BSM: Experimental Results

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UNLP- IFLP

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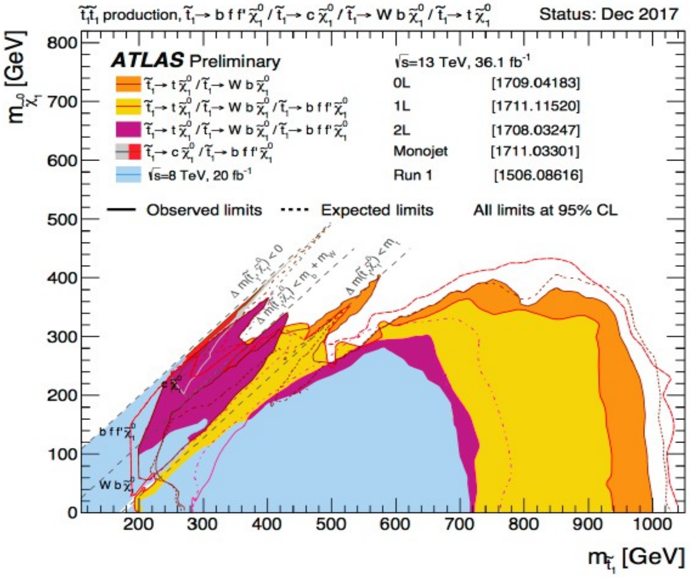
I F L P
CONICET
U N L P

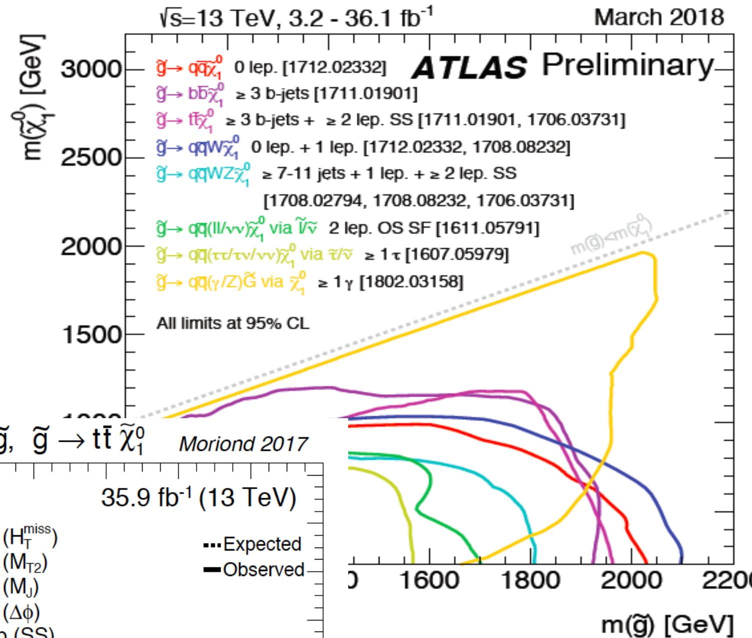
Run II results 2015-2016 data

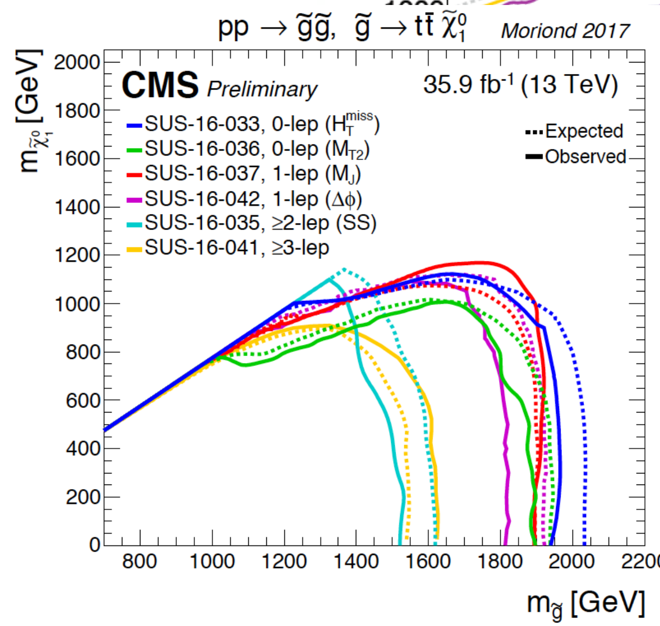
- SUSY
  - Standard searches
  - RPC → RPV
  - Long-lived
  - Disappearing tracks
- Exotics
  - Z' & W'
  - New heavy vector boson in diboson final states
  - Di-jet final states
  - Vector like quarks
- Dark Mater
  - Mono X

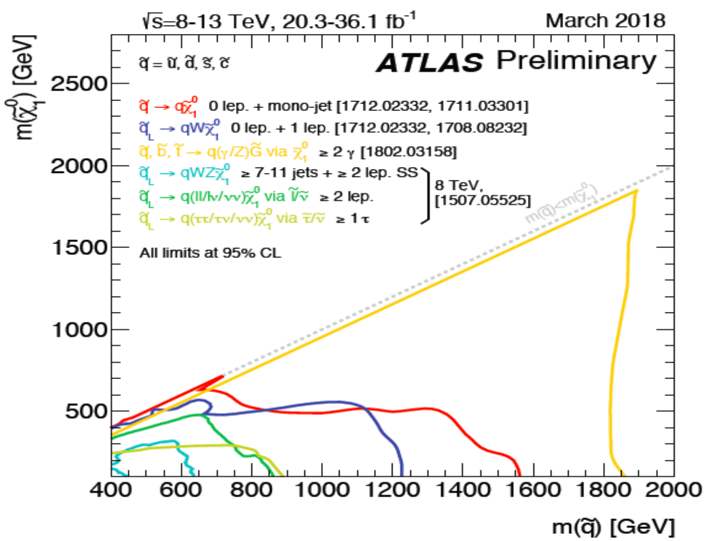
Will not include dedicated BSM Higgs searches
Most of the results shown form ATLAS experiment

SUSY









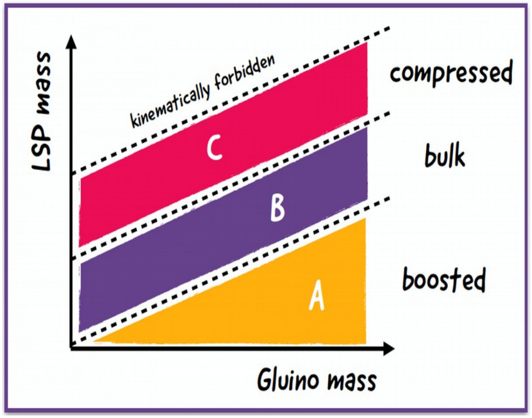
Simplified models recent limits exploiting the 2015-2016 Run 2 dataset

- 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

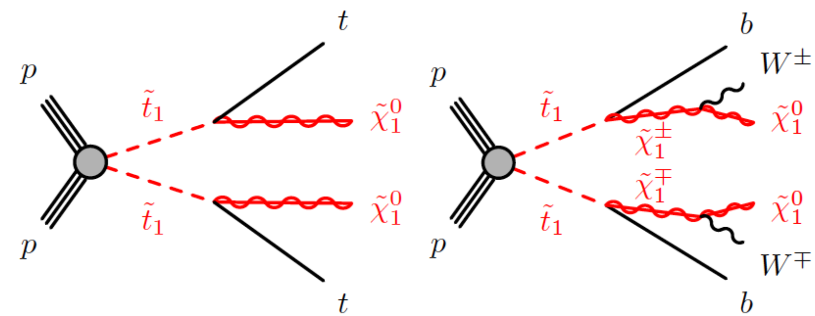
SUSY: Paradigm Shift

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

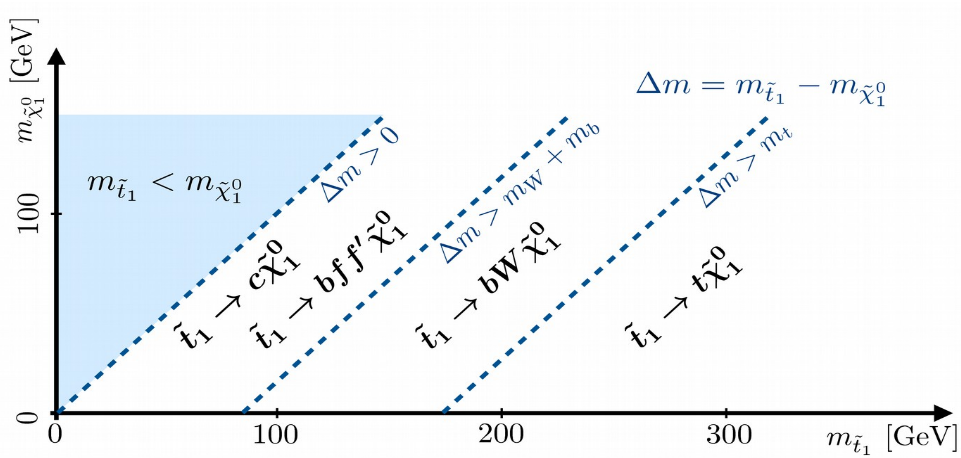


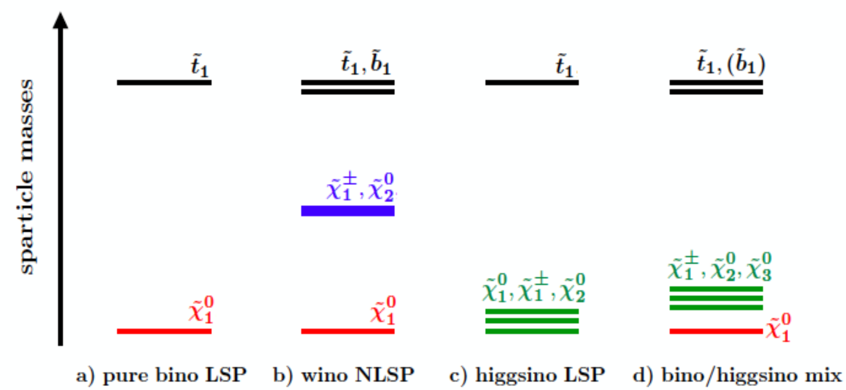
Low-mass top squarks required for natural models

- could be the 2nd lightest SUSY particle (and the first detectable sparticle at the LHC)

Signature

- favored decay via $t^{(*)}$ and LSP: final states classified according to W decay mode
- approaches SM tt signature for Δm≈m(t) and low LSP mass

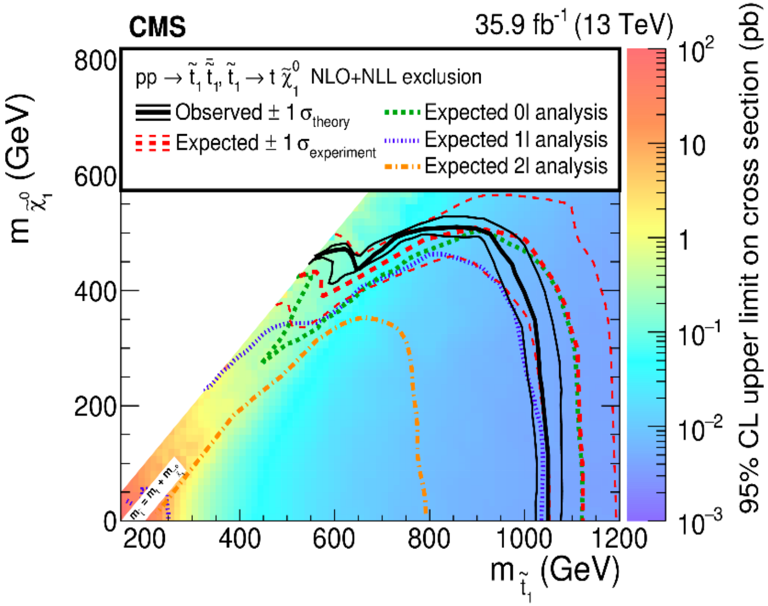


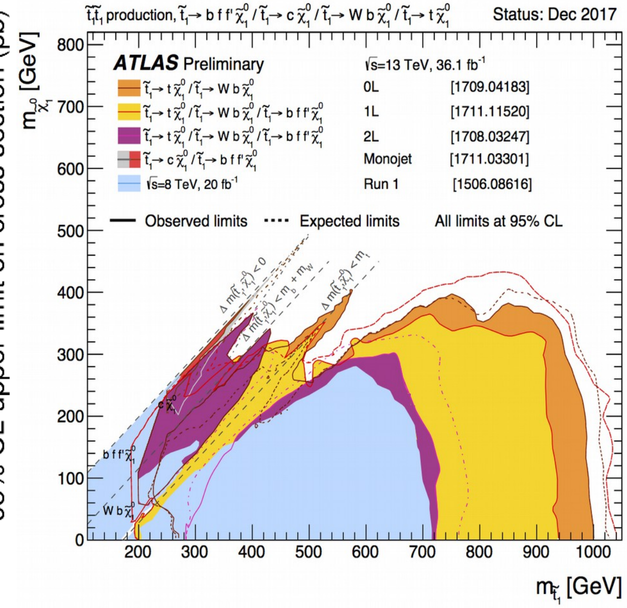


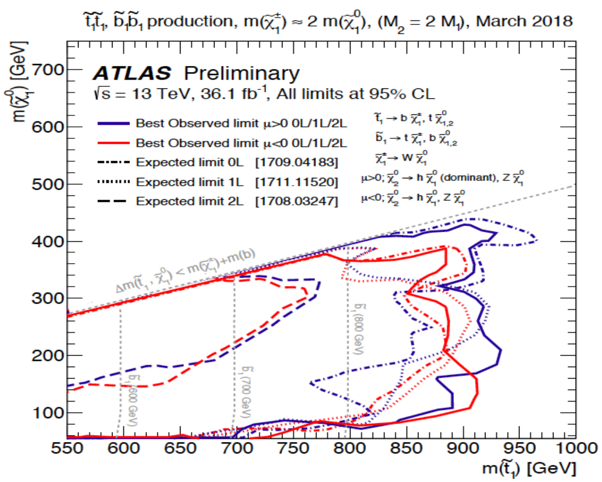
Top Squark

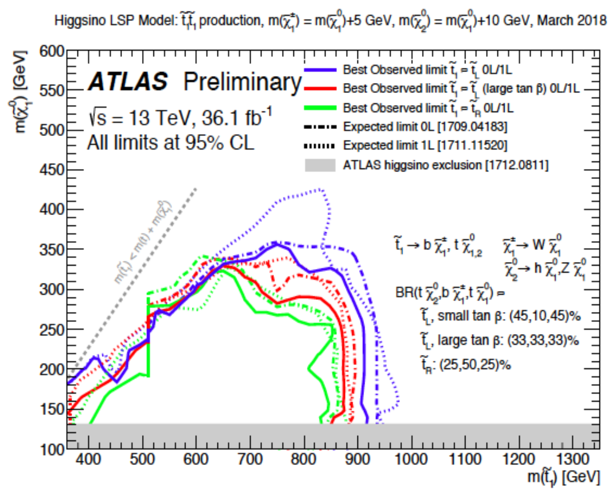
The Higgs at 125 GeV inspires O(1TeV) stop

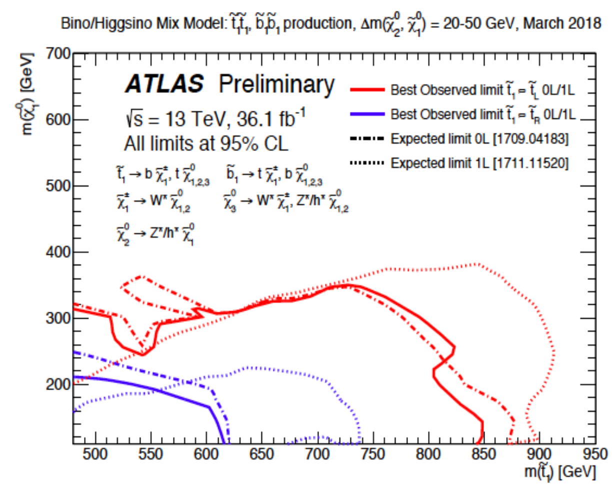
If natural SUSY exists, we are decreasing the places where it can hide.







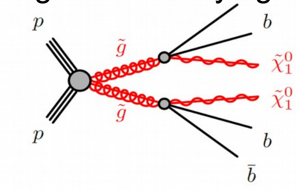




Note that these plots overlay contours belonging to different stop decay channels, different sparticle mass hierarchies, and simplified decay scenarios. Care must be taken when interpreting them.

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

Multi b jets

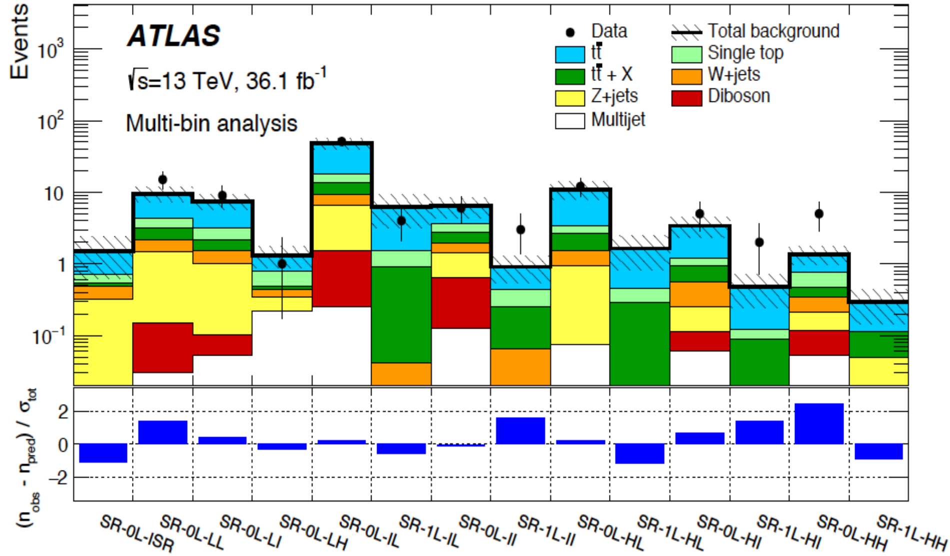


Exclusion stream uses meff shape & jet multiplicity information to perform a multi-bin fit. All search regions dominated by ttbar + heavy flavour events.

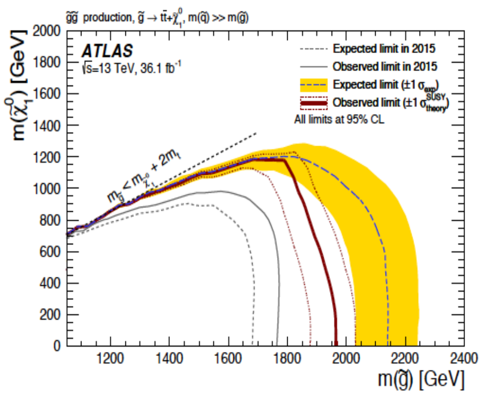
$$H_T = \sum_{\text{visible}} |p_T| \qquad m_{\text{eff}} = H_T + E_T^{\text{miss}}$$

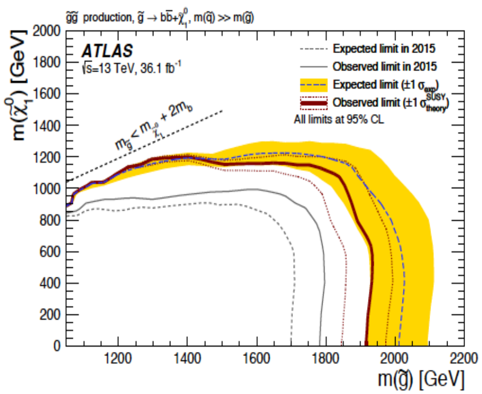
Largest uncertainties:

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

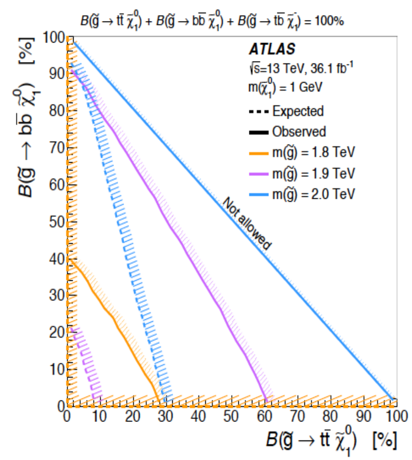


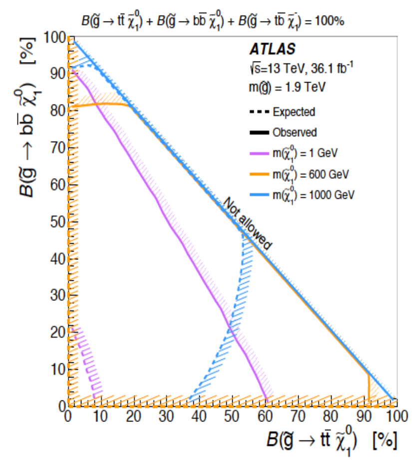
Most significant deviation from expectation in multi-bin SR-0L-HH (High meff and Δm): ~2.5sig local.





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.





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

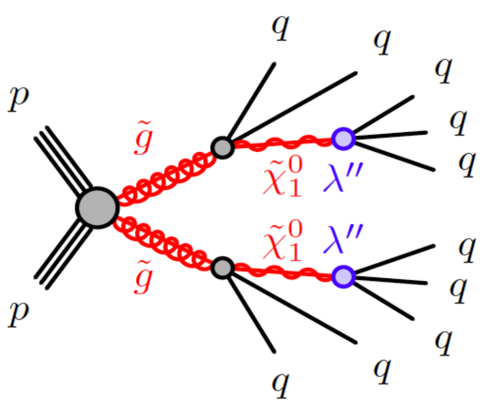
arXiv:1711.01901 [hep-ex]

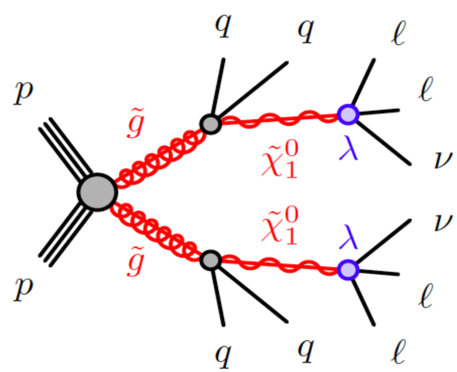
RPV

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

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
- κ, λ, λ' all give rise to final states with some amount of MET from neutrinos
- λ'' gives rise to quark-y final states

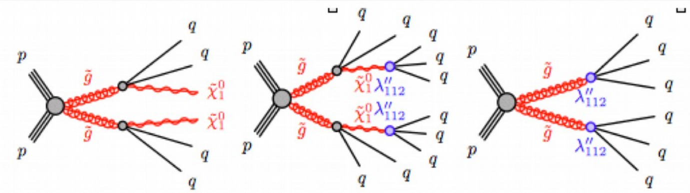




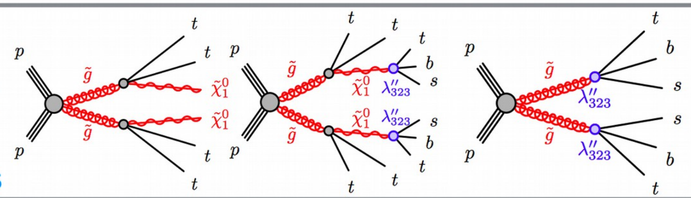
Hadronic RPV

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

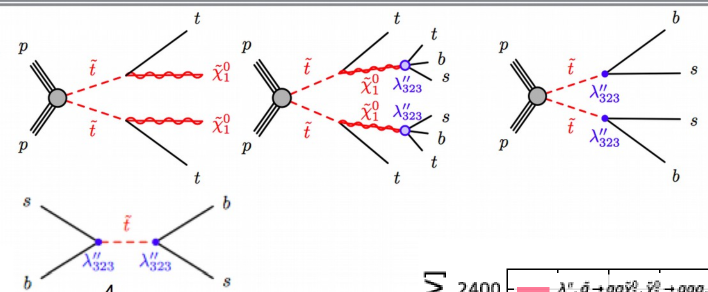
- **Gqq-Model:** $\lambda''_{112} \neq 0$, masses of 1st and 2nd generation squarks 3 TeV, other sparticle masses > 5 TeV -> multi jet final state

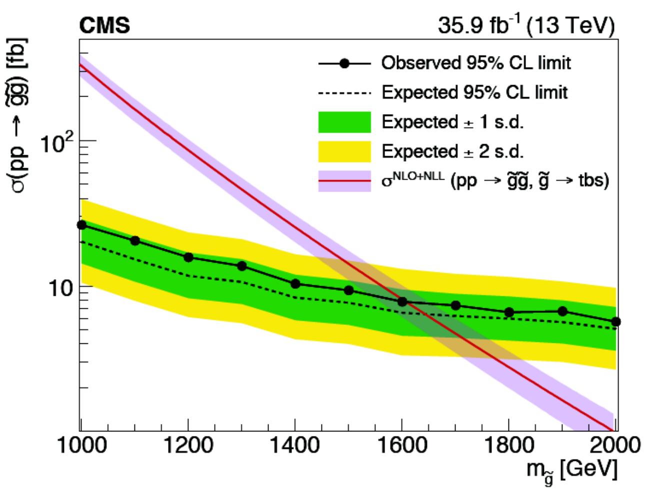


- **Gtt-Model:** $\lambda''_{323} \neq 0$, masses of 3rd generation squarks 2.4 TeV, all other sparticle masses > 5 TeV -> final states with b-jets and leptons



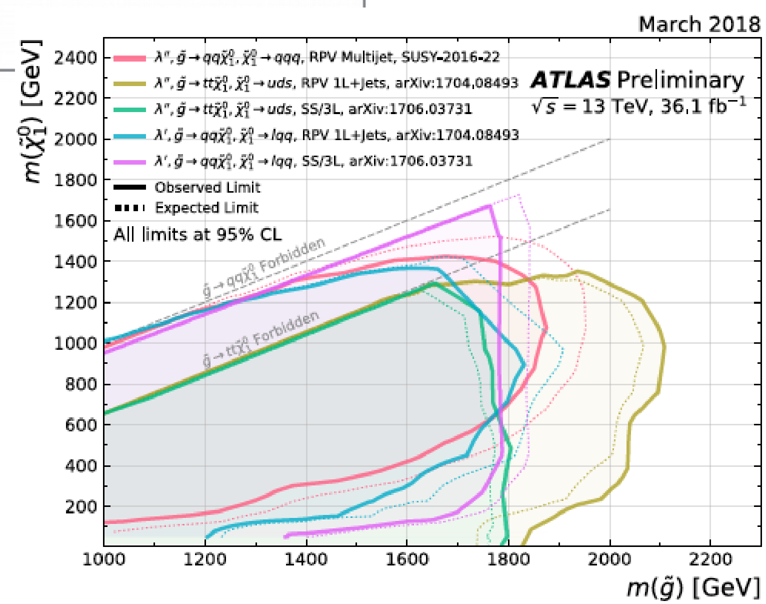
- **Stop-Model:** $\lambda''_{323} \neq 0$, light mostly right-handed stop ->final states with b-jets and leptons





Exclusion of gluino masses up to 1600 GeV

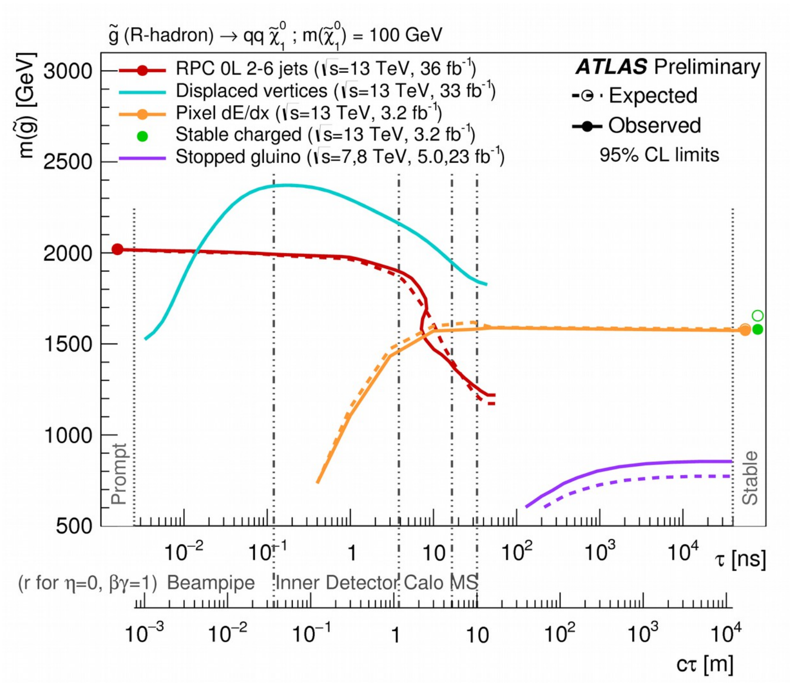
Higher limits for 1L+Jets

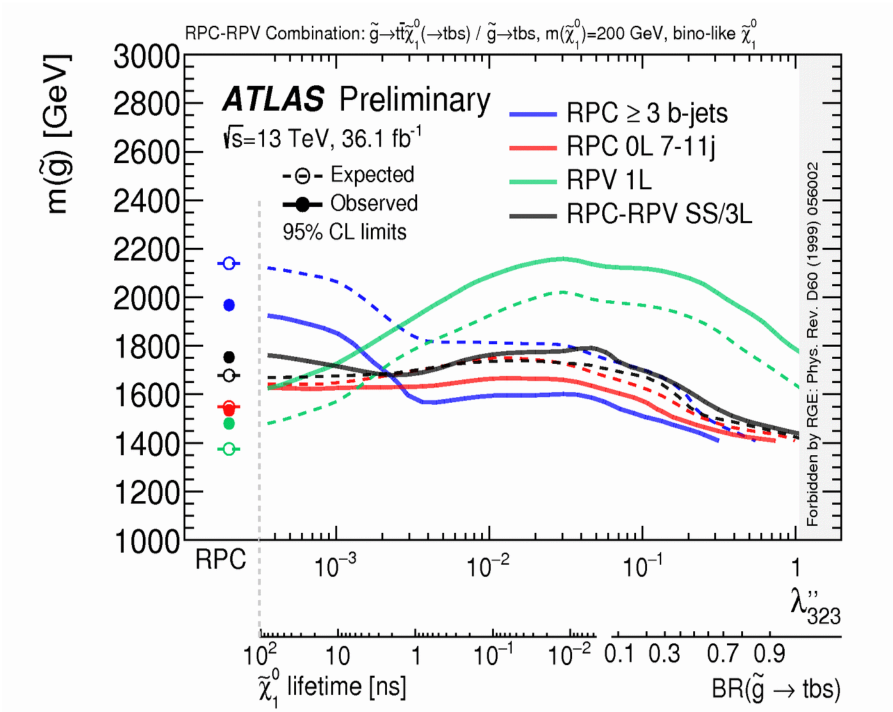


RPC meets RPV

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

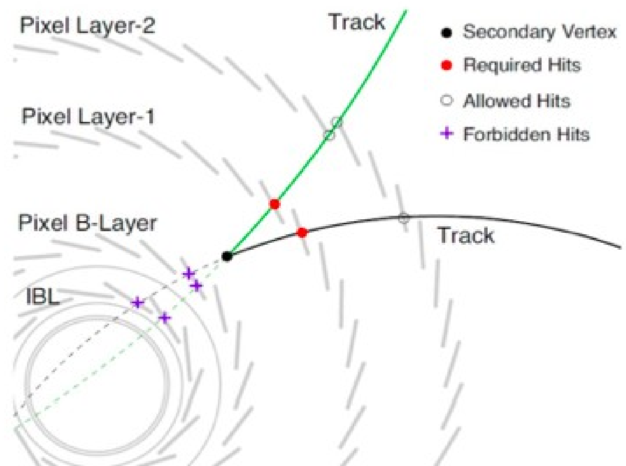
ATLAS-CONF-2018-003

Search for long-lived massive particles

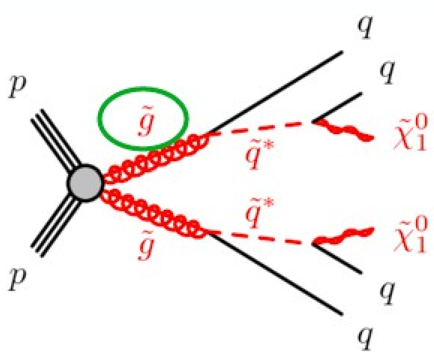
Events with displaced vertices

Long lifetimes in BSM models:

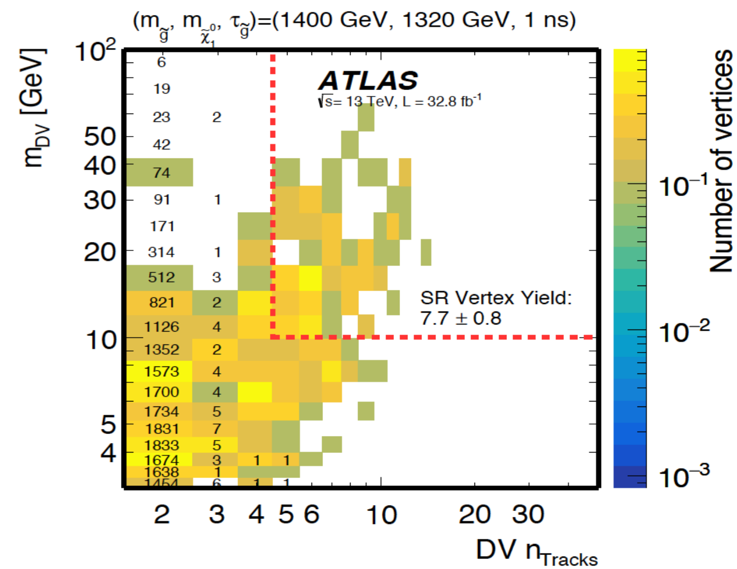
- R-parity violating models
- R-Hadrons: Split SUSY decays via a highly virtual intermediate state

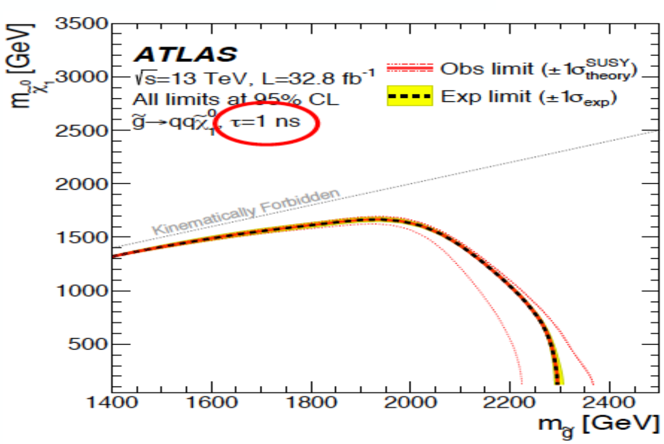


LLP decays occurring at 4 mm < r < 300 mm from the PV



- $m_{\tilde{g}}$ = 400 - 2000 GeV,
- $c\tau$ = 0.01 - 50 ns,
- $m_{\tilde{\chi}_1^0}$ ranges from 100 GeV to $m(\tilde{g})$ – 30 GeV.



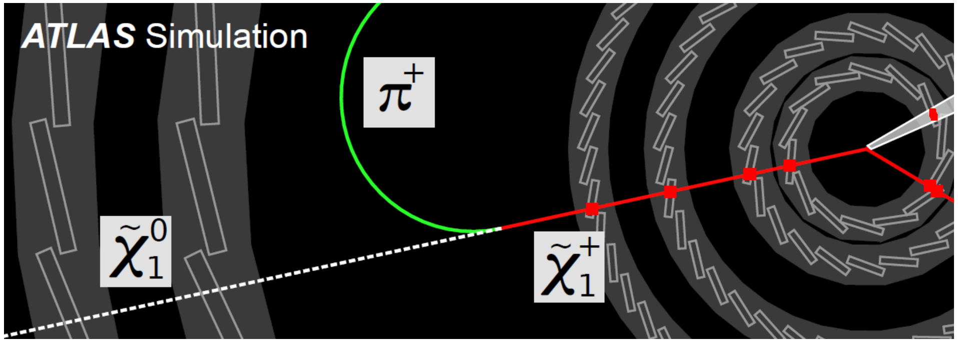


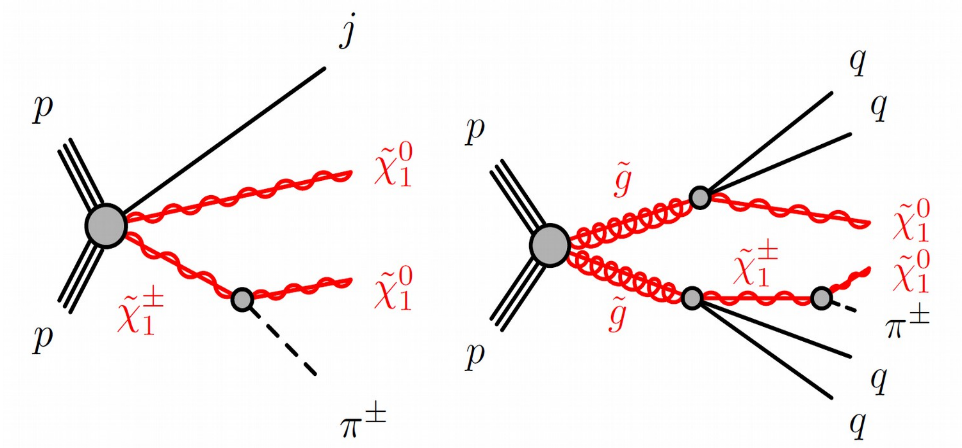
One of the highest gluino mass exclusion amongst all SUSY searches thanks to zero background

ATLAS-SUSY-2016-08 Phys. Rev. D 97 (2018) 052012

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)

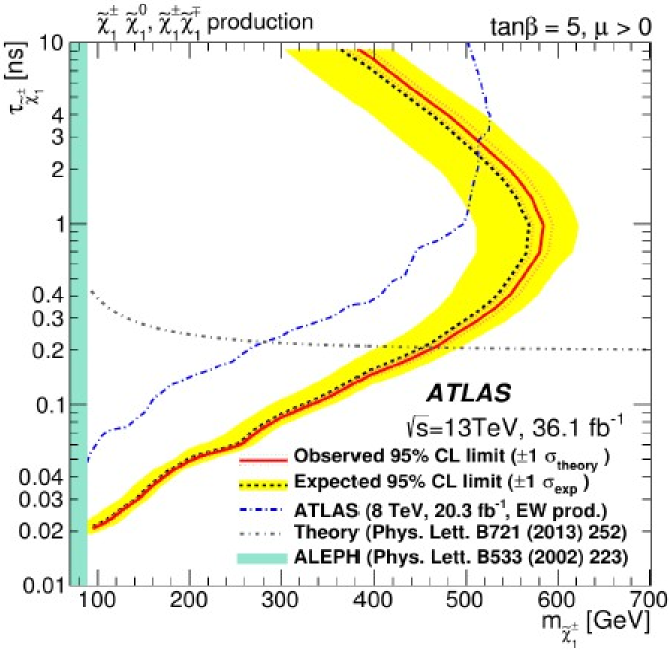


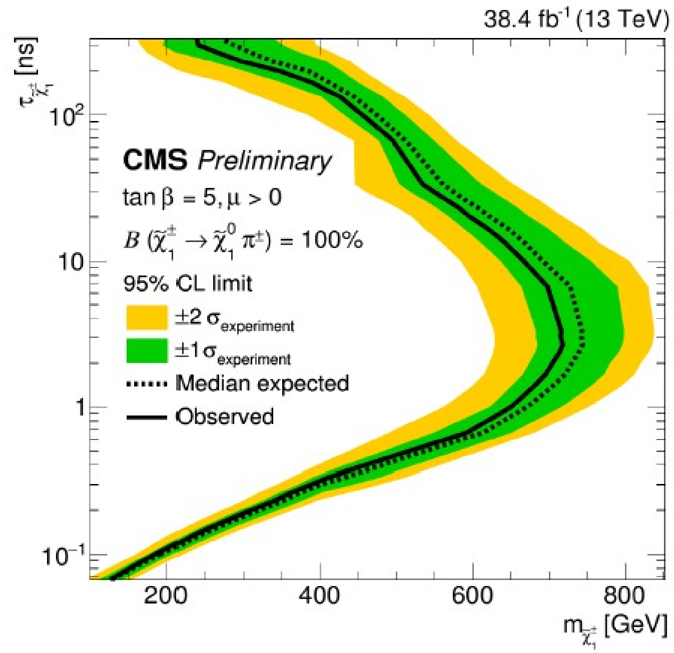


Signature: Chargino track disappears when decays, into MET and low momentum pion track (~0.1 GeV) that is hard to reconstruct. Challenge to identify the legitimate real tracklets (non-fake) using only a few measurement tracks

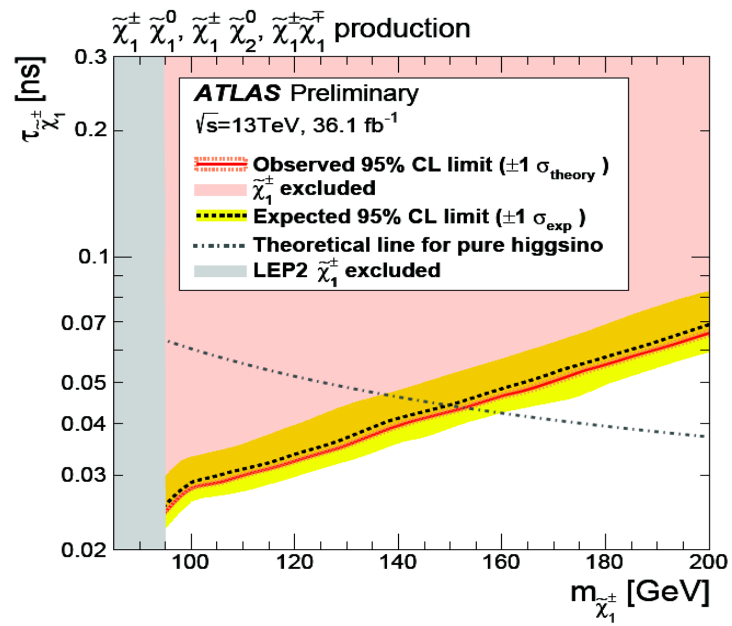
Almost pure wino LSP scenario

Search for disappearing tracks





Sensitivity gains from use of ATLAS IBL and new dedicated CMS trigger



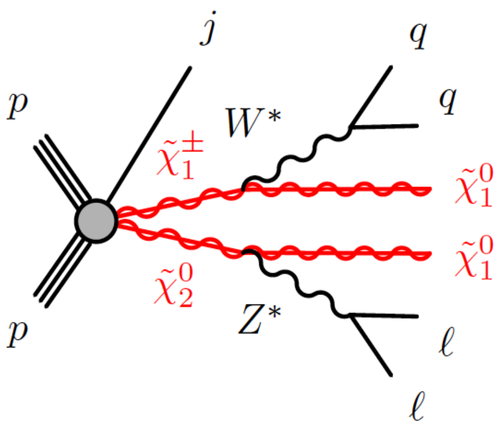
Reinterpretation of the disappearing track search

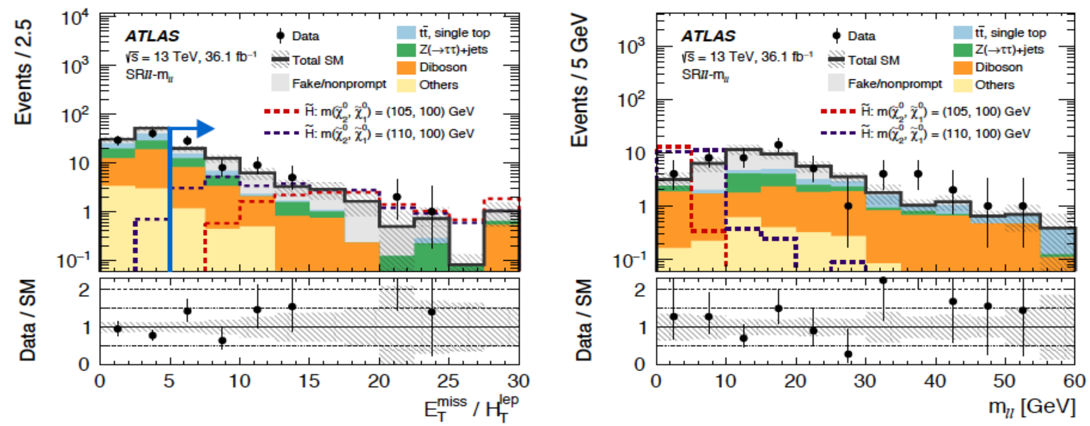
- Targeting the pure-higgsino signature.
- Chargino masses up to 152 GeV are excluded in the pure-higgsino LSP model.

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

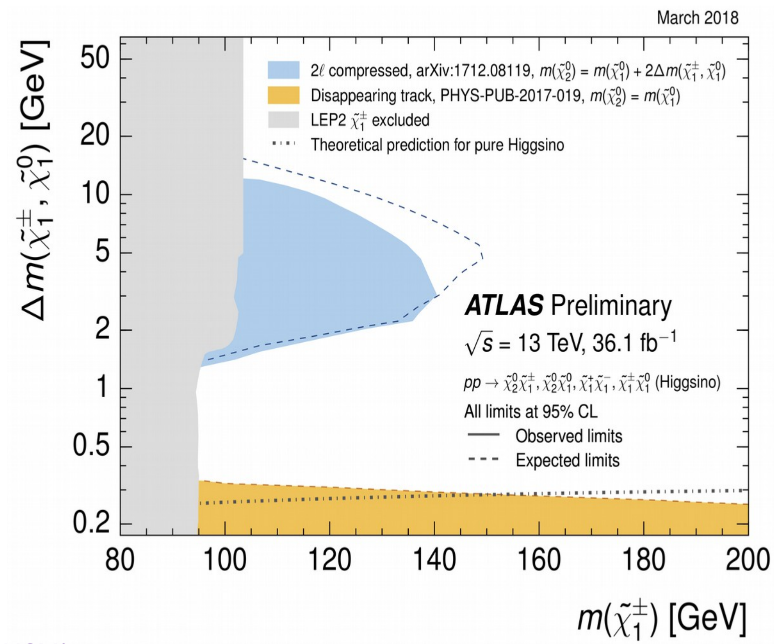
Higgsino searches

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.





ISR allows highly efficient triggering at lower masses



For the Higgsino simplified model, exclusion limits at 95% CL are set up to masses of 145 GeV and down to mass splittings of 2.5 GeV

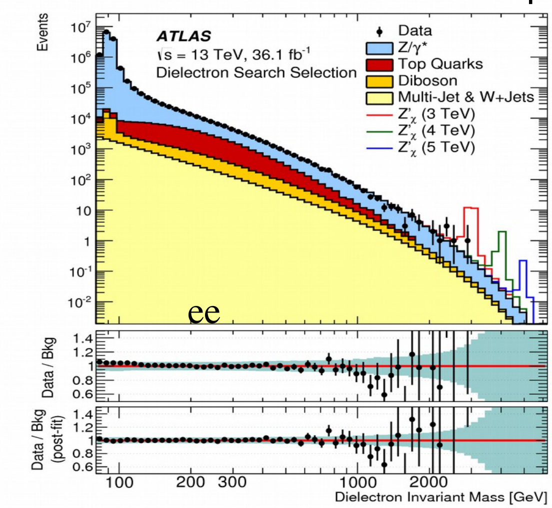
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/SUSY/
Phys. Rev. D 97 (2018)

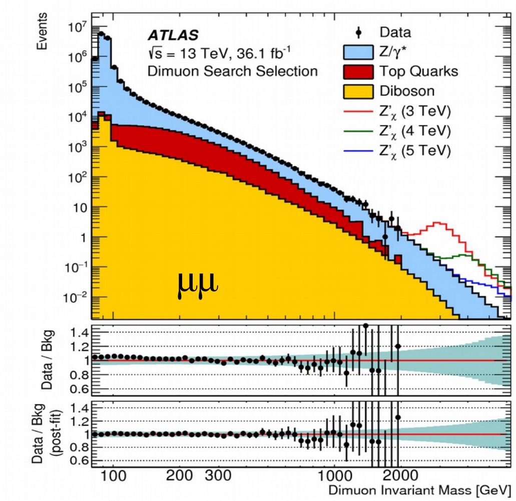
Exotics

Search Z´ / W´ in lepton decays

new heavy gauge boson

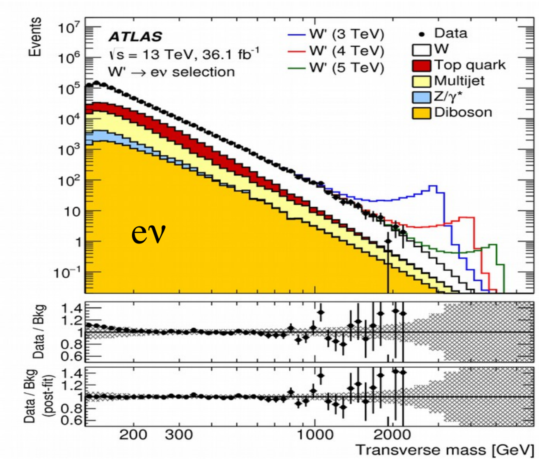
Search for resonant Z´ and non-resonant excesses in dilepton LFC and LFV
Search of resonant W´in lepton + MET

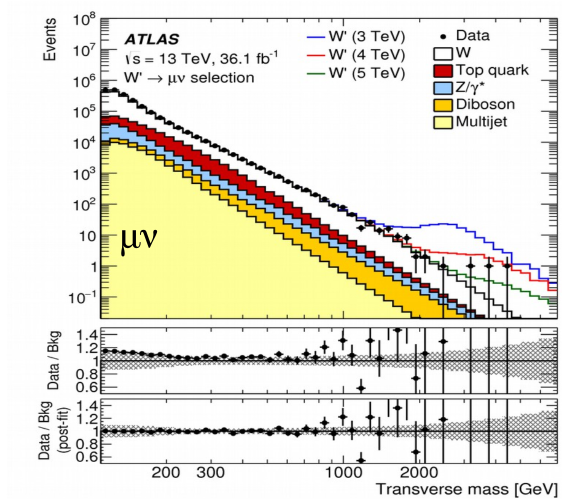




A pair of e/μ with pT > 30 GeV
Fully reconstructed, high signal-selection efficiency, small & well-understood Backgrounds (DY)

Highest invariant mass at ~2.1 TeV for all combinations





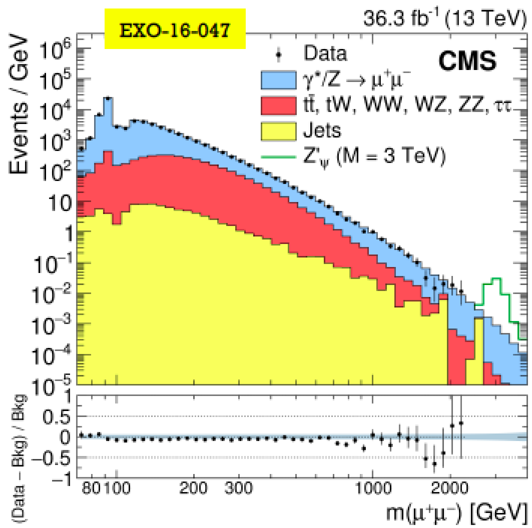
Signature
A well define e/μ with pT > 55/65 GeV
MeT > 55/65 GeV
Dominant background
- W → lν
- ttbar + single top

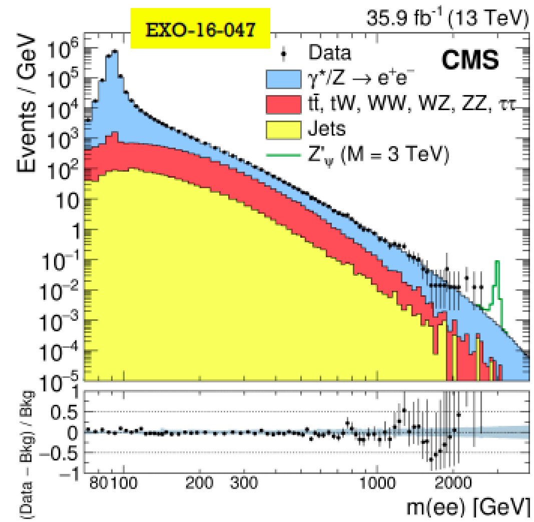
No excess found
Z´limit at 3.8TeV
W´ limit at 5.1TeV

$$m_T = \sqrt{2 p_T^{\ell} E_T^{miss} \left(1 - \cos \Delta\phi_{\ell, E_T^{miss}}\right)}$$

ATLAS-EXOT-2016-05/ (JHEP 10 (2017) 182) ATLAS-/EXOT-2016-06/ (arXiv:1706.04786)

Search Z´ / W´ in lepton decays





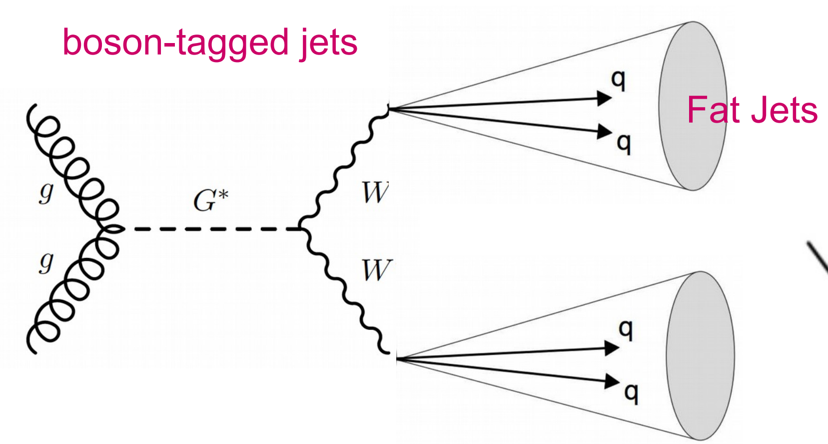
Process	New physics	Lower Mass Exclusion (TeV)	Lumi (fb^{-1})	Publication
X → ee/ $\mu\mu$	Boson spin 1 (Z') Graviton DM mediator	From 3.9 to 4.5 From 2.1 to 4.25	35.9	EXO-16-047 Submitted to JHEP
X → ee	Boson spin 1 (Z')	From 4.1 to 4.7	41.4 + 35.9	EXO-18-006 (PAS only)
X → eμ	Boson spin 1 (Z') τ sneutrino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

Searches in diboson final state

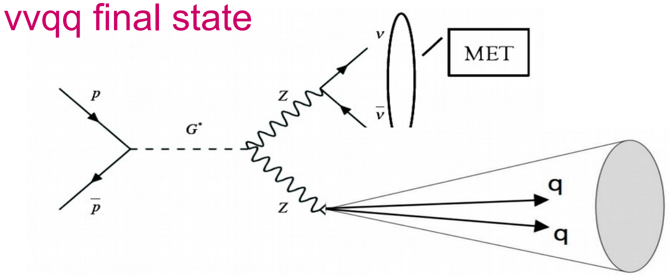
Extensions of the SM predict the existence of new particles decaying into vector-boson pairs:

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

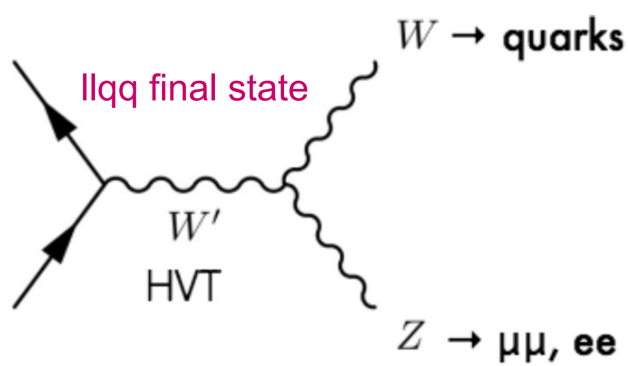
boson-tagged jets

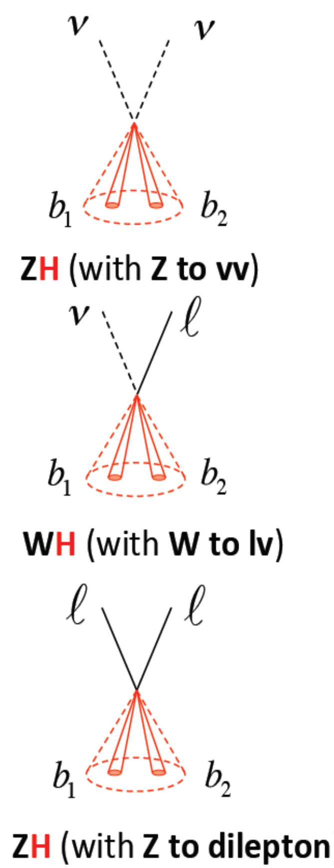


vvqq final state



llqq final state



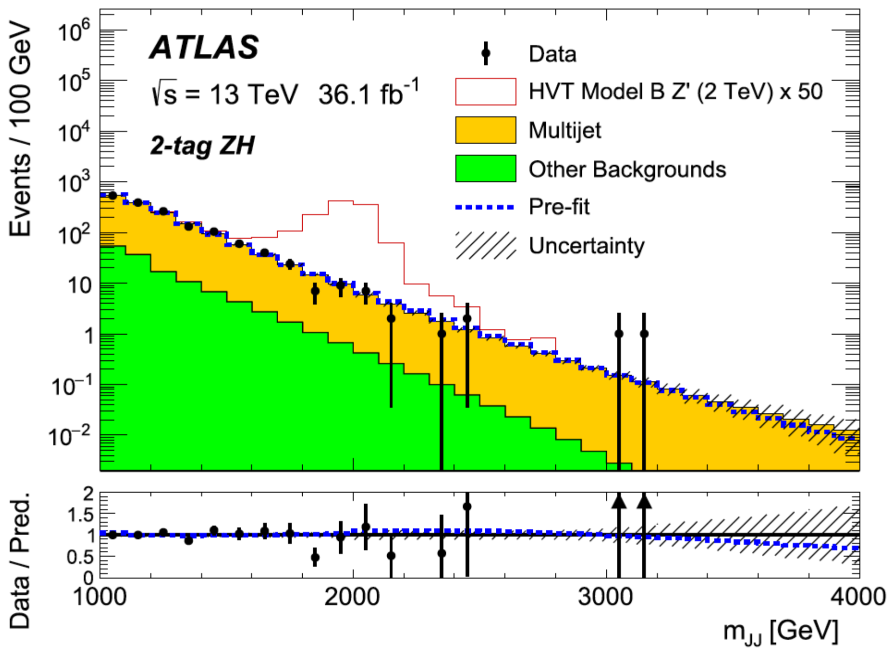


ATLAS-/EXOT-2016-19/ (Phys. Lett. B 777 (2017) 91) ATLAS-EXOT-2016-28/ (arXiv:1710.07235)
ATLAS-EXOT-2016-29/ (arXiv:1708.09638) ATLAS-/EXOT-2016-12/ (Phys. Lett. B 774)(2017) 494)
ATLAS-/EXOT-2016-10/ (arXiv:1712.06518)

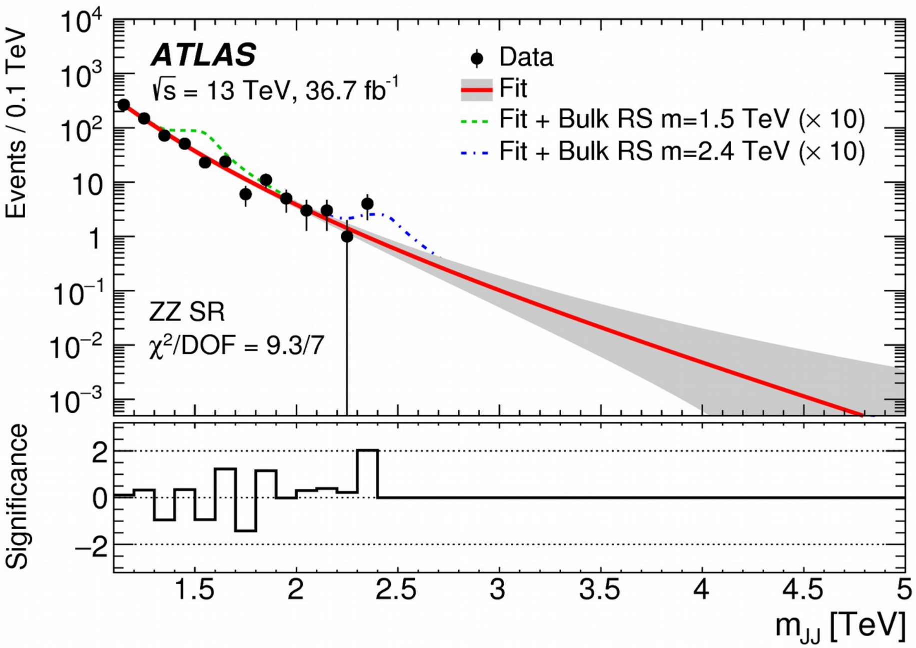
Fully hadronic diboson-tagged jets (JJ) decays

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

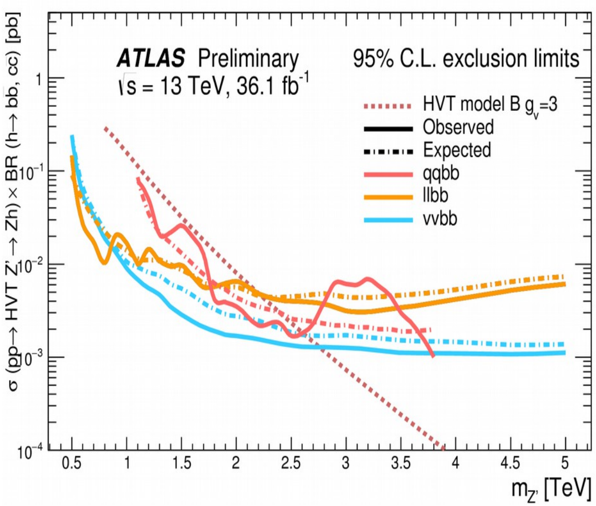


largest excess found at a resonance mass of 3.0 TeV with a local (global) significance of 3.3 (2.1)σ

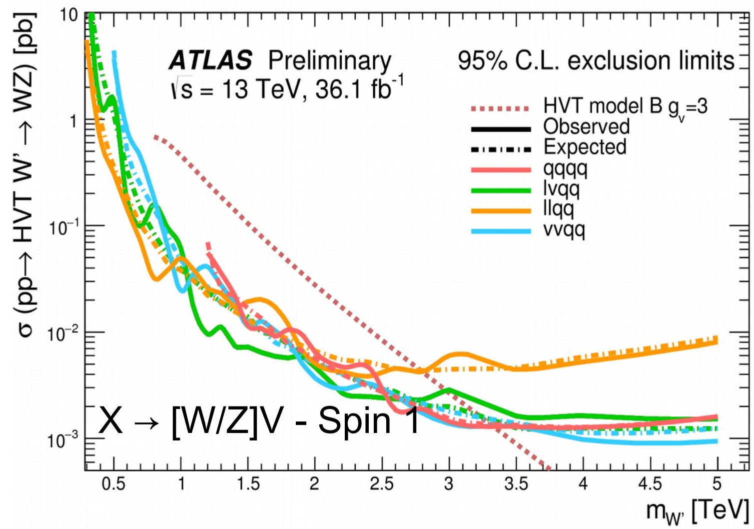


No significant excess observed at Run II

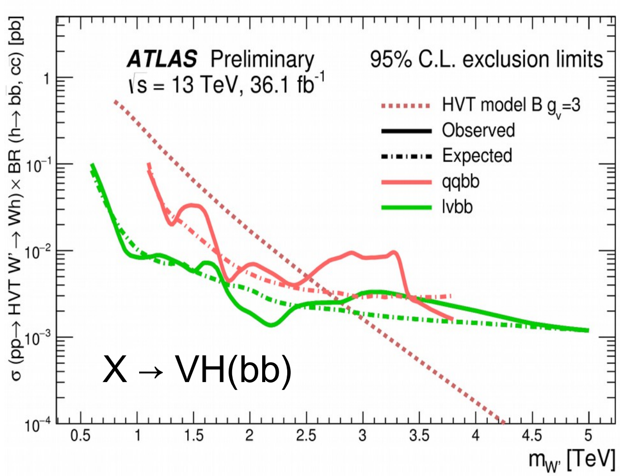
Diboson limit summary



mz' < 2.7 TeV is excluded



mw' < 3.3 TeV is excluded



mw' < 2.8 TeV is excluded

Process	New physics	Lower limit exclusion	Lumi (fb^{-1})	Publication
X → ZZ → 4l	Graviton	From 0.8 to 1.35 TeV	35.9	B2G-16-023 JHEP03(2018)003
X → H H → 4 jets	Graviton	From 0.97 to 1.4 TeV	35.9	B2G-16-026 Submitted to PLB CERN-EP-2017-238
X → Z+W → 2ν + qq X → Z+Z → 2ν + qq	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
X → Z+W → 2l + qq X → Z+Z → 2l + qq	Spin 1 resonance (W') Graviton	3-3000 fb^{-1} 1.5-400 fb^{-1}	35.9	B2G-17-013
X → W+W → 2l + qq X → W+Z → 2l + qq	Graviton Spin 1 resonance (W')	1 TeV 3 TeV	35.9	B2G-16-029 Submitted to JHEP CERN-EP-2018-015
X → H+H → ττ + bb X → HZ/HW → ττ +qq	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

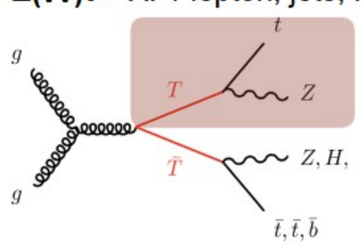
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/

Vector like quarks

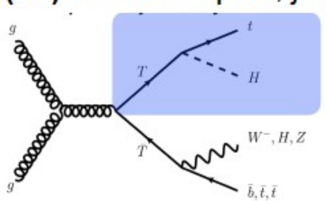
Color-triplet spin-½ fermions, left-handed and right-handed components transform in a same way under the SM gauge group

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

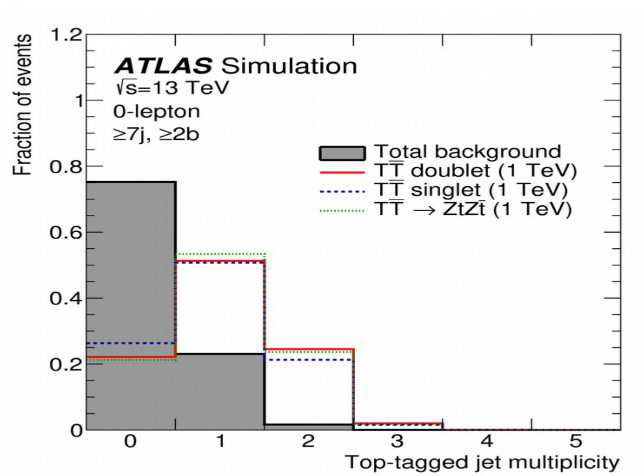
TT → **Z(νν)**t + X: 1 lepton, jets, MET



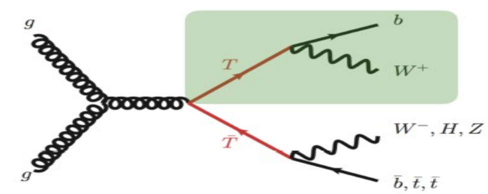
TT → **H(*bb*)**t + X: 0/1 lepton, jets, *b*-jets



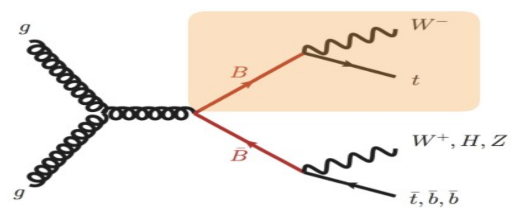
categorize using N(H), N(t), N(b), N(j) multiplicities



a) TT → **W(qq)*b*** + X: 1 lepton, 1 large-R W tagged jet, >1 b-tagged Small-R jets, MET

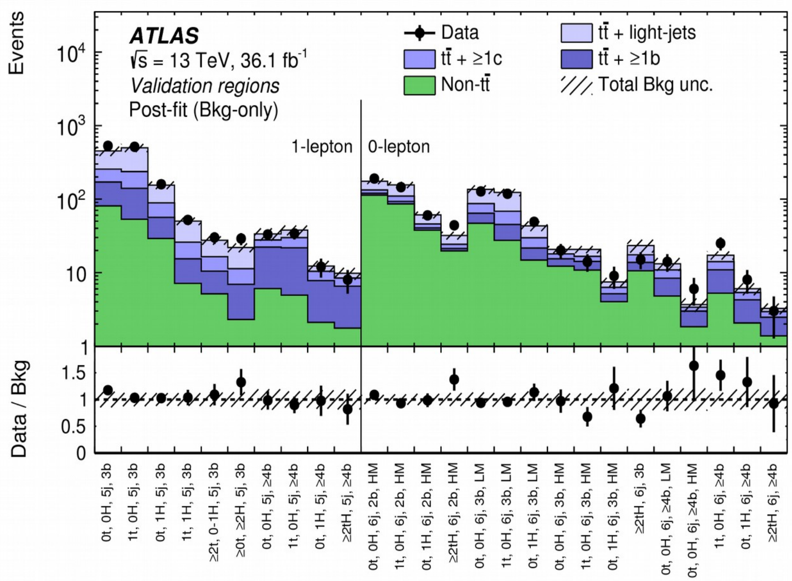


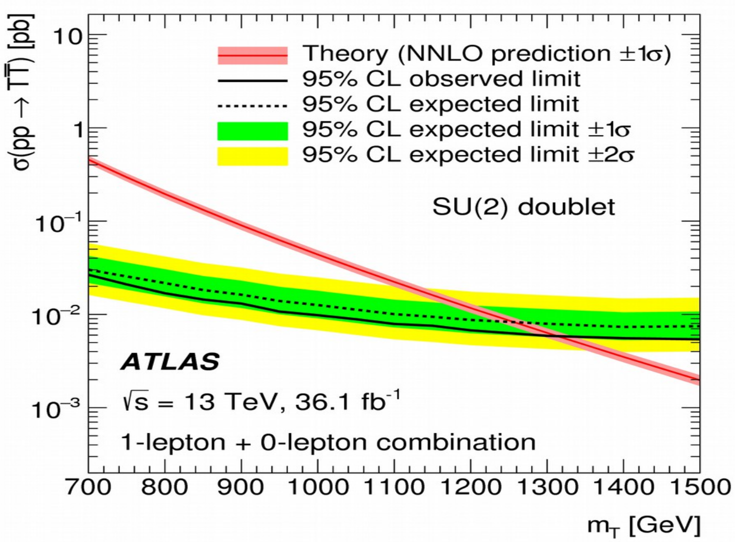
b) BB → **W⁻tW⁺t / W⁻tZ*b***: > 1 same-sign leptons, > 1 jets, >0 b-tagged Small-R jets



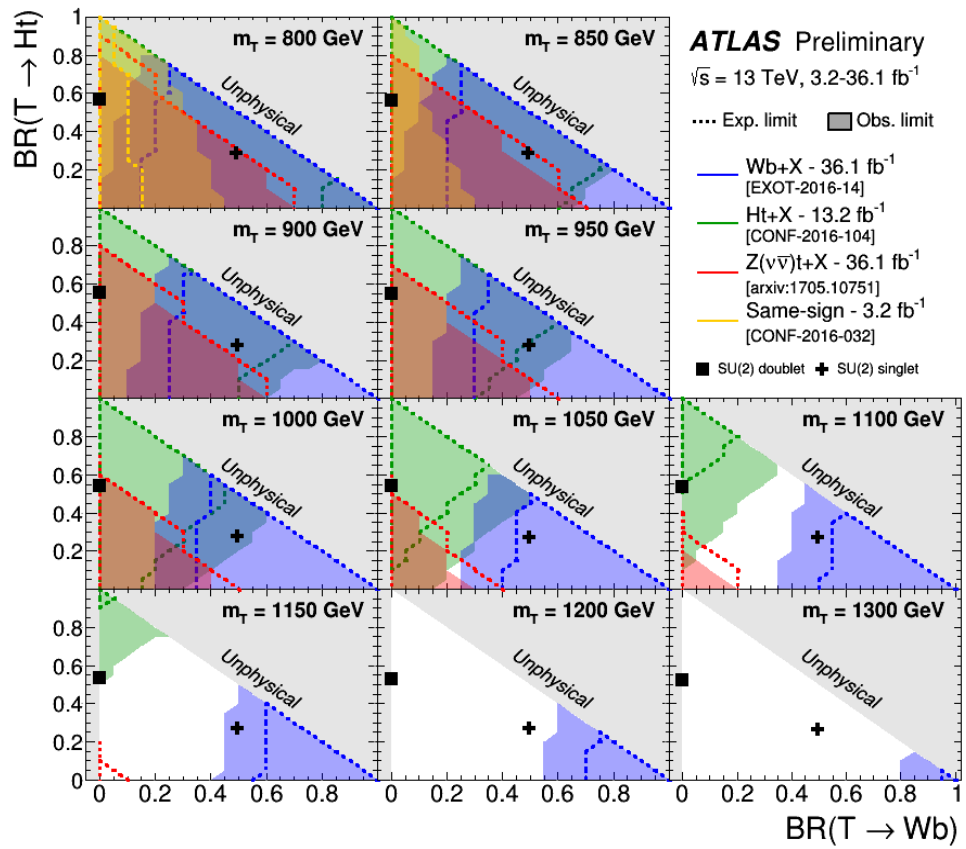
ATLAS-CONF-2016-104/ (Phys. Lett. B 774)(2017) 494)
ATLAS-EXOT-2016-15/ (ATLAS-CONF-2017-055)

Vector like quarks





Analysis with 20 Signal combined Fit!



95% CL exclusion in the plane of different BRs for different values of the vector-like T quark mass

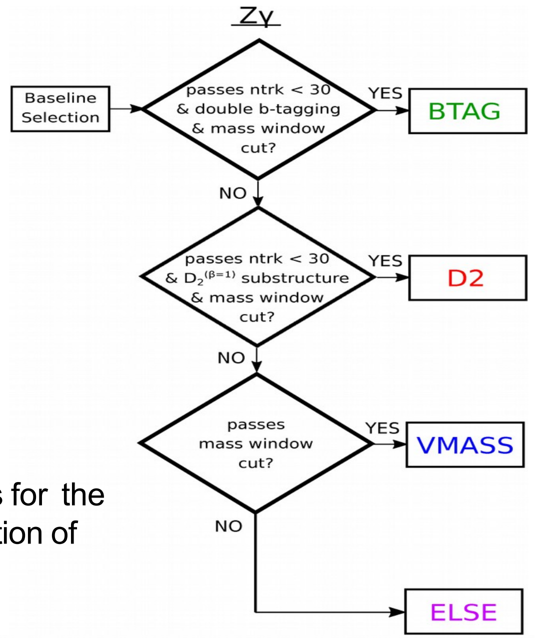
ATLAS-EXOT-2016-30

V + γ

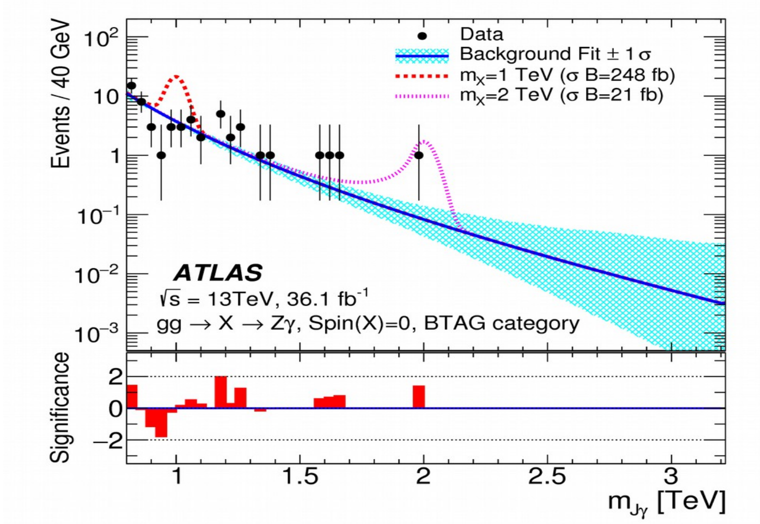
Others

ATLAS-EXOT-2016-36 arXiv:1804.09568

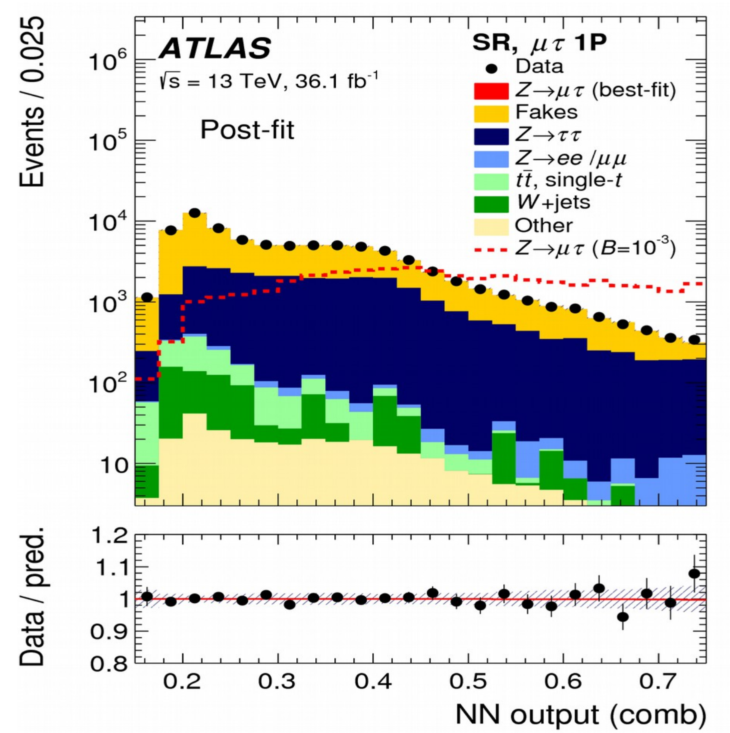
LFV



Flowcharts for the categorization of the events



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



$$\mathcal{B}(Z \to e\tau) < 5.8 \times 10^{-5}$$

$$\mathcal{B}(Z \to \mu\tau) < 2.4 \times 10^{-5}$$

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

Dark Matter

ATLAS-CMS Dark Matter Forum

arXiv:1507.00966v

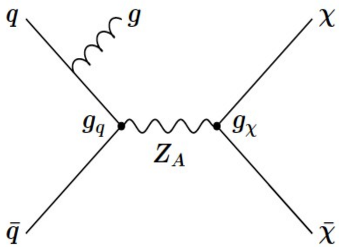
Define benchmark models for kinematically distinct signals for the so called Run-2 searches

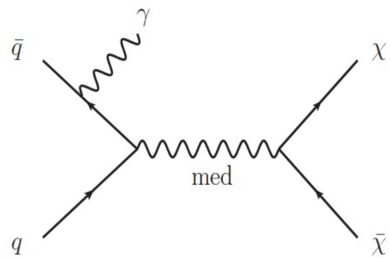
- Simplified Models
- Provide basis for re-interpretations (distinct kinematics)
- Collected by LHC DM forum
- Dirac-fermionic WIMPs

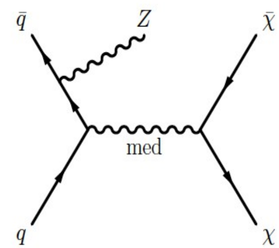
Mostly 4 parameters:
- mediator mass (M_{Med})
- WIMP mass (m_χ)
- 2 couplings (g_q,g_χ), typically (1, 0.25)

DM as WIMP
- Neutral, stable, weakly interacting particles with mass O(100 GeV)

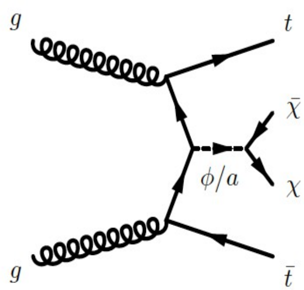
Mono X Analysis - General Analysis Strategy

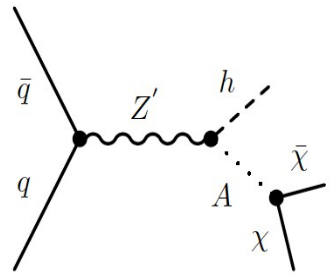






Non-interacting DM particles → Missing transverse energy (MET)





X (ɣ, jet, $W^{\pm}$, Z, h)

Event Selection

- High MET, compatible with production
- If X=ɣ, jet → high p_T(X) with quality criteria
- If X=W, Z, h → reconstruct mass within a windows
- Large (X,MET)
- Veto events with other “good” physics objects, like leptons

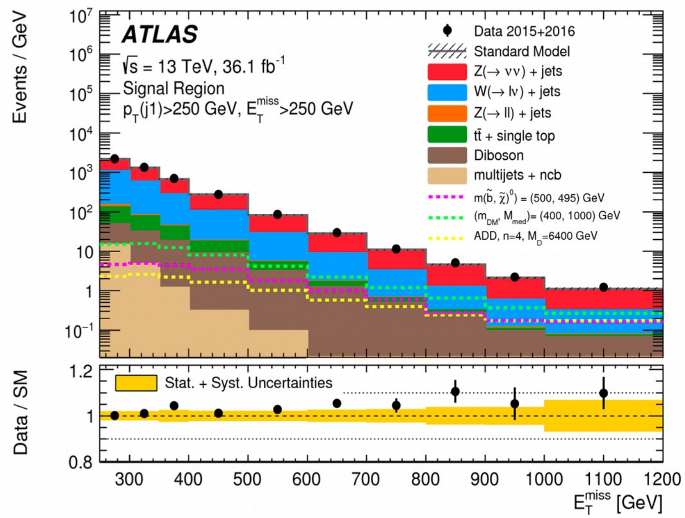
The search focus in look for excess in different regions of high MET, and in case of absence of excess, exclusion limits are extracted for the model

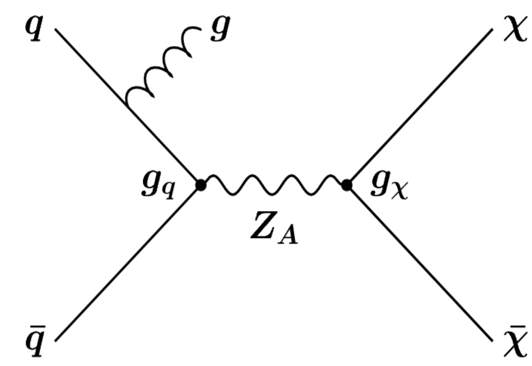
Mono-Jet

Signature
High pT Jet + MET

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

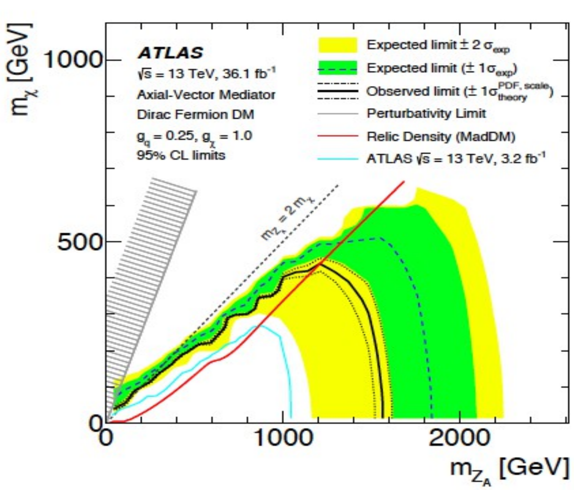
Main backgrounds
Z(vv) + jets
W(lv) + jets



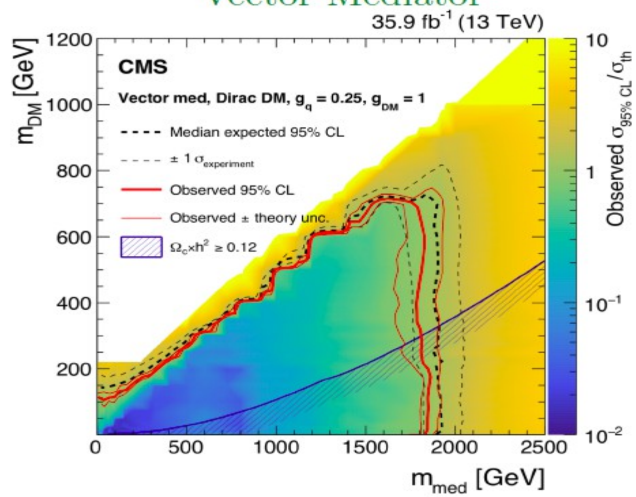


Mono-jet is one of the most powerful channels

Axial-Vector Mediator



Vector Mediator

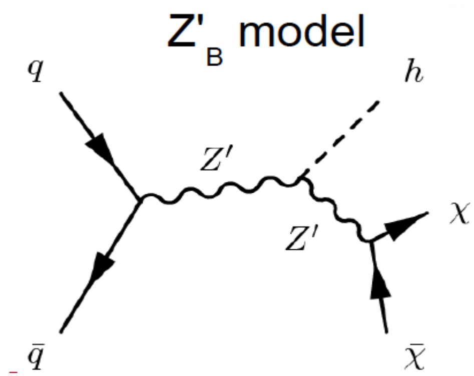


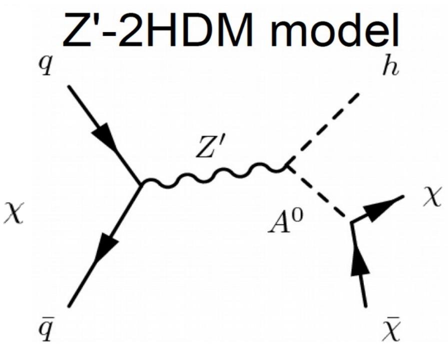
For couplings g_q = 0.25, g_χ = 1.0, axial-vector and vector mediators excluded up to 1.8 TeV (1.55 TeV) by CMS (ATLAS) for low DM masses.

ATLAS-EXOT-2016-27/ (JHEP 01 (2018) 126)
CMS-EXO-16-048

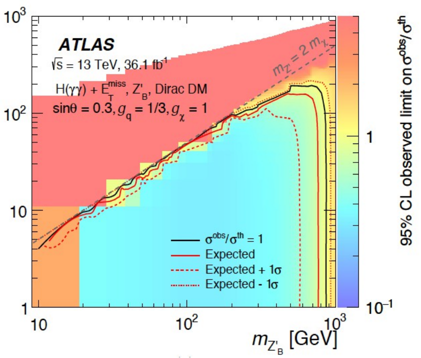
Mono-Higgs

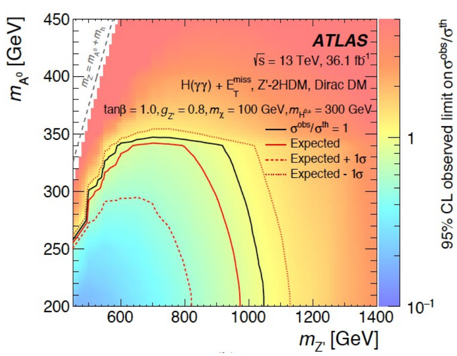
Models in which the higgs couples to dark sector particles, e.g. higgs couplings to the mediator

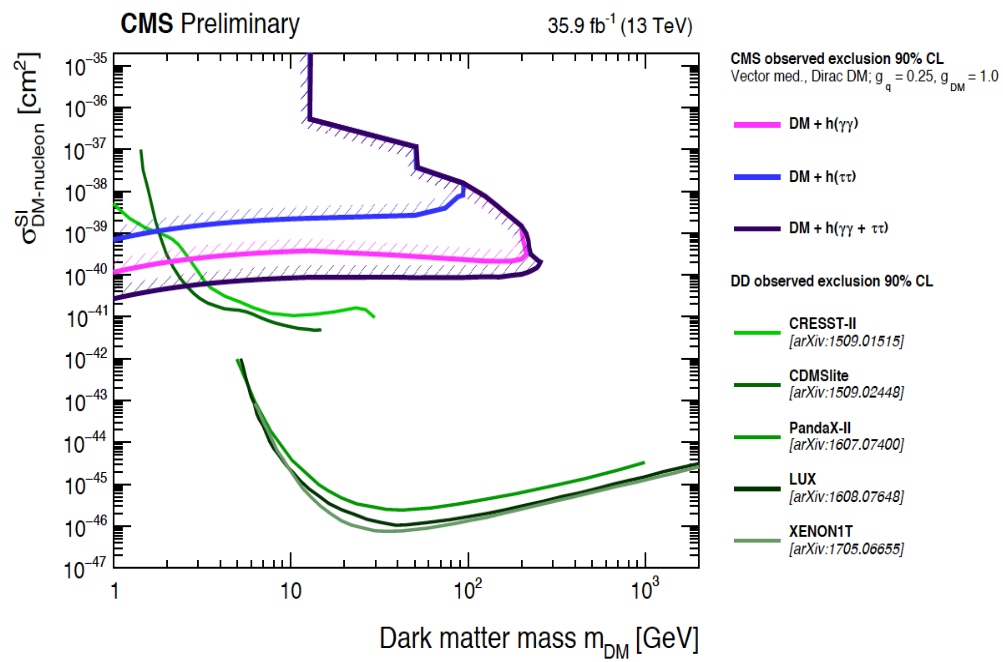




- Not ISR (small coupling)
- Mainly Simplified Models:
- s-channel vector mediator radiating Higgs
- Other models considered:
- s-channel scalar mediator radiating Higgs
- Z'-2HD simplified model
- scalar 2HD simplified model
- Additional parameters as: $g_{Z'Z'h}$, mixing angles...



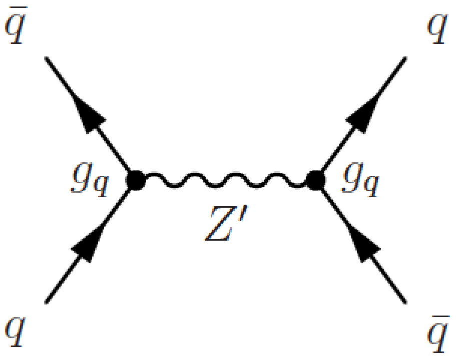




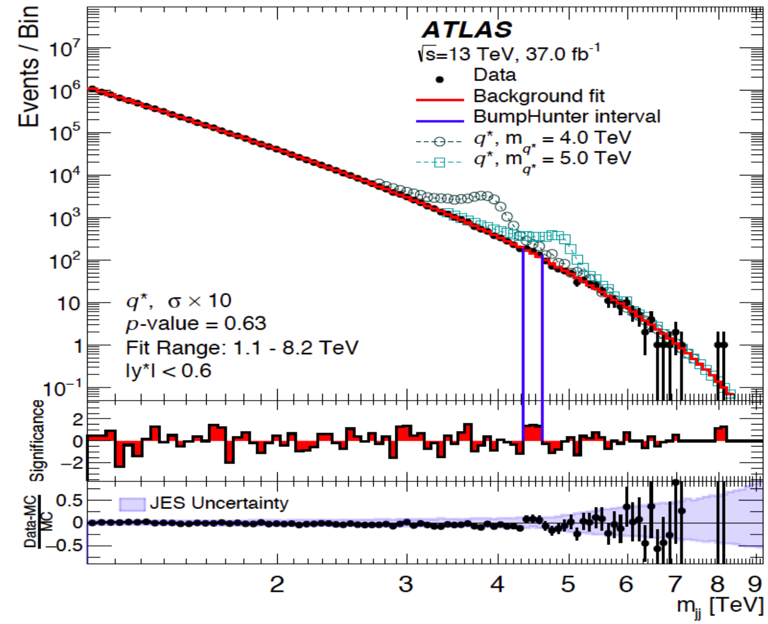
ATLAS HIGG-2016-18/ (Phys. Rev. D 96 (2017) 112004)
ATLAS EXOT-2016-25/ (Phys. Rev. Lett. 119 (2017) 181804)
CMS PAS EXO-16-055 (13 March 2018)

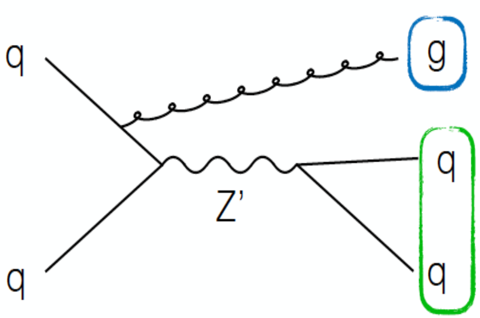
New phenomena in dijet

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



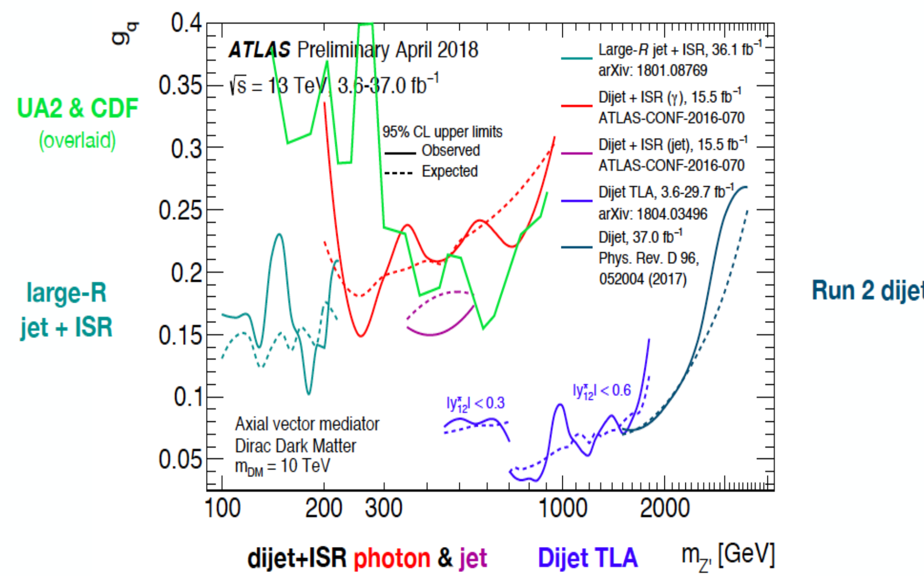
2 high p_T jets. mjj is the discriminant, search for bump on a smooth, falling background. Background modelled by a parametrize function.





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

Mediator masses excluded ~ 2.6 TeV



Trigger-level analysis greatly improves sensitivity

ATLAS-EXOT-2016-20

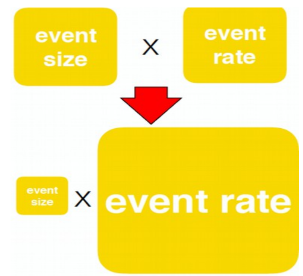
Dijet TLA

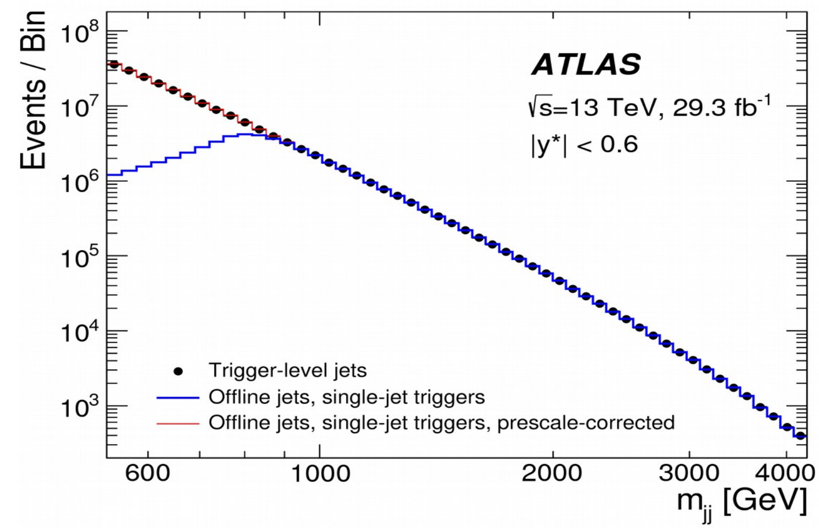
Standard dijet search sensitive to mjj ≥ 1 TeV

Trigger-level search:

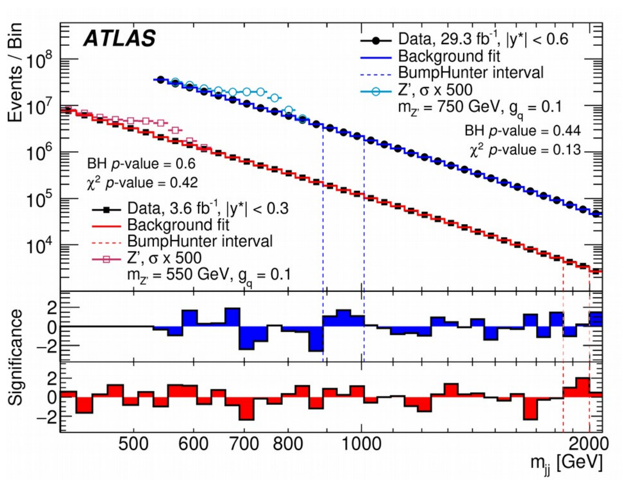
- Dedicated data stream allows to go down to 450 GeV

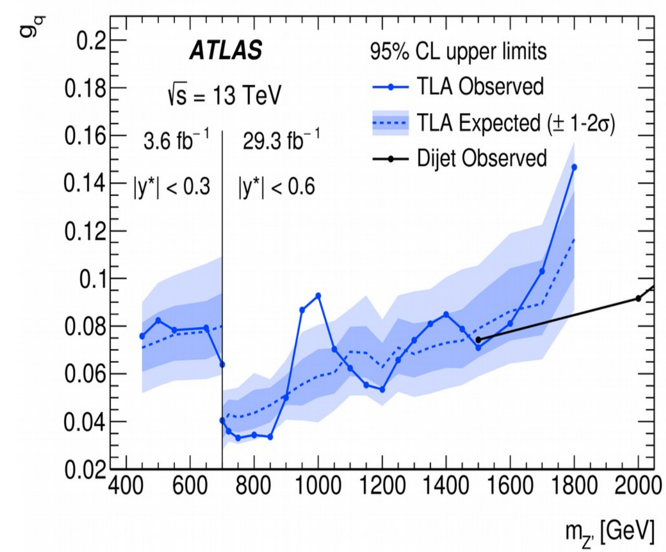
Only a reduced set of information from the trigger system is recorded and subsequently analyzed.





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





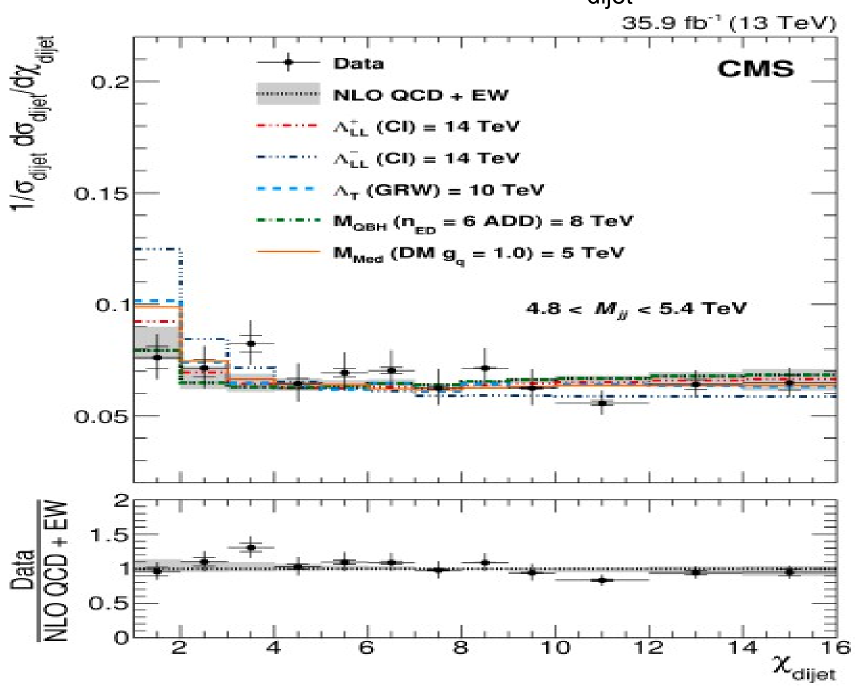
First implemented in LHCb: “Turbo stream” arXiv: 1604.05596

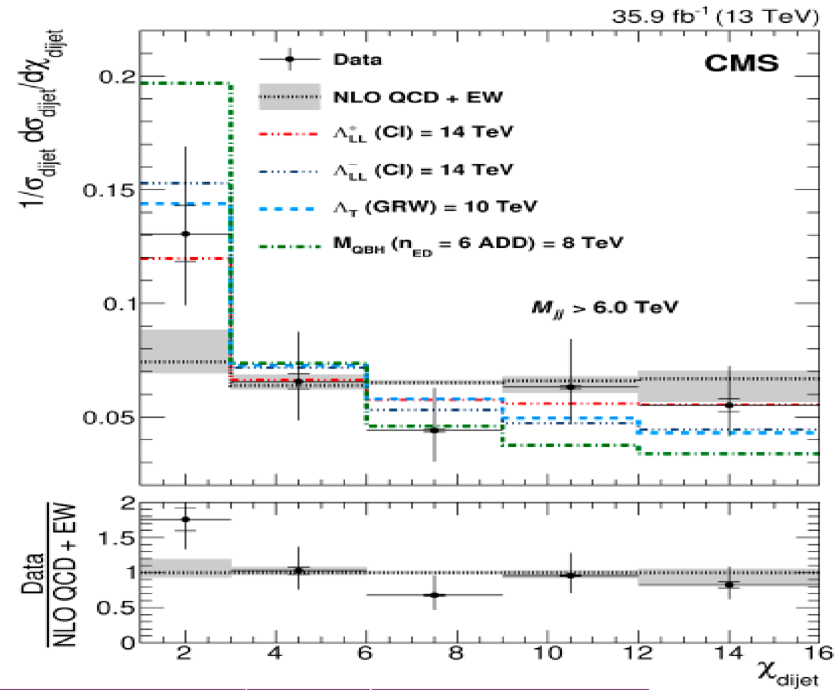
CMS: “Data Scouting” Phys. Lett. B 769 (2017) 520, arXiv: 1611.03568 [hep-ex].

Dijet angular distributions

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

QCD predicts a relatively flat χ_{dijet} distribution while new physics (quark compositeness) is expected to produce an excess at low values of χ_{dijet}

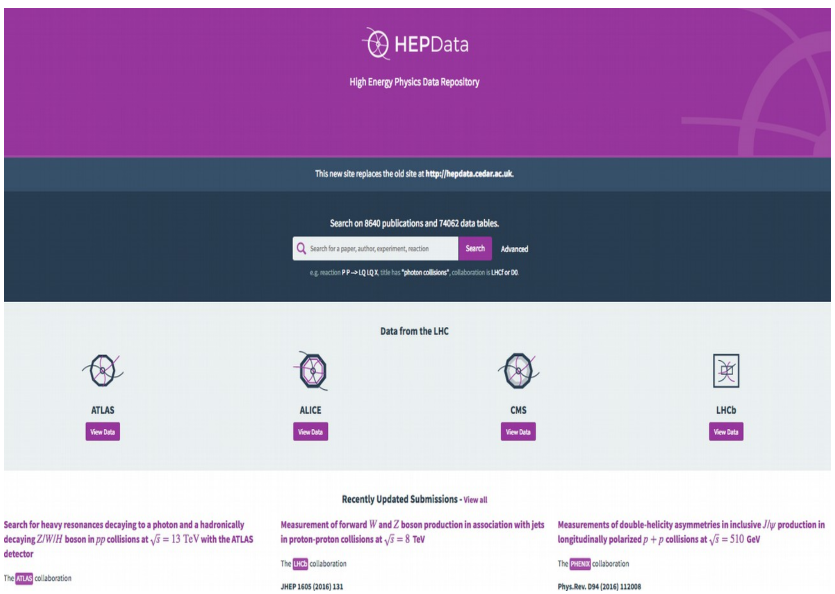


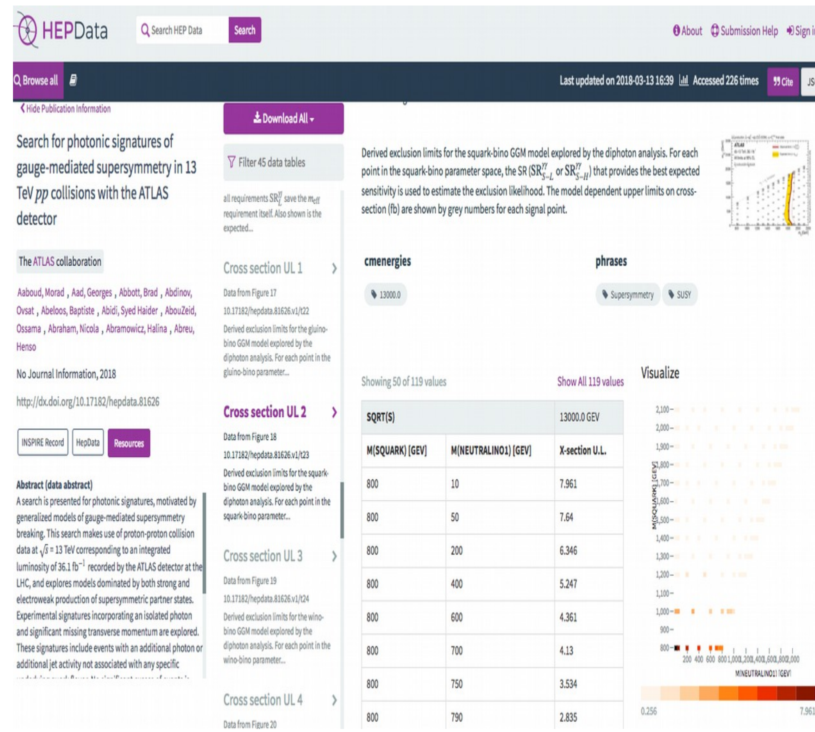


Process	New physics	Lower limit exclusion	Lumi (fb^{-1})	Publication
X → q q	Low mass Z' DM mediator	From 50 to 300 GeV From 50 to 300 GeV	35.9	EXO-17-001 JHEP01(2018)097
q+ b + X → q + b + b H	Heavy vector-like quark	From 1.20 to 0.07 pb For 700<B<1800 GeV	35.9	B2G-17-009 Submit to JHEP CERN-EP-2017-338
X → q q Dijet angular distribution	DM mediator Quantum black holes Contact Interaction	From to 2 to 4.6 TeV From 5.9 to 8.2 TeV From 12.8 to 17.5 TeV	35.9	EXO-16-046 Submitted to EPJC CERN-EP-2018-036

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

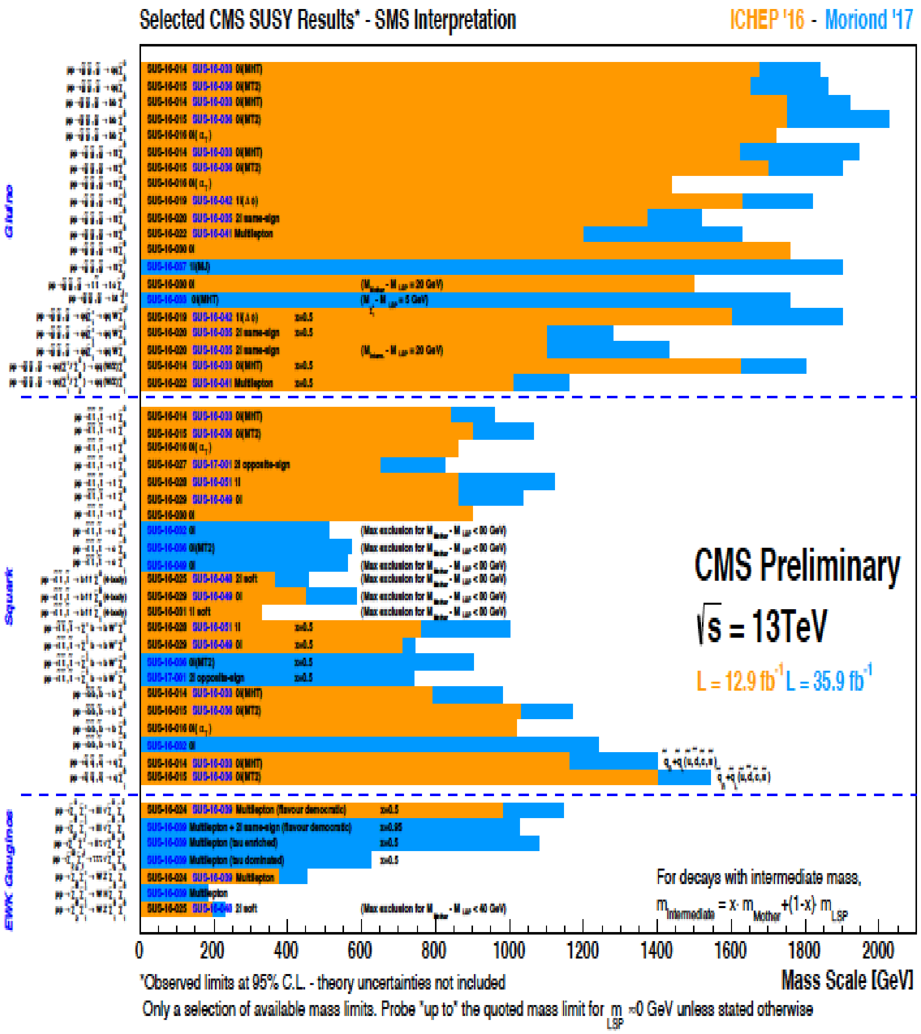
The Durham High Energy Physics Database (HEPData) has been built up over the past four decades as a unique open-access repository for scattering data from experimental particle physics. It currently comprises the data points from plots and tables related to several thousand publications including those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

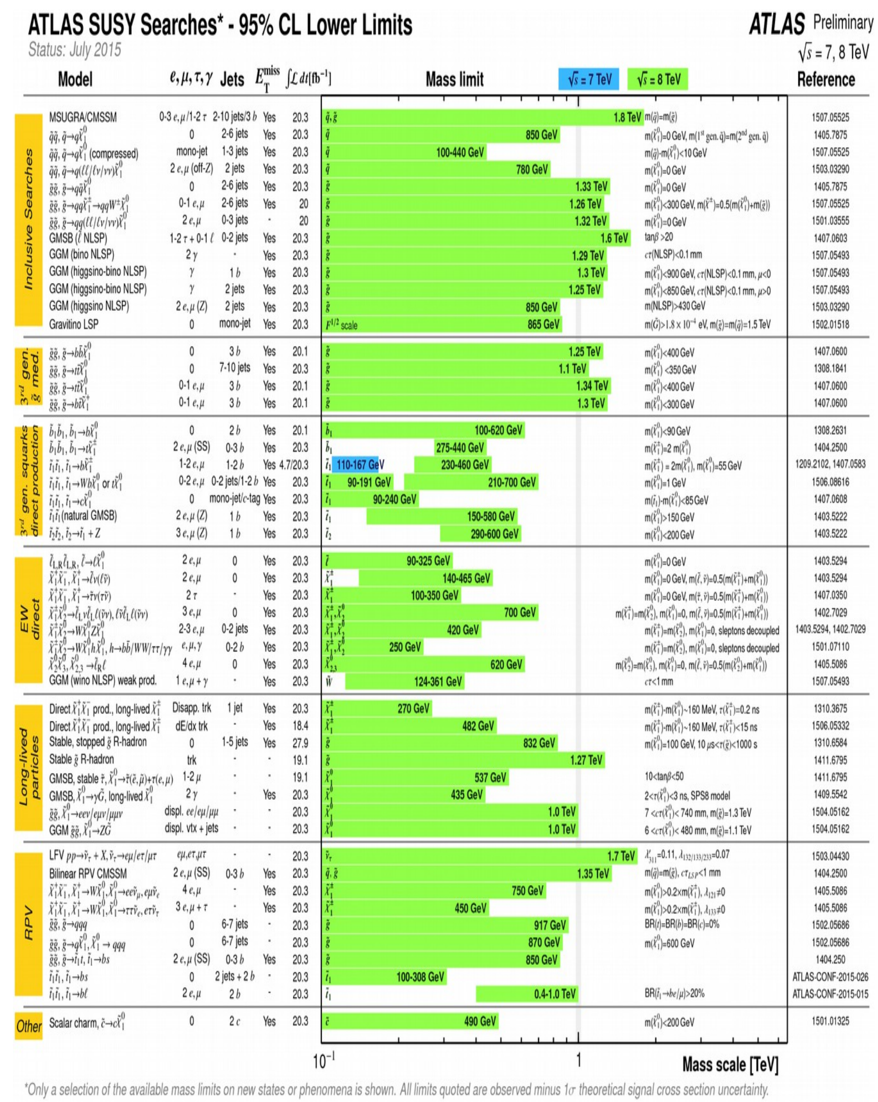




Summary

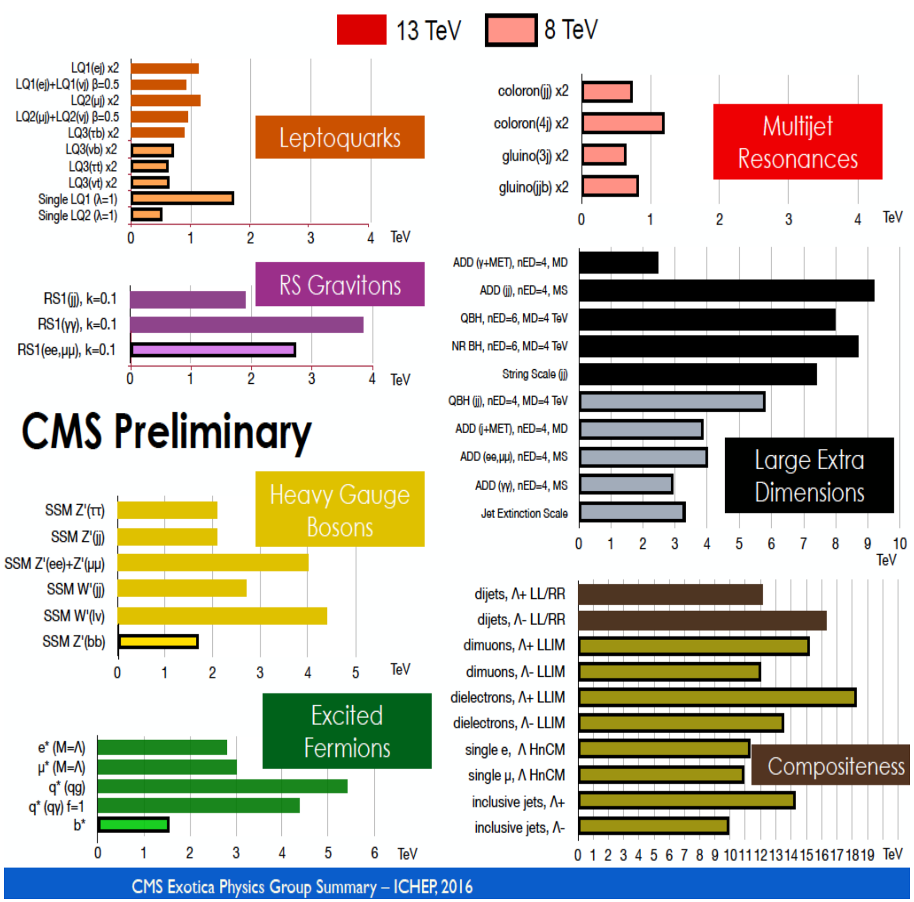
Search for supersymmetric particles

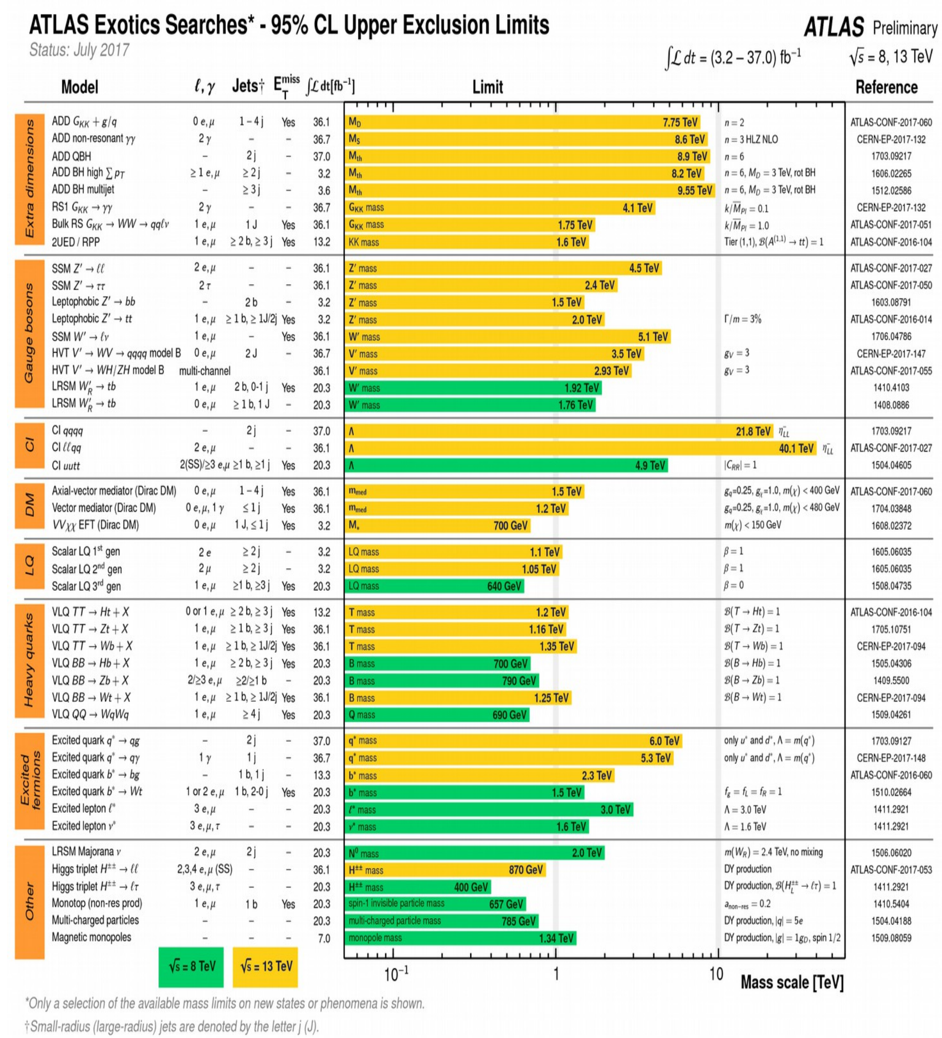




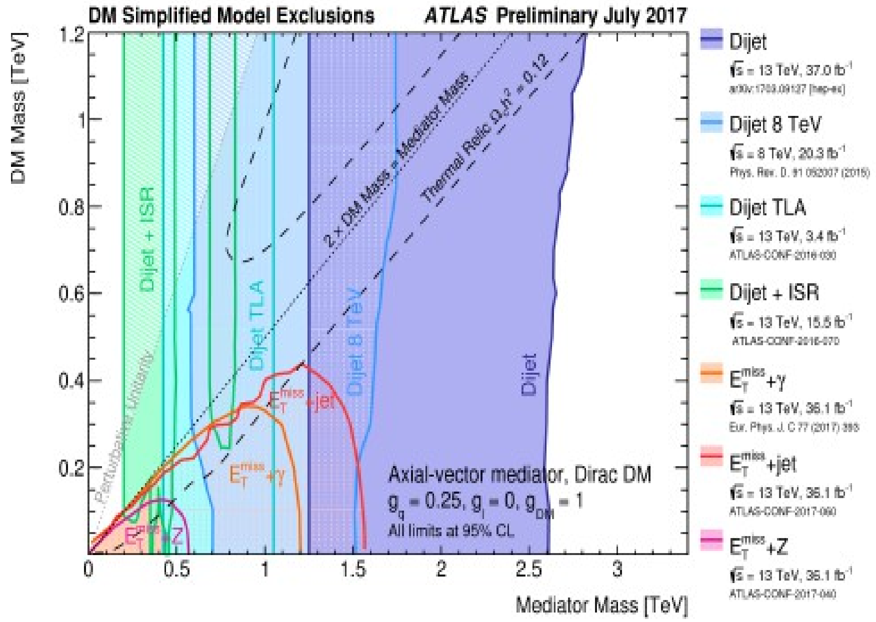
Gluino/Squark limits are pushing 1.5 - 2 TeV
Stop limits are pushing Selected 1 TeV

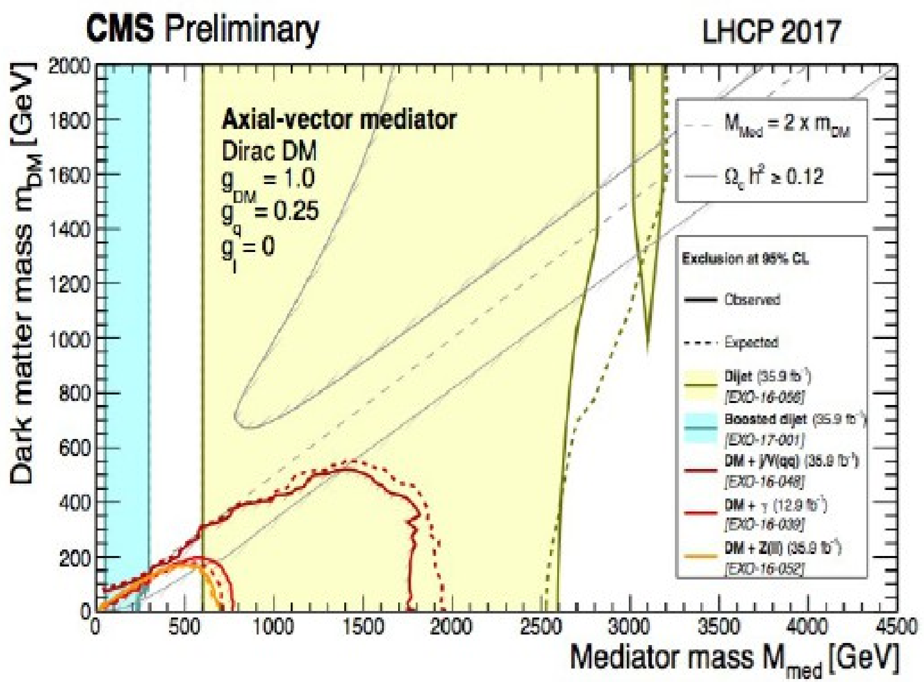
Search for exotic particles





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

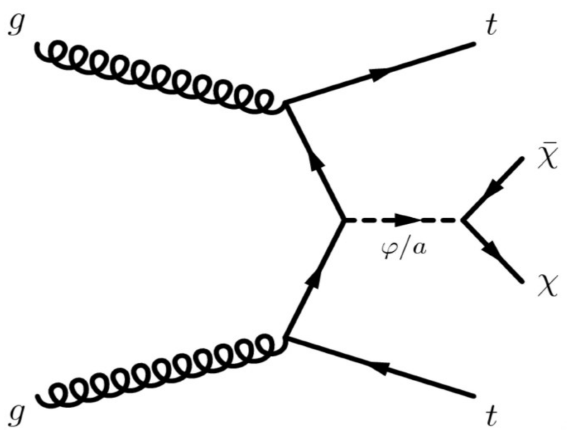
1.	RPV multijet 1-lepton	1704.08493 [hep-ex]
2.	long-lived reinterpretation	CONF-SUSY-2018-03
3.	displaced vertices	1710.04901 [hep-ex]
4.	disappearing track	PHYS-PUB-2017-019
5.	multijet (7-11)	1708.02794 [hep-ex]
6.	0L inclusive	1712.02332 [hep-ex]
7.	1-lepton + MET + jet	1708.08232 [hep-ex]
8.	stop in Z/h	1706.03986 [hep-ex]
9.	**SS/3L**	**1706.03731 [hep-ex]**
10.	**stop 2L**	**1708.03247 [hep-ex]**
11.	2b+MET	1708.09266 [hep-ex]
12.	**stop 0L**	**1709.04183 [hep-ex]**
13.	stop b-l	1710.05544 [hep-ex]
14.	**multi b-jets**	**1711.01901 [hep-ex]**
15.	stop 2x2	1710.07171 [hep-ex]
16.	**stop 1L**	**1711.11520 [hep-ex]**
17.	Stop in stau	ATLAS-CONF-2017-079
18.	electroweak compressed	1712.08119 [hep-ex]
19.	**SUSY with photons**	**1802.03158 [hep-ex]**
20.	GMSB Higgsinos in 4b	ATLAS-CONF-2017-081
21.	Electroweak di-tau	1708.07875 [hep-ex]
22.	EW 2/3L	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

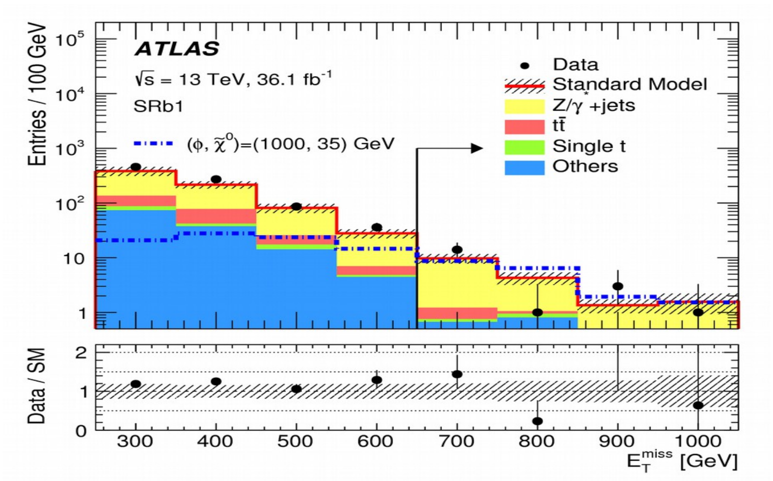


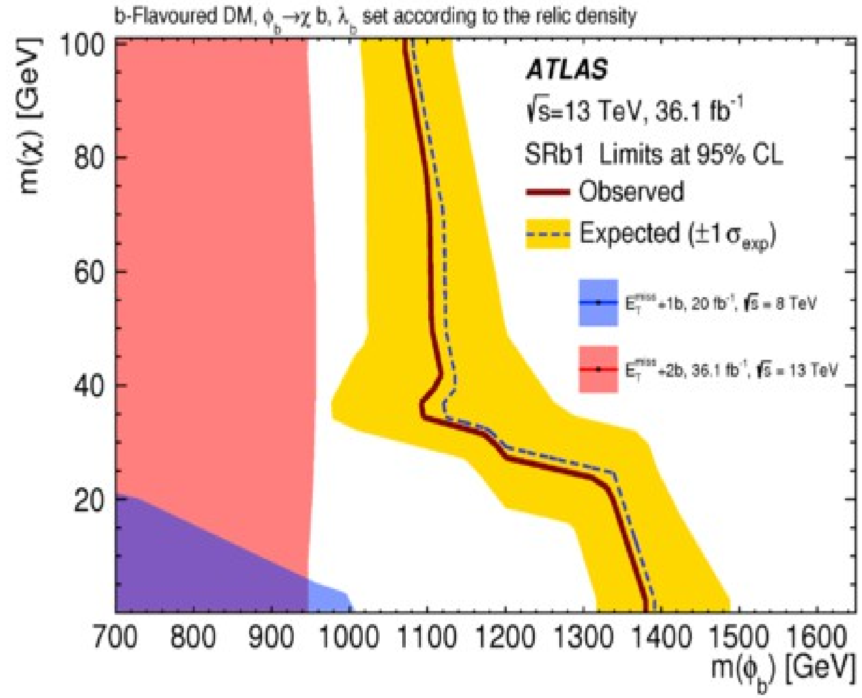
Selection

- 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



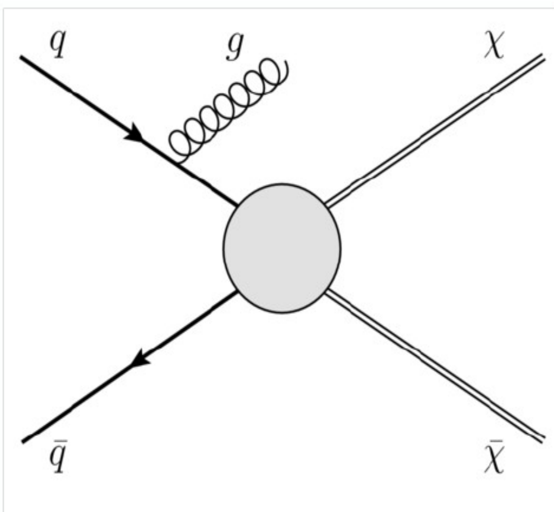


ATLAS-SUSY-2016-18/ (Eur. Phys. J. C 78 (2018)18)

DM models

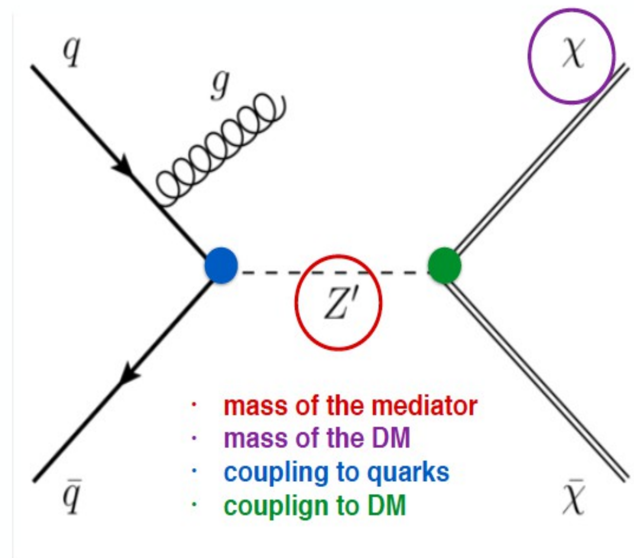
Effective field theories

Mediator energies >>
energy transfer at the LHC



Simplified models

Mediator is light enough to be produced at
the LHC!



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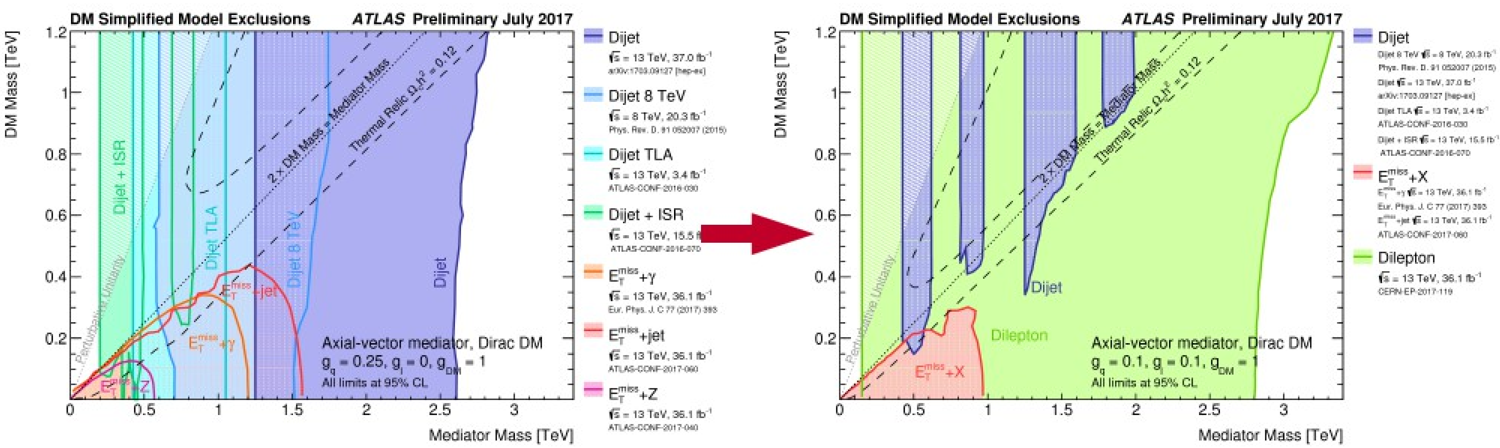
Zeynep Demiragli

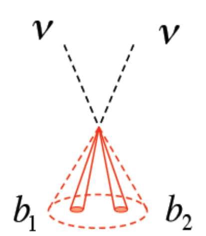
Search DM

Big picture changes with the choice of couplings

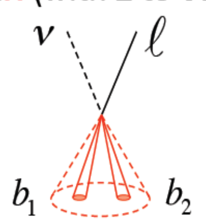


- Dijet and mono-X constraints weakened if g_q=0.25 → 0.1

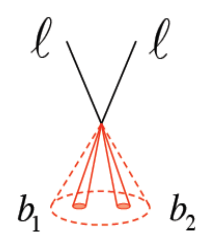
New resonances decaying to W/Z + Higgs



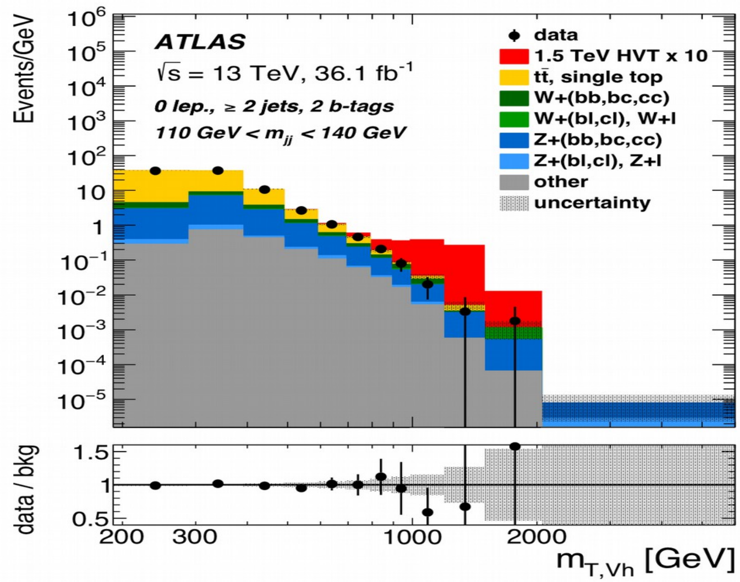
ZH (with **Z to νν**)



WH (with **W to lν**)



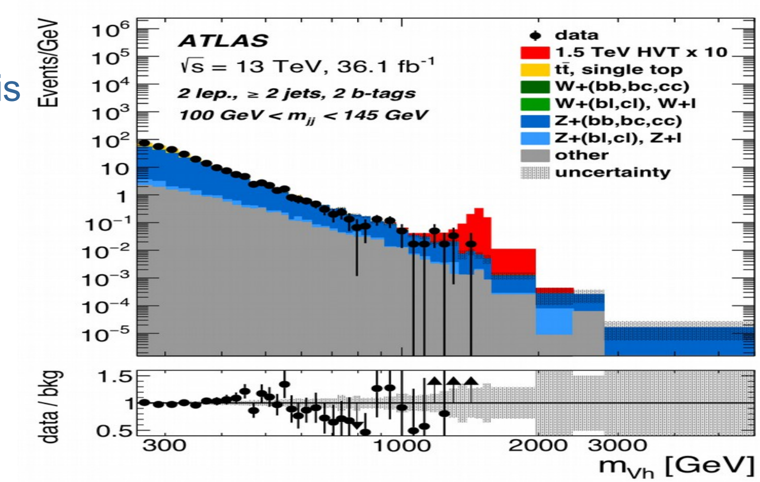
ZH (with **Z to dilepton**)



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

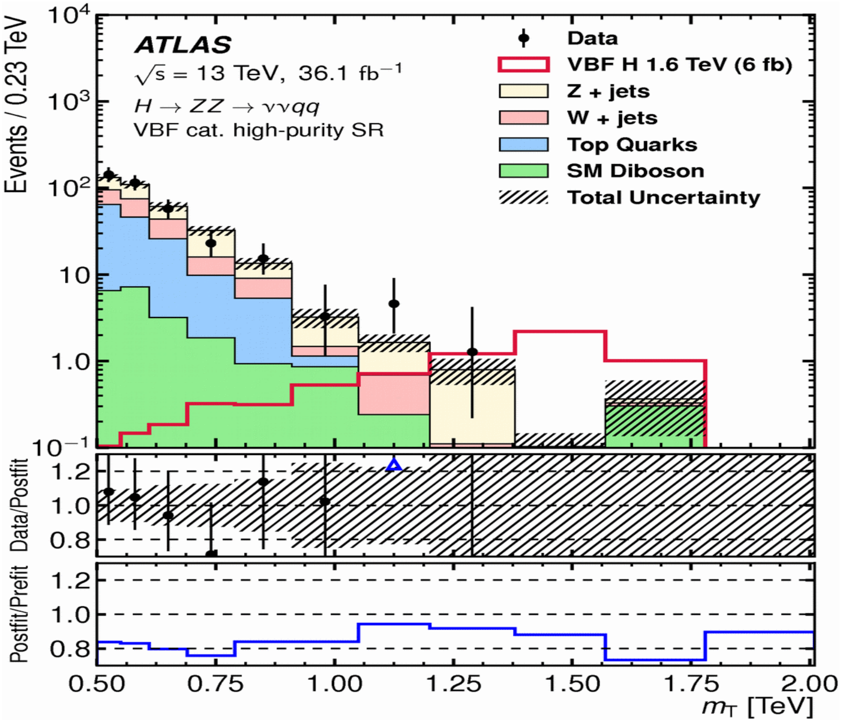
ttbar and Z+jets , shape is MC estimated, normalisation is constrained from CRs

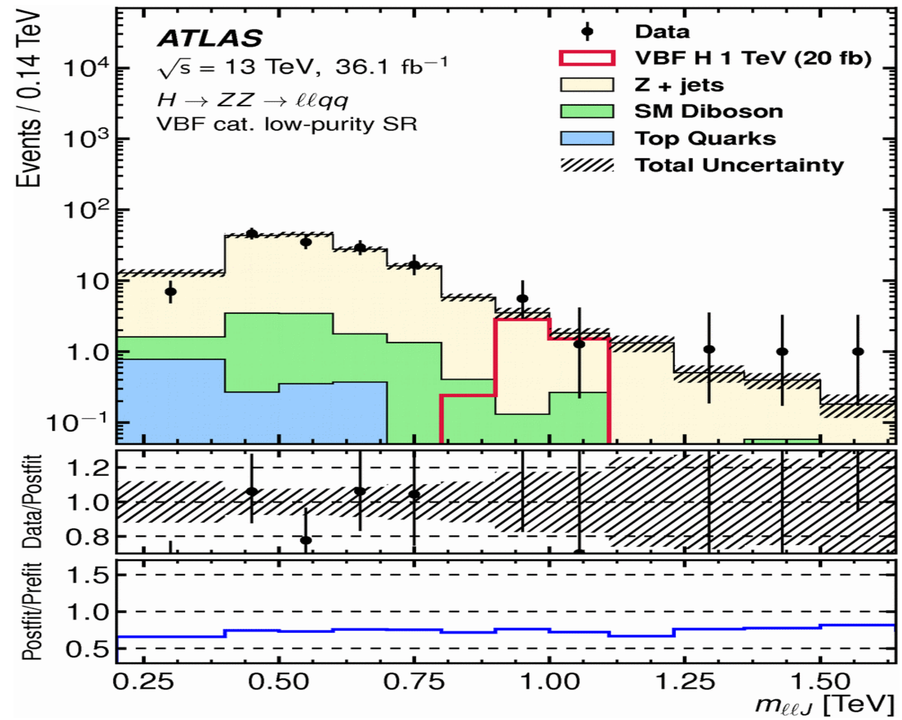
Multi-jet (V→qq), both shape and normalisation are data-driven, re-weighting from untagged regions



ATLAS-/EXOT-2016-12/ (Phys. Lett. B 774)(2017) 494)
ATLAS-/EXOT-2016-10/ (arXiv:1712.06518)

Diboson results





Main background

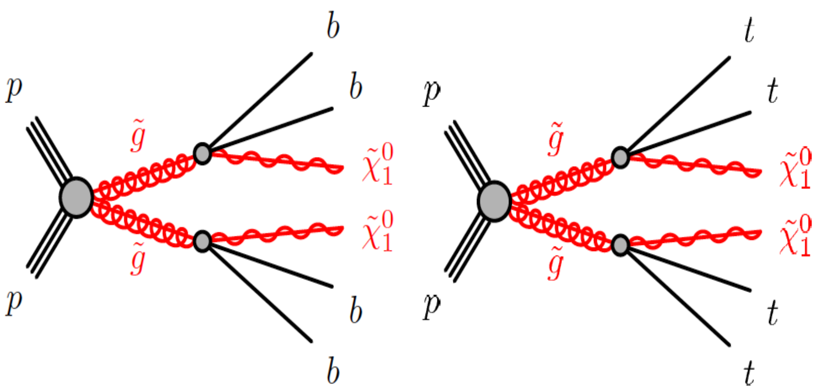
- Z + jets, data-driven (normalisation) from CRs (sideband m_J or m_{jj})
- ttbar dedicated CRs

Systematic Uncertainties

- Background modelling (llqq: 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: $N_{b\text{-jets}} \geq 3$, $p_T^{\text{jet}} > 30$ GeV

Targeted kinematics	Type	N_{lepton}	$\Delta\phi^{4j}_{\text{min}}$	m_T	N_{jet}	$m^{b\text{-jets}}_{T,\text{min}}$	M^{Σ}_{J}	E_T^{miss}	m_{eff}
High-m_{eff} (HH) (Large Δm)	SR-0L	$= 0$	> 0.4	–	≥ 7	> 100	> 200	> 400	> 2500
	SR-1L	≥ 1	–	> 150	≥ 6	> 120	> 200	> 500	> 2300
	CR	≥ 1	–	< 150	≥ 6	> 60	> 150	> 300	> 2100
	VR-0L	$= 0$	> 0.4	–	≥ 7	< 100 if $E_T^{\text{miss}} > 300$	–	< 300 if $m^{b\text{-jets}}_{T,\text{min}} > 100$	> 2100
	VR-1L	≥ 1	–	> 150	≥ 6	< 140 if $m_{\text{eff}} > 2300$	–	< 500	> 2100
Intermediate-m_{eff} (HI) (Intermediate Δm)	SR-0L	$= 0$	> 0.4	–	≥ 9	> 140	> 150	> 300	[1800, 2500]
	SR-1L	≥ 1	–	> 150	≥ 8	> 140	> 150	> 300	[1800, 2300]
	CR	≥ 1	–	< 150	≥ 8	> 60	> 150	> 200	[1700, 2100]
	VR-0L	$= 0$	> 0.4	–	≥ 9	< 140 if $E_T^{\text{miss}} > 300$	–	< 300 if $m^{b\text{-jets}}_{T,\text{min}} > 140$	[1650, 2100]
	VR-1L	≥ 1	–	> 150	≥ 8	< 140 if $E_T^{\text{miss}} > 300$	–	< 300 if $m^{b\text{-jets}}_{T,\text{min}} > 140$	[1600, 2100]
Low-m_{eff} (HL) (Small Δm)	SR-0L	$= 0$	> 0.4	–	≥ 9	> 140	–	> 300	[900, 1800]
	SR-1L	≥ 1	–	> 150	≥ 8	> 140	–	> 300	[900, 1800]
	CR	≥ 1	–	< 150	≥ 8	> 130	–	> 250	[900, 1700]
	VR-0L	$= 0$	> 0.4	–	≥ 9	< 140	–	> 300	[900, 1650]
	VR-1L	≥ 1	–	> 150	≥ 8	< 140	–	> 225	[900, 1650]

arXiv:1711.01901 [hep-ex]