g_χ), typically (1, 0.25)

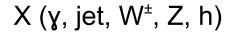
DM as WIMP

• Neutral, stable, weakly interacting particles with mass O(100 GeV)

Mono X Analysis - General Analysis Strategy



Non-interacting DM particles \rightarrow Missing transverse energy (MET)



Event Selection

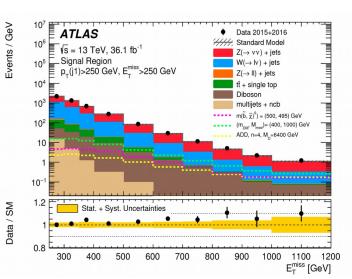
- High MET, compatible with production
- If X= γ , jet \rightarrow high $p_{\tau}(X)$ with quality criteria
- If X=W, Z, $h \rightarrow$ reconstruct mass within a windows
- Large (X,MET)
- Veto events with other "good" physics objects, like leptons

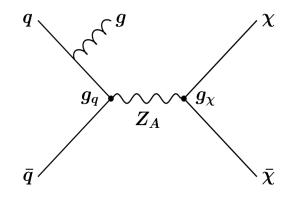
The search focus in look for excess in different regions of high MET, and in case of absence of excess, exclusion limits are extracted for the model

Mono-Jet

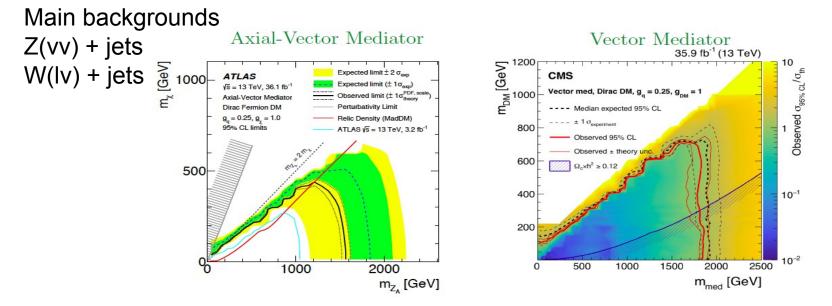
Signature High pT Jet + MET

MET triggers: efficiency turn-on reaches ~100% at 250 GeV





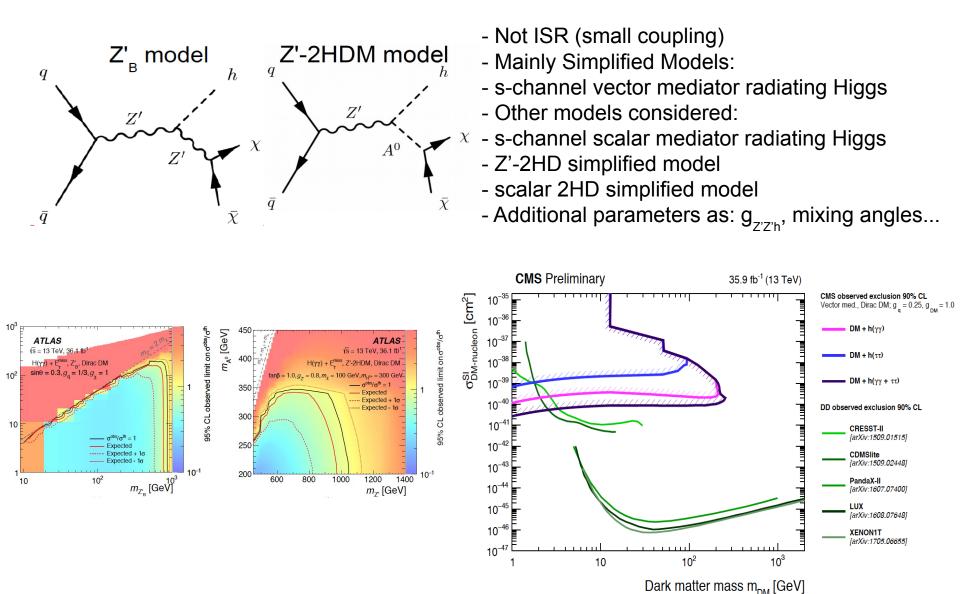
Mono-jet is one of the most powerful channels



For couplings $g_q = 0.25$, $g_{\chi} = 1.0$, axial-vector and vector mediators excluded up to 1.8 TeV (1.55 TeV) by CMS (ATLAS) for low DM masses.

Mono-Higgs

Models in which the higgs couples to dark sector particles, e.g. higgs couplings to the mediator



ATLAS HIGG-2016-18/ (Phys. Rev. D 96 (2017) 112004) ATLAS EXOT-2016-25/ (Phys. Rev. Lett. 119 (2017) 181804) CMS PAS EXO-16-055 (13 March 2018)

New phenomena in dijet

 \bar{q}

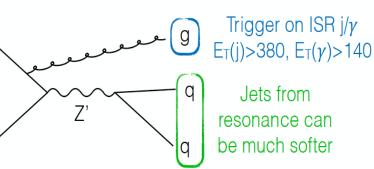
 g_{q}

Q

C

If there is a mediator that couples to quarks and DM then we can forget about the DM and look for the mediator. Many BSM models that predict dijet excesses (Quantum black holes, excited quarks, and W' and Z' bosons

2 high p_T jets. mjj is the
discriminant, search for
bump on a smooth, falling
background. Background
modelled by a parametrize
function.

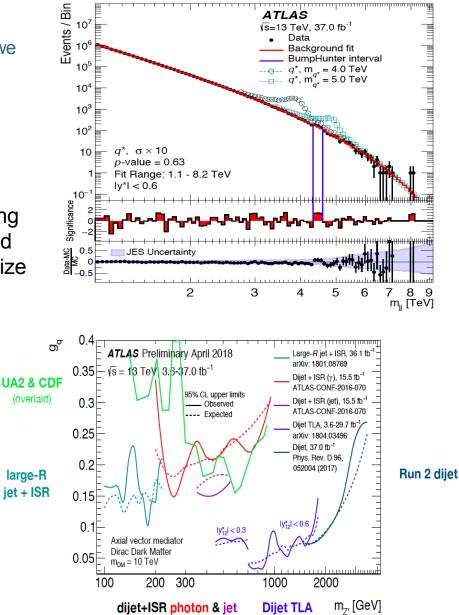


 \bar{q}

At Z' masses below ~ 200 GeV, resonance jets merge -> large-R jet

Mediator masses excluded ~ 2.6 TeV

PRD 96, 052004 (2017)



Trigger-level analysis greatly improves sensitivity

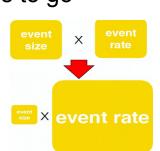
ATLAS-EXOT-2016-20

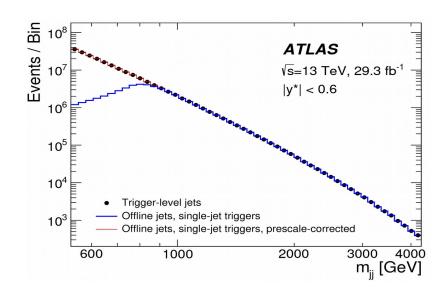
Dijet TLA

Standard dijet search sensitive to mjj \geq 1 TeV Trigger-level search:

 Dedicated data stream allows to go down to 450 GeV

Only a reduced set of information from the trigger system is recorded and subsequently analyzed.





95% CL upper limits

- TLA Observed

- Dijet Observed

----- TLA Expected (± 1-2σ)

ATLAS

29.3 fb⁻¹

 $|y^*| < 0.6$

800

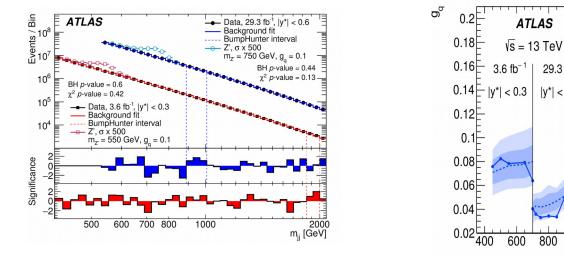
1000

1200

1400

1600

The trigger-object-level analysis (TLA) allows jet events to be recorded at a peak rate of up to twice the total rate of events using the standard approach, while using less than 1% of the total trigger bandwidth



First implemented in LHCb: "Turbo stream" arXiv: 1604.05596 CMS: "Data Scouting" Phys. Lett. B 769 (2017) 520, arXiv: 1611.03568 [hep-ex]. m₇, [GeV] 30/37

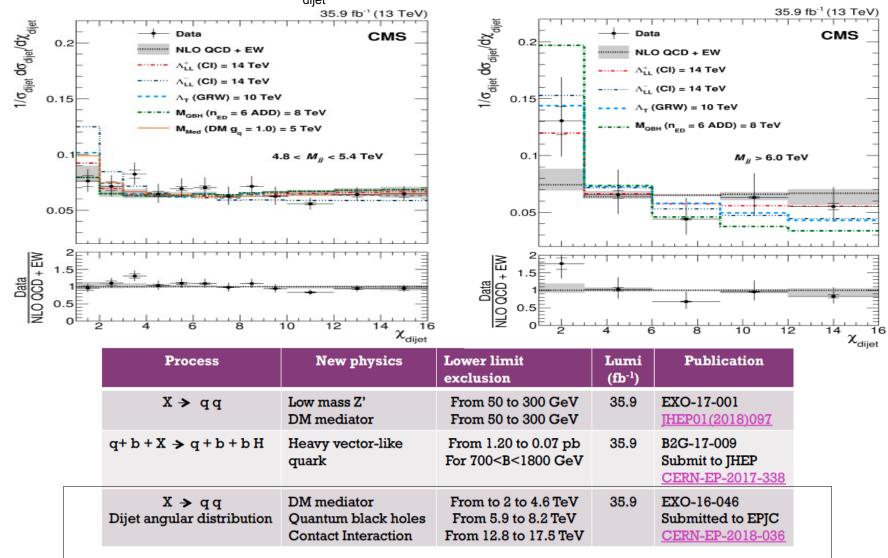
1800 2000

Dijet angular distributions

 $\chi_{\rm dijet} = \exp(|y_1 - y_2|)$

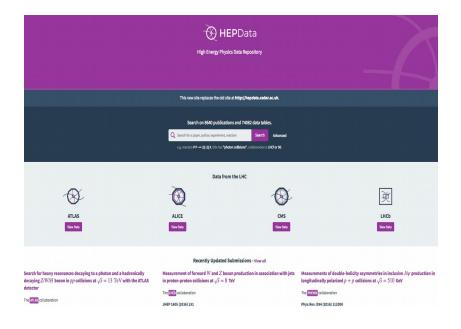
QCD predicts a relatively flat χ_{dijult} distribution while new physics (quark compositeness) is expected to

produce an excess at low values of $\chi_{_{dijet}}$



Reminder: all results in HEPData (https://hepdata.net/)

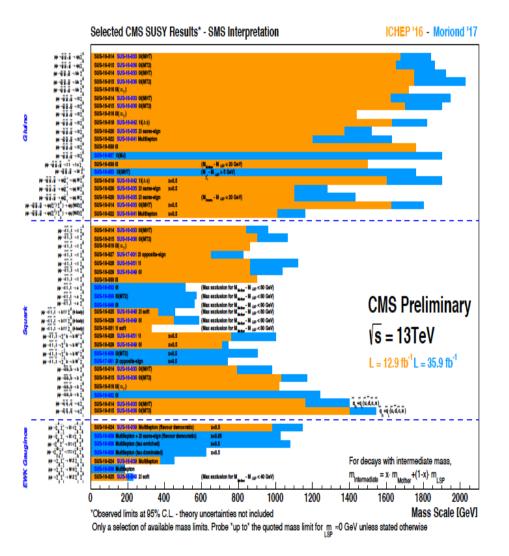
The Durham High Energy Physics Database (HEPData) has been built up over the past four decades as a unique open-access repository for scattering data from experimental particle physics. It currently comprises the data points from plots and tables related to several thousand publications including those from the Large Hadron Collider (LHC).



2, Browse all 🖉				Last updated on 201	8-03-13 16:39 📶 Accessed 226 times 🛛 55 Cite 🛛 US		
K Hide Publication Information	🕹 Download All 🗸	0					
Search for photonic signatures of gauge-mediated supersymmetry in 13 TeV <i>pp</i> collisions with the ATLAS	Filter 45 data tables	Derived exclusion limits for the squark-bino GGU model explored by the diphoton analysis. For each point in the squark-bino parameter space, the SR $(SR_{d-1}^{V} \circ SR_{d-1}^{V})$ that provides the base expected sensitivity is used to estimate the exclusion likelihood. The model dependent upper limits on cross-section (b) are shown by grey numbers for each signal point.					
detector	requirement itself. Also shown is the expected						
The ATLAS collaboration	Cross section UL 1 >	cmenergies		phrases			
Aaboud, Morad , Aad, Georges , Abbott, Brad , Abdinov, Dvsat , Abeloos, Baptiste , Abidi, Syed Haider , AbouZeid, Ossama , Abraham, Nicola , Abramowicz, Halina , Abreu, Hetso	Data from Figure 17 10.11182/htepdata.81626v1/t22 Derived exclusion limits for the gluino- bino GGM model explored by the diphoton analysis. For each point in the	€ 13000 F			Supersymmetry SUSY		
No Journal Information, 2018	gluino-bino parameter	Showing 50 of 119 valu	65	Show All 119 values	Visualize		
http://dx.doi.org/10.17182/hepdata.81626	Cross section UL 2 >	SQRT(S)	13000.0 GEV	2,100-			
INSPIRE Record HepData Resources	Data from Figure 18 10.17182/hepdata.81626.v1/t23	M(SQUARK) [GEV]	M(NEUTRALINO1) [GEV]	X-section U.L.	2,000-		
Abstract (data abstract) A search is presented for photonic signatures, motivated by	Derived exclusion limits for the squark- bino GGM model explored by the diphoton analysis. For each point in the	800	10	7.961	51,000 - 95,700 - 95,600 -		
generalized models of gauge-mediated supersymmetry breaking. This search makes use of proton-proton collision	opnoton analysis. For each point in the squark bino parameter	800	50	7.64	2,500		
data at \sqrt{s} = 13 TeV corresponding to an integrated luminosity of 36.1 fb ⁻¹ recorded by the ATLAS detector at the	Cross section UL 3	800	200	6.346	1,000-		
LHC, and explores models dominated by both strong and electroweak production of supersymmetric partner states.	Data from Figure 19 10.17182/hepdata.81626.v1/t24	800	400	5.247	1,200-		
Experimental signatures incorporating an isolated photon and significant missing transverse momentum are explored. These signatures include events with an additional photon or additional jet activity not associated with any specific	Derived exclusion limits for the wino- bino GGM model explored by the	800	600	4.361	1,000-		
	diphoton analysis. For each point in the wino-bino parameter	800	700	4.13	800		
	Cross section UL 4 >	800	750	3.534			
	Data from Figure 20	800	790	2.835	0.256 7.963		

Summary

Search for supersymmetric particles

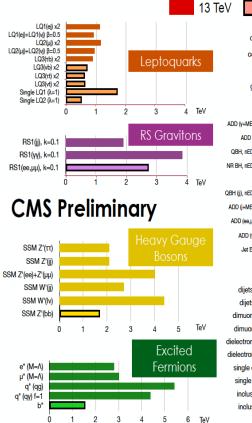


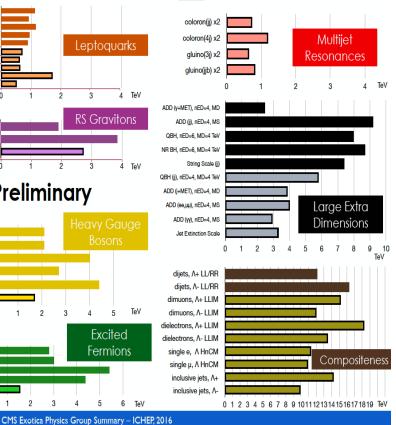
	Model	e, μ, τ, γ	Jets	E_{T}^{miss}	∫£ dt[fb ⁻	Mass limit $\sqrt{s} = 7$ Te	$\sqrt{s} = 8 \text{ TeV}$	Reference
	MSUGRA/CMSSM	D-3 e,μ/1-2 τ 2	2-10 jets/3 /	Yes	20.3	ž	1.8 TeV m(ĝ)=m(ĝ)	1507.05525
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_{1}^{0}$	0	2-6 jets	Yes	20.3	850 GeV	$m(\tilde{\chi}_1^0)=0$ GeV, $m(1^{st}$ gen, $\tilde{q})=m(2^{sd}$ gen, $\tilde{q})$	1405.7875
S	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_{1}^{0}$ (compressed)	mono-jet	1-3 jets	Yes	20.3	100-440 GeV	m(\tilde{q})-m($\tilde{\chi}_{1}^{0}$)<10 GeV	1507.05525
he	$\tilde{a}\tilde{a}, \tilde{a} \rightarrow a(ll/lv/vv)\tilde{\chi}_1^0$	2 e, µ (off-Z)	2 jets	Yes	20.3	780 GeV	m($\tilde{\chi}_{1}^{0}$)=0 GeV	1503.03290
arc	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q \tilde{q} \tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	1.33 Te ¹	m(¹ ⁰)=0 GeV	1405.7875
Searches	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_{1}^{\pm} \rightarrow qqW^{\pm}\tilde{\chi}_{1}^{0}$	0-1 e, µ	2-6 jets	Yes	20	1.26 TeV	$m(\tilde{\chi}_{1}^{0})$ <300 GeV, $m(\tilde{\chi}^{\pm})=0.5(m(\tilde{\chi}_{1}^{0})+m(\tilde{g}))$	1507.05525
0)	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e,µ	0-3 jets	•	20	1.32 Te		1501.03555
Inclusive	GMSB (<i>l</i> NLSP)	1-2 τ + 0-1 <i>l</i>	0-2 jets	Yes	20.3		.6 TeV tanβ >20	1407.0603
Ins	GGM (bino NLSP)	2γ	•	Yes	20.3	1.29 TeV		1507.05493
1CL	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	1.3 TeV		1507.05493
4	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	20.3	1.25 TeV	$m(\tilde{t}_1^0)$ <850 GeV, $c\tau$ (NLSP)<0.1 mm, μ >0	1507.05493
	GGM (higgsino NLSP)	2 e, µ (Z)	2 jets	Yes	20.3	850 GeV	m(NLSP)>430 GeV	1503.03290
	Gravitino LSP	0	mono-jet	Yes	20.3	^{/2} scale 865 GeV	$m(\tilde{G})$ >1.8 × 10 ⁻⁴ eV, $m(\tilde{g})$ = $m(\tilde{q})$ =1.5 TeV	1502.01518
ned.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b \bar{b} \tilde{\chi}_{1}^{0}$	0	36	Yes	20.1	1.25 TeV	m(\tilde{t}_1^0)<400 GeV	1407.0600
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t \tilde{\chi}_{1}^{0}$	0	7-10 jets	Yes	20.3	1.1 TeV	m($\tilde{\ell}_1^0$) <350 GeV	1308.1841
18	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t \tilde{l} \tilde{\chi}_{1}^{0}$	0-1 e, µ	36	Yes	20.1	1.34 Te		1407.0600
1	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{t}\tilde{\chi}_{1}^{*}$	0-1 e,µ	3 b	Yes	20.1	1.3 TeV		1407.0600
ion	$\tilde{b}_1 \tilde{b}_1, \tilde{b}_1 \rightarrow b \tilde{\chi}_1^0$	0	2 b	Yes	20.1	100-620 GeV	m(ℓ ₁ ⁰)<90 GeV	1308.2631
lot	$\tilde{b}_1 \tilde{b}_1, \tilde{b}_1 \rightarrow t \tilde{\chi}_1^{\pm}$	2 e, μ (SS) 1-2 e, μ	0-3 b	Yes	20.3	275-440 GeV 110-167 GeV 230-460 GeV	$m(\tilde{\chi}_{1}^{2})=2 m(\tilde{\chi}_{1}^{0})$	1404.2500 1209.2102, 1407.058
oduction	$\tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow b \tilde{X}_1^{\dagger}$		1-2 b)-2 jets/1-2		.7/20.3		$m(\tilde{\ell}_{1}^{\pm}) = 2m(\tilde{\ell}_{1}^{0}), m(\tilde{\ell}_{1}^{0})=55 \text{ GeV}$	
Not pre	$\tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow Wh \tilde{\chi}_1^0 \text{ or } t \tilde{\chi}_1^0$		nono-jet/c-ta		20.3 20.3	90-191 GeV 210-700 GeV 90-240 GeV	m($\tilde{\ell}_{1}^{0}$)=1 GeV	1506.08616 1407.0608
Sct	$\tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow c \tilde{t}_1^0$ $\tilde{t}_1 \tilde{t}_1$ (natural GMSB)	2 e, µ (Z)	1 b	Yes	20.3	150-580 GeV	m(t̃₁)·m(t̃₁)<85 GeV m(t̃₁)>150 GeV	1407.0008
dire	$\tilde{t}_2 \tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$	$3 e, \mu(Z)$	16	Yes	20.3	290-600 GeV	m(t ₁)>100 GeV m(t ⁰)<200 GeV	1403.5222
_	$\tilde{l}_{L,R}\tilde{l}_{L,R}, \tilde{l} \rightarrow \ell \tilde{\chi}_1^0$	2 e.µ	0	Yes	20.3	90-325 GeV	m(ž ⁰)=0 GeV	1403.5294
	$\tilde{\chi}_{1,R}^{+}\tilde{\chi}_{1,\tilde{\chi}_{1}}^{-}, \tilde{\chi}_{1}^{+} \rightarrow \tilde{\ell}\nu(\ell\tilde{\nu})$	2 e, µ	0	Yes	20.3	140-465 GeV	$m(\tilde{\chi}_{1}^{0})=0 \text{ GeV}$ $m(\tilde{\chi}_{1}^{0})=0 \text{ GeV}, m(\tilde{\chi}, \tilde{v})=0.5(m(\tilde{\chi}_{1}^{0})+m(\tilde{\chi}_{1}^{0}))$	1403.5294
	$\tilde{\chi}_{1}^{\dagger}\tilde{\chi}_{1}^{\dagger}, \tilde{\chi}_{1}^{\dagger} \rightarrow \tilde{t}\nu(t\bar{\nu})$	27		Yes	20.3	100-350 GeV	$m(\tilde{\chi}_{1}^{0})=0$ GeV, $m(\tilde{\tau}, \tilde{\nu})=0.5(m(\tilde{\chi}_{1}^{1})+m(\tilde{\chi}_{1}^{0}))$ $m(\tilde{\chi}_{1}^{1})=0$ GeV, $m(\tilde{\tau}, \tilde{\nu})=0.5(m(\tilde{\chi}_{1}^{1})+m(\tilde{\chi}_{1}^{0}))$	1407.0350
of ,	$\tilde{\chi}_{1}^{\dagger}\tilde{\chi}_{2}^{0} \rightarrow \tilde{\ell}_{L} v \tilde{\ell}_{L} \ell (\tilde{\nu} v), \ell \tilde{\nu} \tilde{\ell}_{L} \ell (\tilde{\nu} v)$	3 e,µ	0	Yes	20.3	.i. 700 GeV	$m(\tilde{\chi}_{1}^{0})=m(\tilde{\chi}_{2}^{0}), m(\tilde{\chi}_{1}^{0})=0, m(\tilde{\ell}, \tilde{\nu})=0.5(m(\tilde{\chi}_{1}^{1})+m(\tilde{\chi}_{1}^{0}))$	1402.7029
direc	$\hat{x}_{1}^{\pm}\hat{x}_{0}^{0} \rightarrow W\hat{x}_{1}^{0}Z\hat{x}_{1}^{0}$	2-3 e. µ	0-2 iets	Yes	20.3	420 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^{0}), m(\tilde{\chi}_1^{0})=0, sleptons decoupled$	1403.5294, 1402.702
0	$\tilde{\chi}_{1}^{\pm}\tilde{\chi}_{2}^{0} \rightarrow W \tilde{\chi}_{1}^{0} h \tilde{\chi}_{1}^{0}, h \rightarrow b \bar{b} / W W / \tau \tau$	1 e, µ, y	0-26	Yes	20.3	.x. 250 GeV	$m(\tilde{\chi}_1^{\pm})=m(\tilde{\chi}_2^0), m(\tilde{\chi}_1^0)=0$, sleptons decoupled	1501.07110
	$\hat{\chi}_{1}^{\pm}\hat{\chi}_{2}^{0} \rightarrow W \hat{\chi}_{1}^{0} Z \hat{\chi}_{1}^{0}$ $\hat{\chi}_{1}^{\pm} \hat{\chi}_{2}^{0} \rightarrow W \hat{\chi}_{1}^{0} h \hat{\chi}_{1}^{0}, h \rightarrow b \bar{b} / W W / \tau \tau,$ $\hat{\chi}_{2}^{0} \hat{\chi}_{3}^{0}, \hat{\chi}_{2,3}^{0} \rightarrow \ell_{R} \ell$	4 e,µ	0	Yes	20.3	620 GeV	$m(\tilde{\ell}_{2}^{0})=m(\tilde{\ell}_{3}^{0}), m(\tilde{\ell}_{1}^{0})=0, m(\tilde{\ell}, \tilde{r})=0.5(m(\tilde{\ell}_{2}^{0})+m(\tilde{\ell}_{1}^{0}))$	1405.5086
-	GGM (wino NLSP) weak prod.	1 e, $\mu + \gamma$	•	Yes	20.3	124-361 GeV	cr<1mm	1507.05493
	Direct $\tilde{\chi}_{1}^{\dagger} \tilde{\chi}_{1}^{-}$ prod., long-lived $\tilde{\chi}_{1}^{\pm}$	Disapp. trk	1 jet	Yes	20.3	270 GeV	$m(\tilde{\chi}_{1}^{\pm}) \cdot m(\tilde{\chi}_{1}^{0}) \sim 160$ MeV, $\tau(\tilde{\chi}_{1}^{\pm}) = 0.2$ ns	1310.3675
	Direct $\tilde{\chi}_{1}^{\dagger} \tilde{\chi}_{1}^{-}$ prod., long-lived $\tilde{\chi}_{1}^{\pm}$	dE/dx trk	•	Yes	18.4	482 GeV	$m(\tilde{\chi}_{1}^{\pm})-m(\tilde{\chi}_{1}^{0})\sim$ 160 MeV, $\tau(\tilde{\chi}_{1}^{\pm})<$ 15 ns	1506.05332
es	Stable, stopped § R-hadron	0	1-5 jets	Yes	27.9	832 GeV	m(μ ⁰)=100 GeV, 10 μs <r(g)<1000 s<="" td=""><td>1310.6584</td></r(g)<1000>	1310.6584
particles	Stable g R-hadron	trk	•	•	19.1	1.27 TeV		1411.6795
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e)$,μ) 1-2 μ	•	•	19.1	537 GeV	10 <tan8<50< td=""><td>1411.6795</td></tan8<50<>	1411.6795
JQ	GMSB, $\tilde{\chi}_{1}^{0} \rightarrow \gamma \tilde{G}$, long-lived $\tilde{\chi}_{1}^{0}$	2γ	•	Yes	20.3	435 GeV	2 <r(x10)<3 model<="" ns,="" sps8="" td=""><td>1409.5542</td></r(x10)<3>	1409.5542
	$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow eev/e\mu v/\mu\mu v$	displ. ee/eµ/µ			20.3	1.0 TeV	$7 < cr(\tilde{\chi}_1^0) < 740 \text{ mm}, m(\tilde{g})=1.3 \text{ TeV}$	1504.05162
_	GGM $\tilde{g}\tilde{g}, \tilde{\chi}^0_1 \rightarrow Z\tilde{G}$	displ. vtx + jet			20.3	1.0 TeV	6 <cτ(\$1)<480 m(g)="1.1" mm,="" td="" tev<=""><td>1504.05162</td></cτ(\$1)<480>	1504.05162
	LFV $pp \rightarrow \tilde{v}_{\tau} + X, \tilde{v}_{\tau} \rightarrow e\mu/e\tau/\mu\tau$	еµ,ет,µт			20.3		1.7 TeV λ' ₃₁₁ =0.11, λ _{132/133/233} =0.07	1503.04430
	Bilinear RPV CMSSM	2 e,μ (SS) 4 e,μ	0-3 b	Yes	20.3 20.3	8 1.35 Te 750 GeV		1404.2500 1405.5086
	$\tilde{\chi}_{1}^{\dagger}\tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{\dagger} \rightarrow W \tilde{\chi}_{1}^{0}, \tilde{\chi}_{1}^{0} \rightarrow e e \tilde{v}_{\mu}, e \mu \tilde{v}_{e}$ $\tilde{\chi}_{1}^{\dagger}\tilde{\chi}_{1}^{-}, \tilde{\chi}_{1}^{\dagger} \rightarrow W \tilde{\chi}_{1}^{0}, \tilde{\chi}_{1}^{0} \rightarrow \tau \tau \tilde{v}_{e}, e \tau \tilde{v}_{\tau}$	4 e,μ 3 e,μ + τ		Yes	20.3	450 GeV	$m(\tilde{\chi}_{1}^{0})>0.2\times m(\tilde{\chi}_{1}^{+}), \lambda_{121}\neq 0$ $m(\tilde{\chi}_{1}^{0})>0.2\times m(\tilde{\chi}_{1}^{+}), \lambda_{123}\neq 0$	1405.5086
RPV	$X_1X_1, X_1 \rightarrow WX_1, X_1 \rightarrow \tau \tau \tilde{v}_e, e \tau \tilde{v}_\tau$ $\tilde{g}\tilde{g}, \tilde{g} \rightarrow qqq$	ο e,μ+τ 0	6-7 jets	res	20.3	450 GeV 917 GeV	$m(\ell_1)>0.2\times m(\ell_1), \ \ell_{133}\neq 0$ BR(t)=BR(b)=BR(c)=0%	1405.5085
ŭ	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{\chi}^{0}_{1}, \tilde{\chi}^{0}_{1} \rightarrow qqq$	0	6-7 jets		20.3	917 GeV 870 GeV	m($\tilde{\chi}_{1}^{0}$)=600 GeV	1502.05686
	$gg, g \rightarrow q \ell_1, \ell_1 \rightarrow q q q$ $\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}_1 t, \tilde{t}_1 \rightarrow b s$	2 e, µ (SS)	0-3 b	Yes	20.3	850 GeV	mix I hood day	1404.250
	$\tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow bs$		2 jets + 2 b		20.3	100-308 GeV		ATLAS-CONF-2015-02
	$\tilde{t}_1 \tilde{t}_1, \tilde{t}_1 \rightarrow b \ell$	2 e,µ	26		20.3	0.4-1.0 TeV	$BR(\tilde{t}_1 \rightarrow be/\mu) > 20\%$	ATLAS-CONF-2015-01
her	Scalar charm, $\tilde{c} \rightarrow c \tilde{\ell}_1^0$	0	20	Yes	20.3	490 GeV	m(\tilde{t}_1^0)<200 GeV	1501.01325

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 or theoretical signal cross section uncertainty.

Gluino/Squark limits are pushing 1.5 - 2 TeV Stop limits are pushing Selected 1 TeV

Search for exotic particles





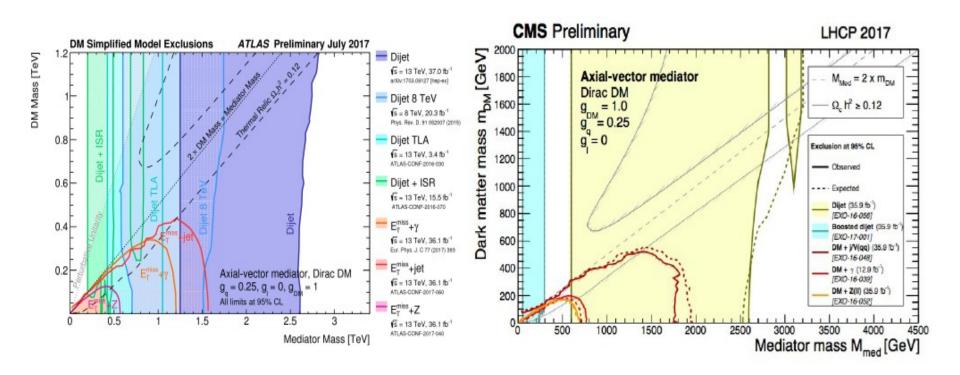
8 TeV

	Model	l.v	Jets†	Emiss	(£ dt[ft	- ¹ l Limit			Reference
_	mouch	,		Т	Janta				neierenee
Extra dimensions	ADD $G_{KK} + g/q$	0 e, µ	1 – 4 j	Yes	36.1	Mo	7.75 TeV	n = 2	ATLAS-CONF-2017-06
0	ADD non-resonant yy	2γ	-	-	36.7	Ms	8.6 TeV	n = 3 HLZ NLO	CERN-EP-2017-132
SU	ADD QBH	-	2 j	-	37.0	Ma	8.9 TeV	<i>n</i> = 6	1703.09217
ne	ADD BH high $\sum \rho_T$	$\geq 1 e, \mu$	≥ 2 j	-	3.2	Ma	8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1606.02265
6	ADD BH multijet	-	≥3j	-	3.6	Ma	9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
B	RS1 $G_{KK} \rightarrow \gamma \gamma$	2γ	-	-	36.7	G _{KK} mass 4.1 TeV		$k/\overline{M}_{Pl} = 0.1$	CERN-EP-2017-132
X	Bulk RS $G_{KK} \rightarrow WW \rightarrow qq\ell v$	1 e, µ	1 J	Yes	36.1	G _{KK} mass 1.75 TeV		$k/\overline{M}_{PT} = 1.0$	ATLAS-CONF-2017-0
	2UED / RPP	1 e, µ	≥ 2 b, ≥ 3 j	Yes	13.2	KK mass 1.6 TeV		Tier (1,1), $\mathcal{B}(A^{(1,1)} \rightarrow tt) = 1$	ATLAS-CONF-2016-10
	$SSM\: Z' \to \ell\ell$	2 e, µ	-	-	36.1	Z' mass 4.5 TeV	r		ATLAS-CONF-2017-02
n	SSM $Z' \rightarrow \tau \tau$	2τ	-	-	36.1	Z' mass 2.4 TeV			ATLAS-CONF-2017-05
5	Leptophobic $Z' \rightarrow bb$	-	2 b	-	3.2	Z' mass 1.5 TeV			1603.08791
ŝ	Leptophobic $Z' \rightarrow tt$	1 e, µ	\geq 1 b, \geq 1J/2	2j Yes	3.2	Z' mass 2.0 TeV		$\Gamma/m = 3\%$	ATLAS-CONF-2016-0
1	SSM $W' \rightarrow \ell v$	1 e, µ	-	Yes	36.1	W' mass 5.1 T	eV		1706.04786
6	HVT $V' \rightarrow WV \rightarrow qqqq$ model	Β 0 e, μ	2 J	-	36.7	V' mass 3.5 TeV		$g_V = 3$	CERN-EP-2017-147
aduge posolis	HVT $V' \rightarrow WH/ZH$ model B	multi-chann	el		36.1	V' mass 2.93 TeV		$g_V = 3$	ATLAS-CONF-2017-05
·	LRSM $W'_R \rightarrow tb$	1 e, µ	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV			1410.4103
	LRSM $W'_R \rightarrow tb$	0 e, µ	≥ 1 b, 1 J	-	20.3	W' mass 1.76 TeV			1408.0886
	Cl qqqq	-	2 j	-	37.0	٨		21.8 TeV 11	1703.09217
Ū	Ci ll qq 2 e, µ		2 e, µ 36		36.1	٨		40.1 TeV 11	ATLAS-CONF-2017-02
	Cl uutt	2(SS)/≥3 e,	µ ≥1 b, ≥1 j	Yes	20.3	۸. 4.9 Te	V	$ C_{RR} = 1$	1504.04605
MD	Axial-vector mediator (Dirac DM) 0 e.u	1-4i	Yes	36.1	m _{med} 1.5 TeV		g ₀ =0.25, g _v =1.0, m(χ) < 400 GeV	ATLAS-CONF-2017-06
	Vector mediator (Dirac DM)	0 e, µ, 1 γ	≤1j	Yes	36.1	m _{med} 1.2 TeV		$g_p=0.25, g_p=1.0, m(\chi) < 480 \text{ GeV}$	1704.03848
1	VV _{χχ} EFT (Dirac DM)	0 e, µ	1 J, ≤ 1 j	Yes	3.2	M. 700 GeV		m(χ) < 150 GeV	1608.02372
	Scalar LQ 1st gen	2 e	≥2i	-	3.2	LQ mass 1.1 TeV		$\beta = 1$	1605.06035
2 2	Scalar LQ 2 nd gen	24	≥ 2 j	-	3.2	LQ mass 1.05 TeV		$\beta = 1$	1605.06035
1	Scalar LQ 3rd gen	1 e,µ	≥1 b, ≥3 j	Yes	20.3	LQ mass 640 GeV		$\beta = 0$	1508.04735
	VLQ $TT \rightarrow Ht + X$	0 or 1 e. u	≥ 2 b. ≥ 3 i	Yes	13.2	T mass 1.2 TeV		$\mathcal{B}(T \rightarrow Ht) = 1$	ATLAS-CONF-2016-10
SY I	VLQ $TT \rightarrow Zt + X$	1 e.u	≥ 1 b, ≥ 3 j		36.1	T mass 1.16 TeV		$\mathcal{B}(T \rightarrow Zt) = 1$	1705.10751
B	$VLQ TT \rightarrow Wb + X$	1 e.u	≥ 1 b, ≥ 1J/2		36.1	T mass 1.35 TeV		$\mathcal{B}(T \rightarrow Wb) = 1$	CERN-EP-2017-094
2	VLQ $BB \rightarrow Hb + X$	1 e,µ	$\geq 2 b, \geq 3$	Yes	20.3	B mass 700 GeV		$\mathcal{B}(B \rightarrow Hb) = 1$	1505.04306
5	VLQ $BB \rightarrow Zb + X$	2/≥3 e,µ	≥2/≥1 b	-	20.3	B mass 790 GeV		$\mathcal{B}(B \rightarrow Zb) = 1$	1409.5500
neavy quarks	$VLQ BB \rightarrow Wt + X$	1 e,µ	$\geq 1 \text{ b}, \geq 1 \text{ J/3}$	2j Yes	36.1	B mass 1.25 TeV		$\mathcal{B}(B \rightarrow Wt) = 1$	CERN-EP-2017-094
٦.	$VLQ \ QQ \rightarrow WqWq$	1 e,µ	$\geq 4 j$	Yes	20.3	Q mass 690 GeV			1509.04261
	Excited quark $q^* \rightarrow qg$	-	2j	-	37.0	q" mass 6,	0 TeV	only u^* and d^* , $\Lambda = m(q^*)$	1703.09127
S	Excited quark $q^* \rightarrow q\gamma$	1 y	1	-	36.7	g" mass 5.3 1		only u^* and d^* , $\Lambda = m(q^*)$	CERN-EP-2017-148
io	Excited quark $b^* \rightarrow bg$	-	1 b, 1 j	-	13.3	b' mass 2.3 TeV		,	ATLAS-CONF-2016-0
fermions	Excited quark $b^* \rightarrow Wt$	1 or 2 e, µ	1 b, 2-0 j	Yes	20.3	b" mass 1.5 TeV		$f_g = f_L = f_R = 1$	1510.02664
fe	Excited lepton l*	3 e, µ	-	-	20.3	<i>l</i> * mass 3.0 TeV		$\Lambda = 3.0 \text{ TeV}$	1411.2921
	Excited lepton v*	3 e,μ,τ	-	-	20.3	v* mass 1.6 TeV		$\Lambda = 1.6 \text{ TeV}$	1411.2921
	LRSM Majorana v	2 e,µ	2 j	-	20.3	N ^e mass 2.0 TeV		$m(W_R) = 2.4$ TeV, no mixing	1506.06020
	Higgs triplet $H^{\pm\pm} \rightarrow \ell \ell$	2,3,4 e, µ (S		-	36.1	H ^{±±} mass 870 GeV		DY production	ATLAS-CONF-2017-0
	Higgs triplet $H^{\pm\pm} \rightarrow \ell \tau$	3 e,µ, τ	-	-	20.3	H ^{±±} mass 400 GeV		DY production, $\mathcal{B}(H_t^{\pm\pm} \rightarrow \ell\tau) = 1$	1411.2921
Unner	Monotop (non-res prod)	1 e,µ	1 b	Yes	20.3	spin-1 invisible particle mass 657 GeV		anon-res = 0.2	1410.5404
C	Multi-charged particles	-	-	-	20.3	multi-charged particle mass 785 GeV		DY production, $ q = 5e$	1504.04188
	Magnetic monopoles	_	-	-	7.0	monopole mass 1.34 TeV		DY production, $ g = 1g_D$, spin 1/2	1509.08059

*Only a selection of the available mass limits on new states or phenomena is shown.

†Small-radius (large-radius) jets are denoted by the letter j (J).

Search DM



Dijet searches can exclude mediator masses between 50 GeV and 2.7 TeV for almost whole DM mass range

Conclusions

- Very extensive set of BSM analyses
- No evidence for any BSM physics yet
- unconventional signatures are gaining in popularity
- In 2017 and 2018 more data is to be added (expected more than 100 fb⁻¹)
 many regions and models still unexplored

Backup slides

Credits

- A. Sanchez KEK-PH 2018
- J. Mitrevski DIS2018
- A. Paramonov Aspen 2018
- M. LeBlanc DIS 2018
- K. Bierwagen Moriond QCD 2018
- C. Sandoval DIS 2018
- J. Butler Alps 2018
- A. Florent Aspen 2018
- E. Torro Moriond QCD 2018
- H. Otono Aspen 2018
- W. Kalderon DIS 2018
- D. Barberis Moriond EW 2018
- C. Seitz Moriond EW 2018

Public Results

All public results:

- ATLAS: https:/twiki.cern.ch/twiki/bin/view/AtlasPublic/WebHome
- CMS: http://cms-results.web.cern.ch/cms-results/public-results/publications/

EXOTICS specific results:

- ATLAS: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ExoticsPublicResults
- CMS: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsEXO

SUSY specific results:

ATLAS: https:/twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults
 CMS: http://cms-results.web.cern.ch/cms-results/public-

results/publications/SUS/index.html

ATLAS Recent Results

- **RPV multijet 1-lepton** 1. long-lived reinterpretation 2. displaced vertices 3. disappearing track 4. 5. multijet (7-11) 6. OL inclusive 1-lepton + MET + jet 7. 8. stop in Z/h SS/3L 9. 10. stop 2L 11. 2b+MET 12. stop 0L 13. stop b-l 14. multi b-jets 15. stop 2x2 16. stop 1L 17. Stop in stau 18. electroweak compressed 19. SUSY with photons GMSB Higgsinos in 4b 20.
- Electroweak di-tau 21.
- 22. EW 2/3L

1704.08493 [hep-ex] CONF-SUSY-2018-03 1710.04901 [hep-ex] PHYS-PUB-2017-019

1708.02794 [hep-ex] 1712.02332 [hep-ex] 1708.08232 [hep-ex]

1706.03986 [hep-ex] 1706.03731 [hep-ex] 1708.03247 [hep-ex] 1708.09266 [hep-ex] 1709.04183 [hep-ex] 1710.05544 [hep-ex] 1711.01901 [hep-ex] 1710.07171 [hep-ex] 1711.11520 [hep-ex] ATLAS-CONF-2017-079

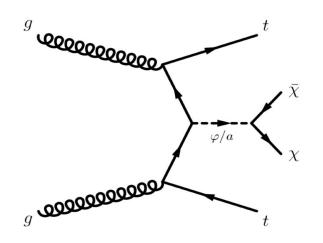
1712.08119 [hep-ex] 1802.03158 [hep-ex] ATLAS-CONF-2017-081 1708.07875 [hep-ex] 1803.02762 [hep-ex]

All these use 2015+2016 data: 36 fb⁻¹ at $\sqrt{s} = 13$ TeV

Expect ~150 fb⁻¹ in Run2. We already have about 80 fb⁻¹.

No significant excesses. Searches in red have slight excess.

ttbar+X

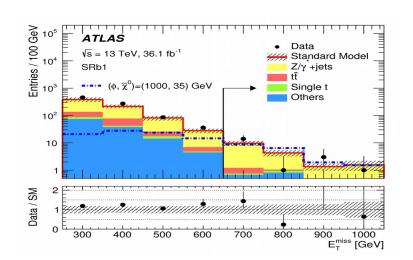


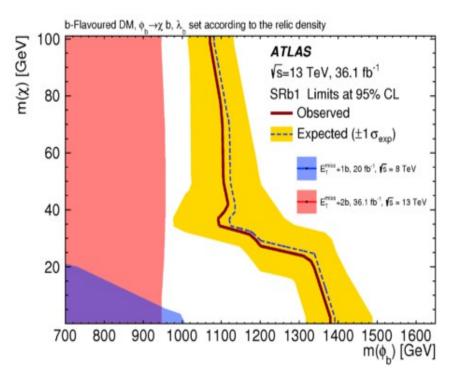
Selection

 Multiple jets (>=2/1/0 b-jets), 0/1/2 well-identified leptons, and MET

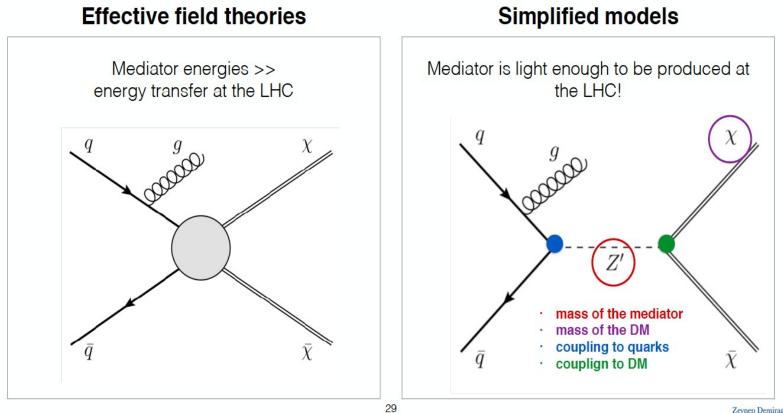
Main backgrounds

• Z+jets (0 lepton), ttbar (1/2 leptons), backgrounds are constrained in different CRs





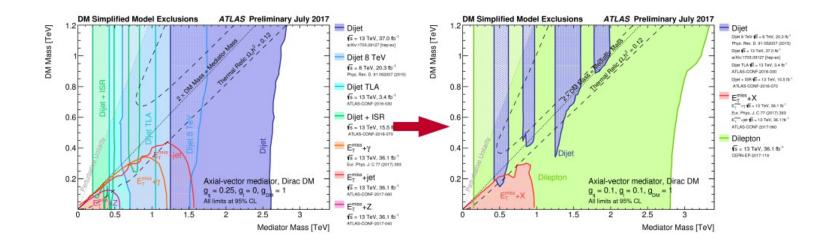
DM models



Zeynep Demiragli

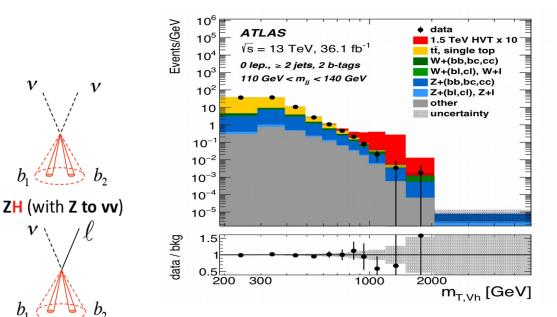
Search DM

Big picture changes with the choice of couplings



- Dijet and mono-X constraints weakened if $g_{_{\alpha}}\text{=}0.25\rightarrow0.1$

New resonances decaying to W/Z + Higgs



Analysis Strategy: different regions 0L, 1L-MET and 2L with at least two jets and 1 or 2 b-tags. Global fit of all regions simultaneously

WH (with W to lv)

 b_1

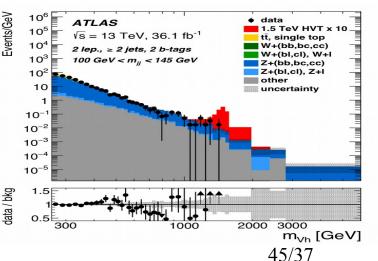
 b_1



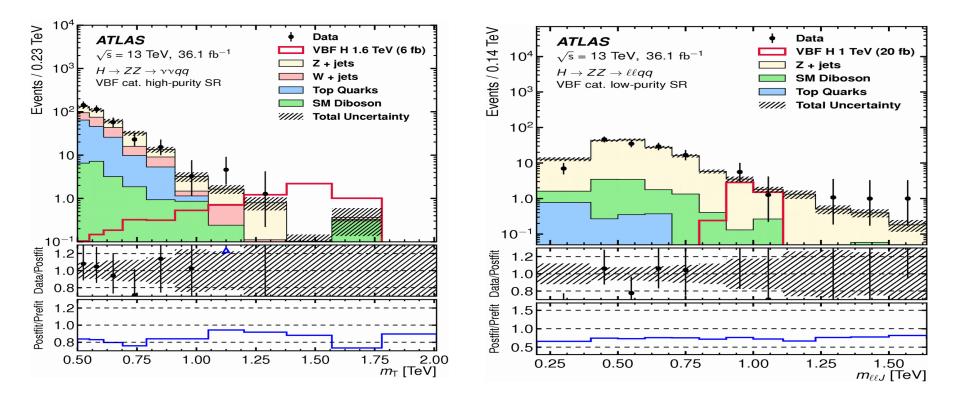
ZH (with **Z to dilepton**)

ttbar and Z+jets , shape is MC estimated, normalisation is constrained from CRs

Multi-jet (V \rightarrow qq), both shape and normalisation are data-driven, re-weighting from untagged regions



Diboson results



Main background

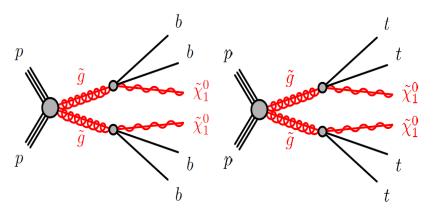
- Z + jets, data-driven (normalisation) from CRs (sideband m or m)
- ttbar dedicated CRs

Systematic Uncertainties

- Background modelling (Ilqq: shape difference in CR, vvqq: PDF variations)
- Large-R jet energy resolution

Third generetion of squarks - multi b jets

gluinos decaying via third generation off-shel squarks to the lightest neutralino



0/1L gives better reach for heavy gluinos and 2SS/3L helps in the compressed region.

High- N_{jet} regions Criteria common to all regions: $N_{b-iets} \ge 3$, $p_T^{jet} > 30$ GeV

						$p_{\text{-jets}} = 0, p_1$			
Targeted kinematics	Туре	Nlepton	$\Delta \phi_{ m min}^{ m 4j}$	m _T	Njet	$m_{\mathrm{T,min}}^{b\text{-jets}}$	M_J^{Σ}	$E_{\mathrm{T}}^{\mathrm{miss}}$	m _{eff}
	SR-0L	= 0	> 0.4	-	≥7	> 100	> 200	> 400	> 2500
High-meff	SR-1L	≥ 1	-	> 150	≥6	> 120	> 200	> 500	> 2300
(HH)	CR	≥ 1	-	< 150	≥6	> 60	> 150	> 300	> 2100
(Large Δm)	VR-0L	= 0	> 0.4	-	≥7	<100 if $E_{\rm T}^{\rm miss}>300$	-	< 300 if $m_{T,min}^{b-jets} > 100$	> 2100
	VR-1L	≥ 1	-	> 150	≥6	<140 if $m_{\rm eff}>2300$	-	< 500	> 2100
	SR-0L	= 0	> 0.4	-	≥9	> 140	> 150	> 300	[1800, 2500]
Intermediate-meff	SR-1L	≥ 1	-	> 150	≥8	> 140	> 150	> 300	[1800, 2300]
(HI)	CR	≥ 1	-	< 150	≥8	> 60	> 150	> 200	[1700, 2100]
(Intermediate Δm)	VR-0L	= 0	> 0.4	-	≥9	<140 if $E_{\rm T}^{\rm miss}>300$	-	< 300 if $m_{T,min}^{b-jets} > 140$	[1650, 2100]
	VR-1L	≥ 1	-	> 150	≥8	<140 if $E_{\rm T}^{\rm miss}>300$	-	< 300 if $m_{T,min}^{b-jets} > 140$	[1600, 2100]
	SR-0L	= 0	> 0.4	-	≥9	> 140	-	> 300	[900, 1800]
Low-m _{eff}	SR-1L	≥ 1	-	> 150	≥8	> 140	-	> 300	[900, 1800]
(HL)	CR	≥ 1	-	< 150	≥8	> 130	-	> 250	[900, 1700]
(Small Δm)	VR-0L	= 0	> 0.4	-	≥9	< 140	-	> 300	[900, 1650]
	VR-1L	≥ 1	-	> 150	≥8	< 140	-	> 225	[900, 1650]