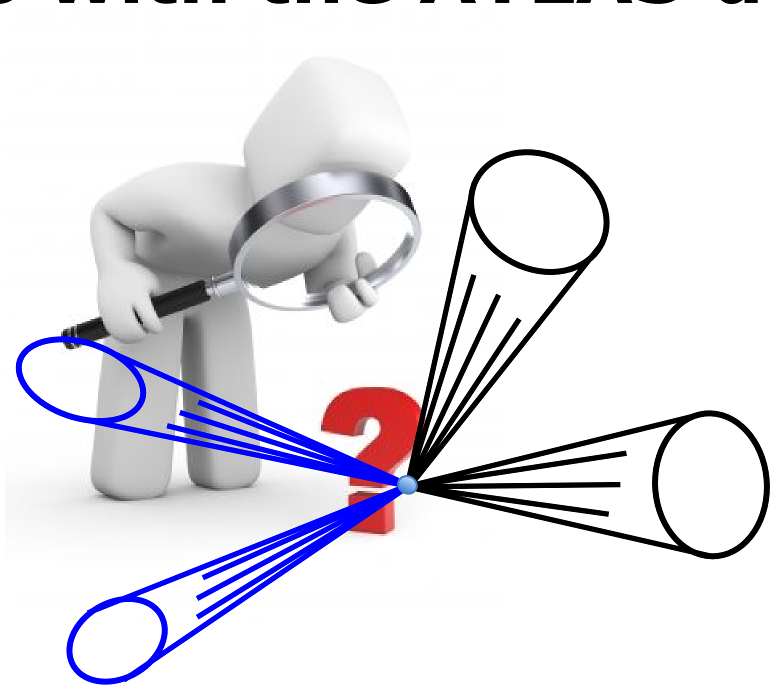
Latest Beyond Standard Model results with the ATLAS detector



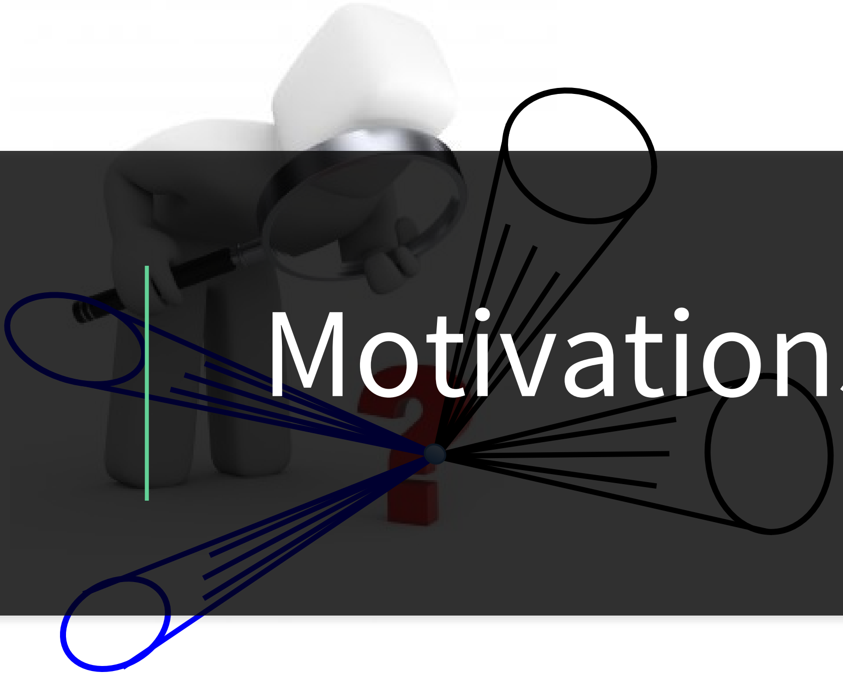
Arturo Sánchez, on behalf the ATLAS Collaboration
University of Udine, ICTP and INFN

February 14th, **KEK-PH 2018**, Tokyo, Japan

Outline

- Motivations
- Resonant searches
  - Leptons
    - Dileptons
    - Lepton + Missing Et
  - Dibosons
    - $\gamma\gamma$
    - VV
  - Dijets & ttbar
- Non-resonant searches
  - Vector-Like Quarks
  - Dark Matter
- Summary
- Backup

Motivations



Motivations

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

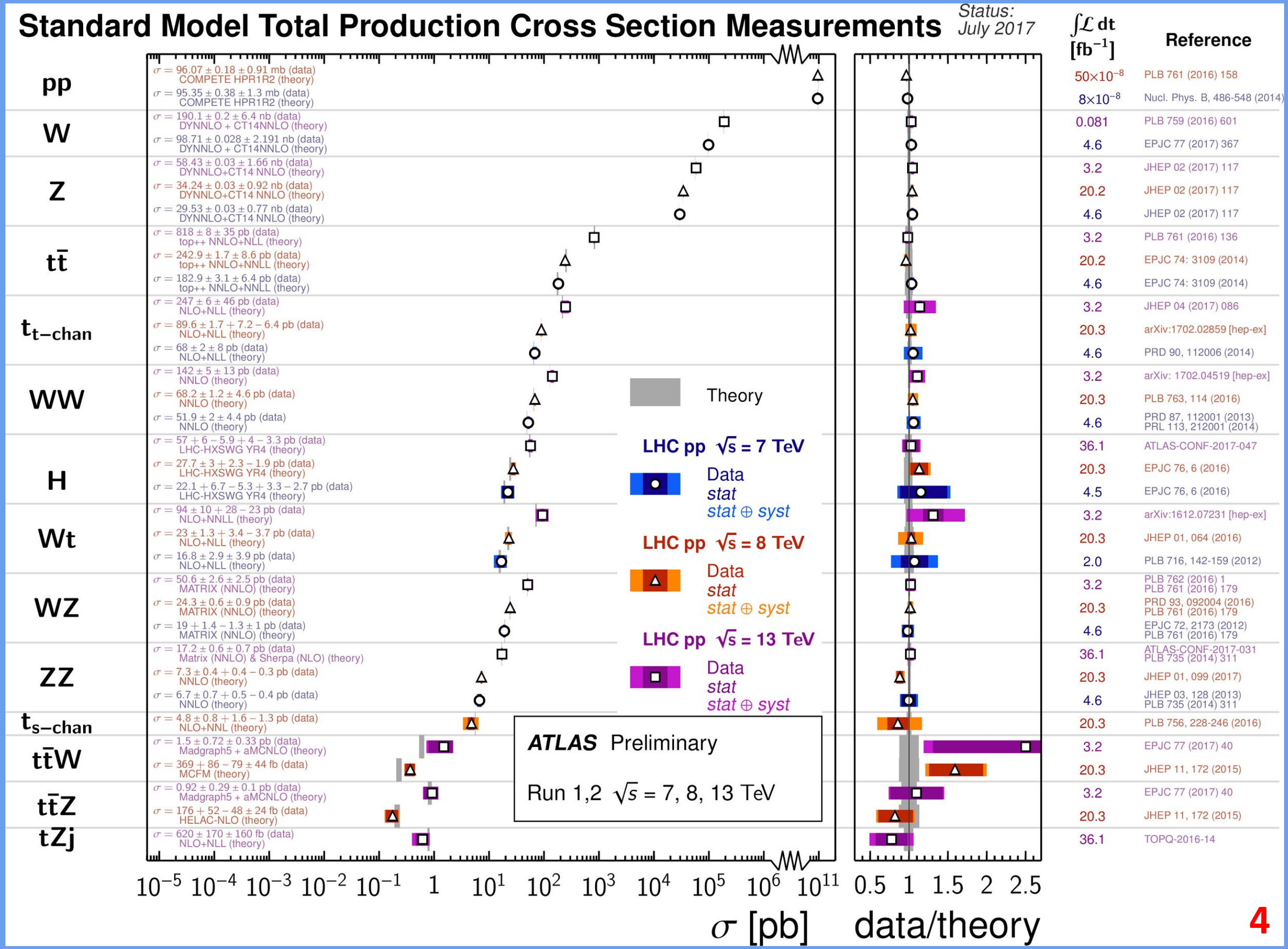
The Standard Model (SM) measurements give a nice agreement with the theory predictions

However, SM can not explain other important questions in physics, like:

- Hierarchy/naturalness/fine-tuning ?
- Dark matter ?
- Matter/anti-matter asymmetry ?

… and the known observation of neutrino masses

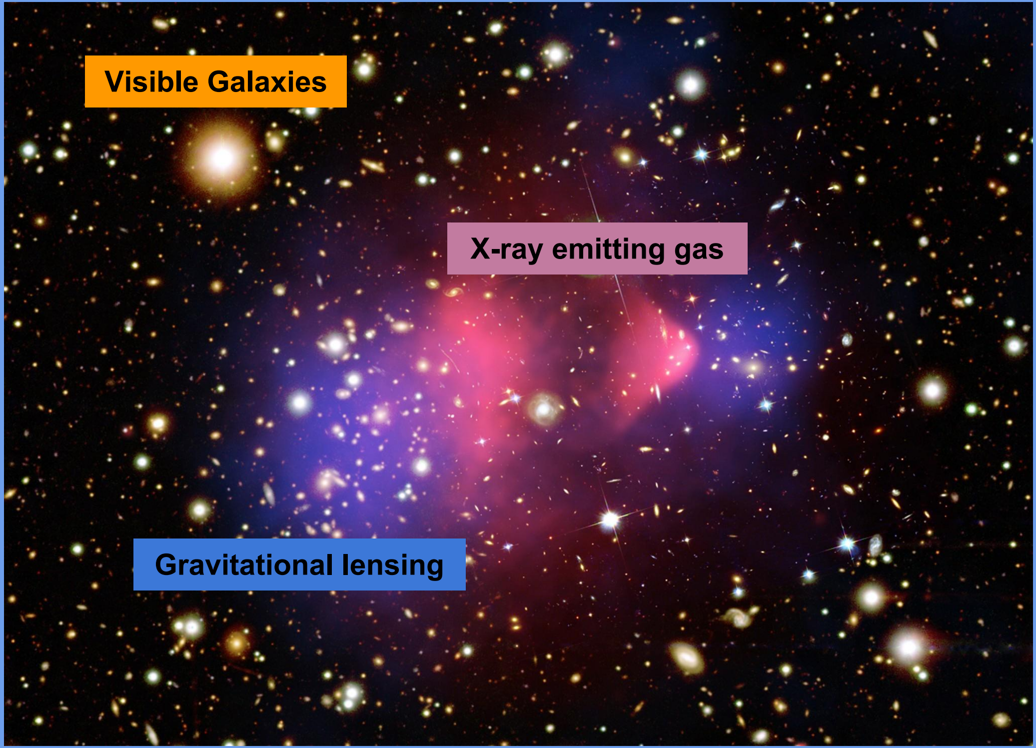
For that reason, ATLAS, as many other experiments has a very large program in Exotics searches!



Motivations

And… we have evidence of the existence of Beyond SM (BSM) physics, particularly when talking about Dark Matter

- Astrophysical and cosmological anomalies
  - Inconsistent with current understanding of gravitation & cosmology
  - Bullet cluster
- Dark matter (DM)
  - Non-luminous, non-interacting particle
  - Universe is 5% ordinary matter and 26% dark matter
- Many DM theories
  - Black holes, axions, unknown particles, etc
- Weakly Interacting Massive Particles
  - Assume that DM couples weakly to the Standard Model (SM)
  - Produced in early universe
  - Thermal relic density

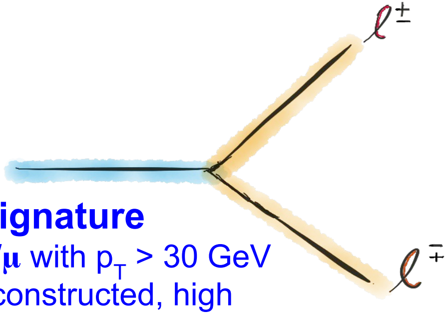


- Composite Credit: X-ray: NASA/CXC/CfA/ M.Markevitch et al.;
- Lensing Map: NASA/STScI; ESO WFI; Magellan/U.Arizona/ D.Clowe et al.
- Optical: NASA/STScI; Magellan/U.Arizona/D.Clowe et al.

Resonant Searches

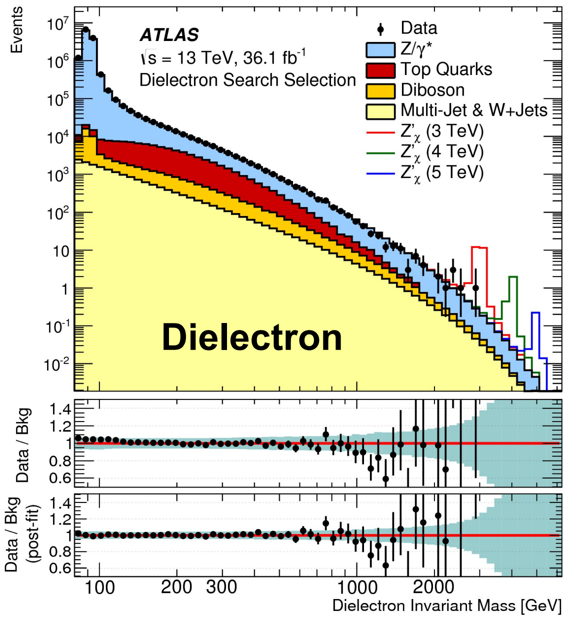
l^+l^- Resonances

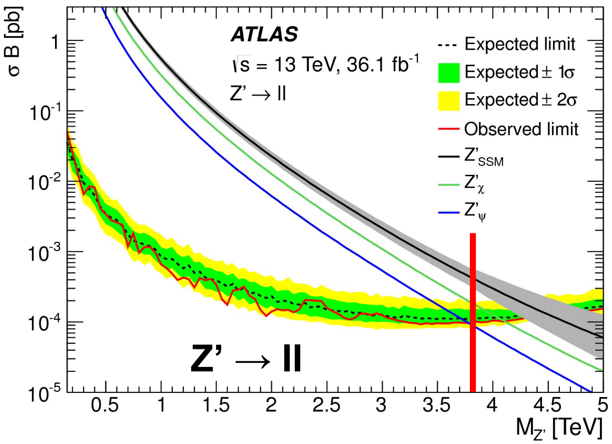
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-05/ (JHEP 10 (2017) 182)



Signature

A pair of **e**/**μ** with p_T > 30 GeV
Fully reconstructed, high signal-selection efficiency, small & well-understood backgrounds





Dominant background

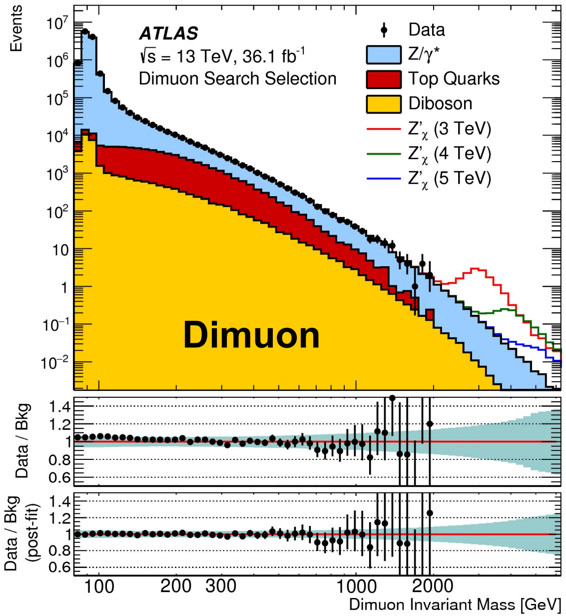
- Drell-Yan (DY)

Systematic uncertainties

- DY PDF variations
- **μ** reconstruction efficiency (high pT)
- Calorimeter-based **e** isolation efficiency

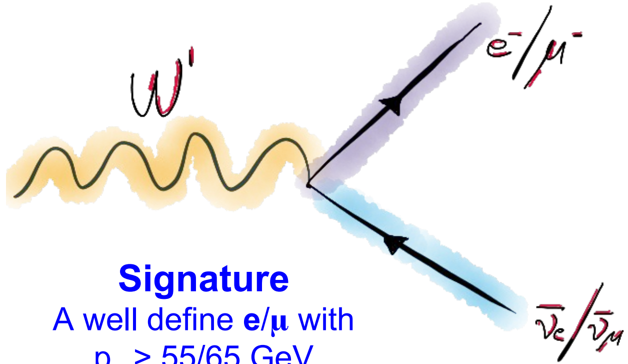
No excess found in data

$M_{Z'}$ exclusion limit up to 3.8 TeV



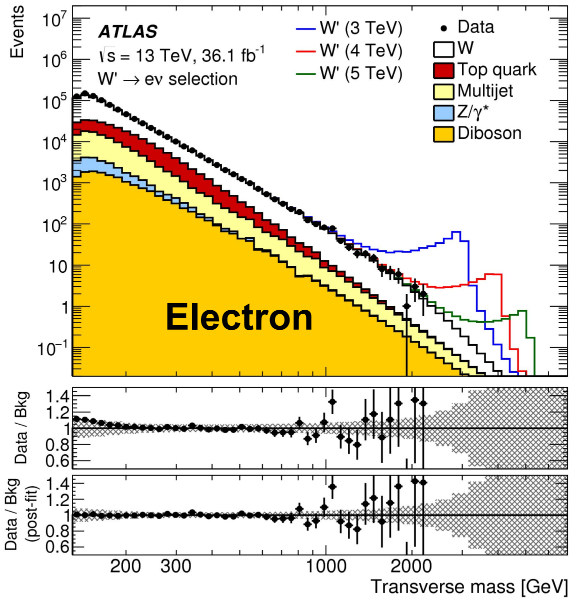
$l + \nu$ Resonances

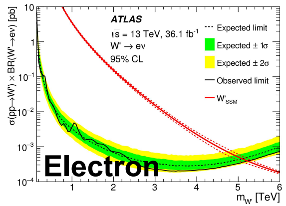
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-06/ (arXiv:1706.04786)



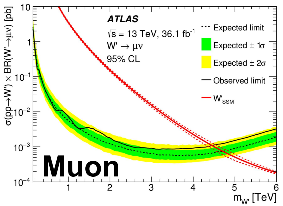
Signature

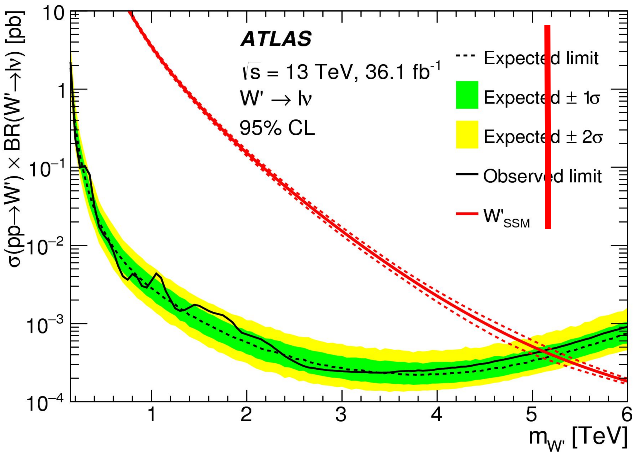
A well define **e/μ** with
p_T > 55/65 GeV
MeT > 55/65 GeV





+

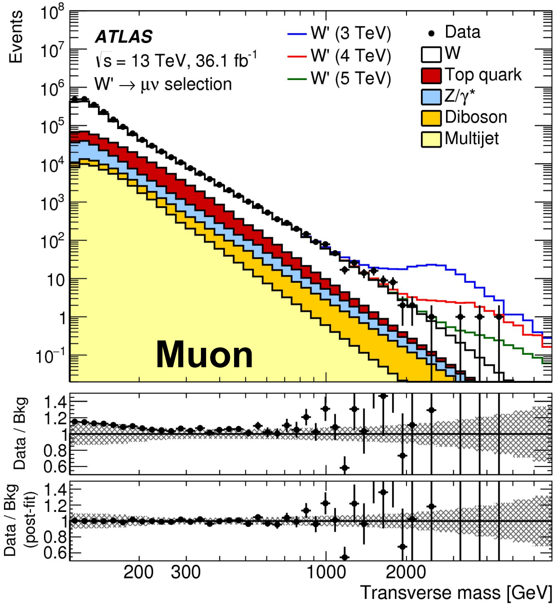




$$m_T = \sqrt{2 p_T E_T^{miss}(1 - \cos\phi_{\ell\nu})}$$

No excess found in data

$M_{W'}$ exclusion limit up to 5.1 TeV

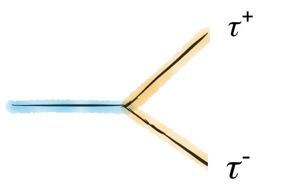


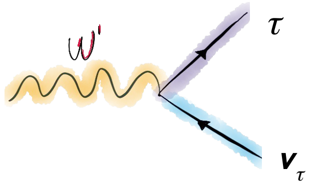
Dominant background

- W → $l\nu$
- ttbar + single top

Systematic Uncertainties

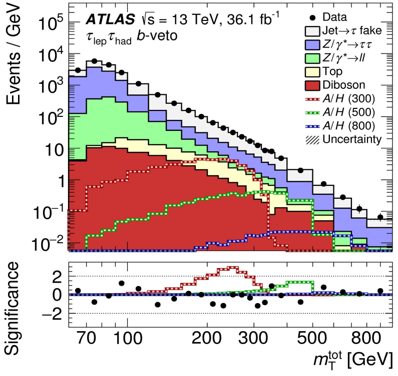
- PDF variation in W → $l\nu$ bkg.
- Muon reconstruction and electron ID eff.





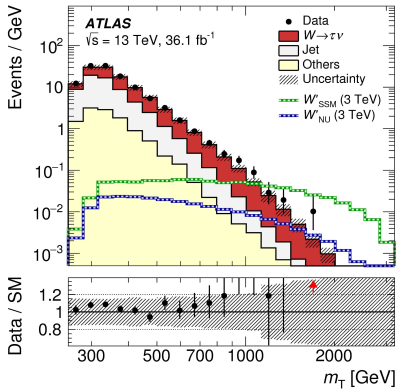
$\tau^+\tau^-$ | $\tau + \nu$ Resonances

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2017-06/ (arXiv:1801.06992)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2016-12/ (arXiv:1709.07242)



In hMSSM scenario, exclude tanβ>1.0 for m_A = 0.25 TeV and tanβ>42 for m_A = 1.5 TeV @95% CL.

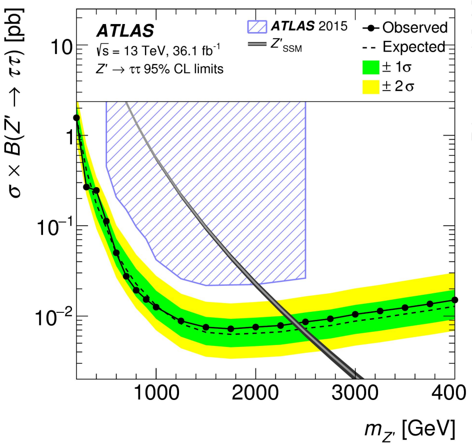
For Sequential SM, Z'_{SSM} with $m_{Z'}$<2.42 TeV is excluded @95% CL, while Z'_{NU} with $m_{Z'}$<2.25 TeV is excluded for the non-universal G(221) model.

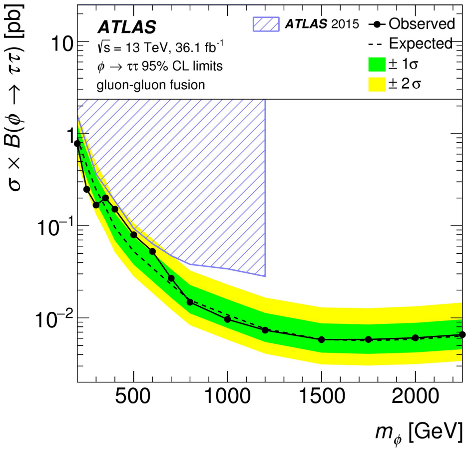


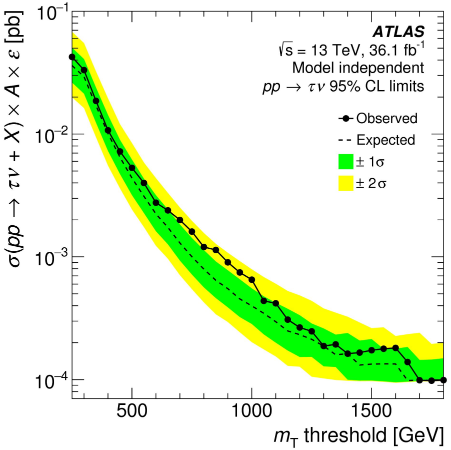
No statistically significant excess above the SM observed

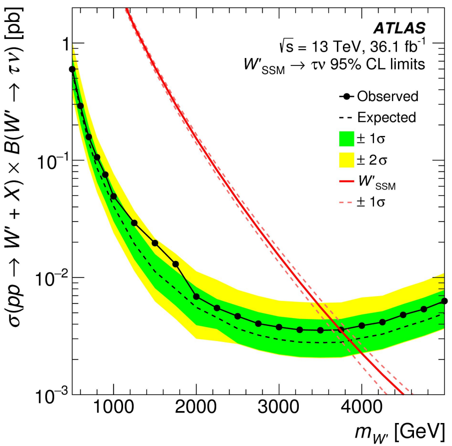
Model-independent upper limits are set on the visible $\tau\nu$ x-section.

W′ bosons with $m_{W'}$< 3.7 TeV in the Sequential SM & $m_{W'}$< 2.2-3.8 TeV depending on the coupling in the non-universal G(221) model are excluded @95%



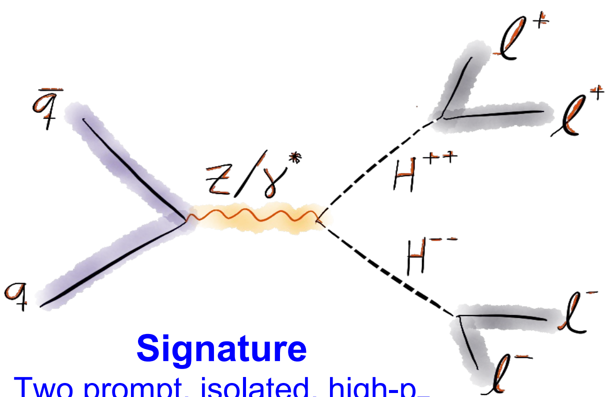






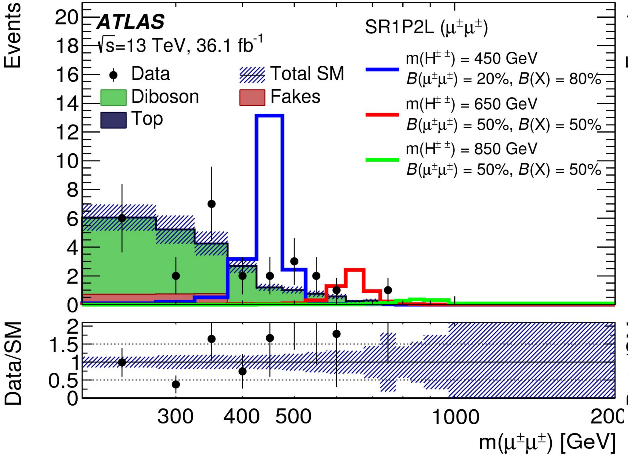
$l^{\mp}l^{\mp}$ Resonances

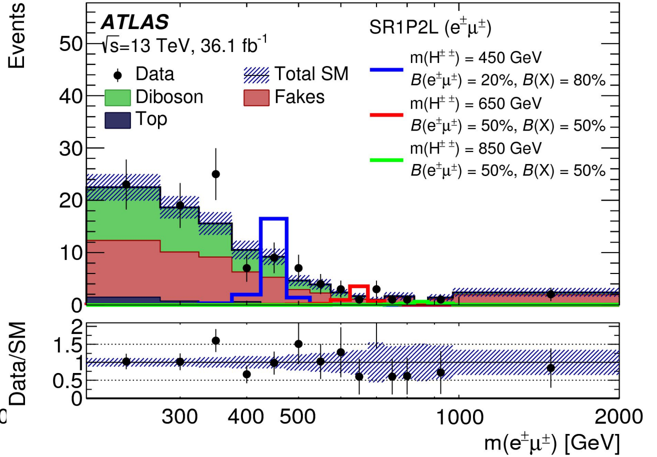
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-07/ (arXiv:1710.09748)

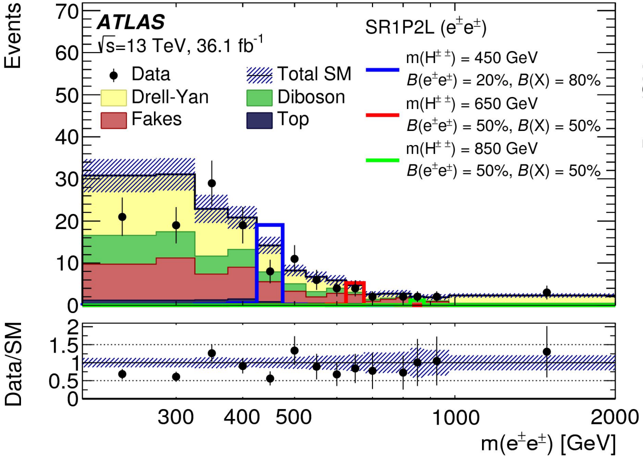


Signature

Two prompt, isolated, high-p_T leptons with the **same charge**







Low irreducible background, but with jets miss-identified as leptons (data-driven factors) and charge flip backgrounds (using $Z \rightarrow ee$ data sample)

Complicated estimation: ***Background is done in a simultaneous fit to 5 CRs and validated in 8 VRs***

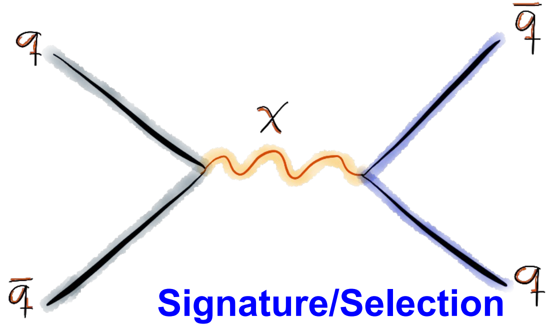
No excess found in data

A visualization of the highest-mass dijet event

the two central high-pT jets each have transverse momenta of 3.79 TeV, they have a |y*| of 0.38 and their invariant mass is 8.12 TeV. The missing transverse momentum in this event is 44 GeV

Dijet Resonances

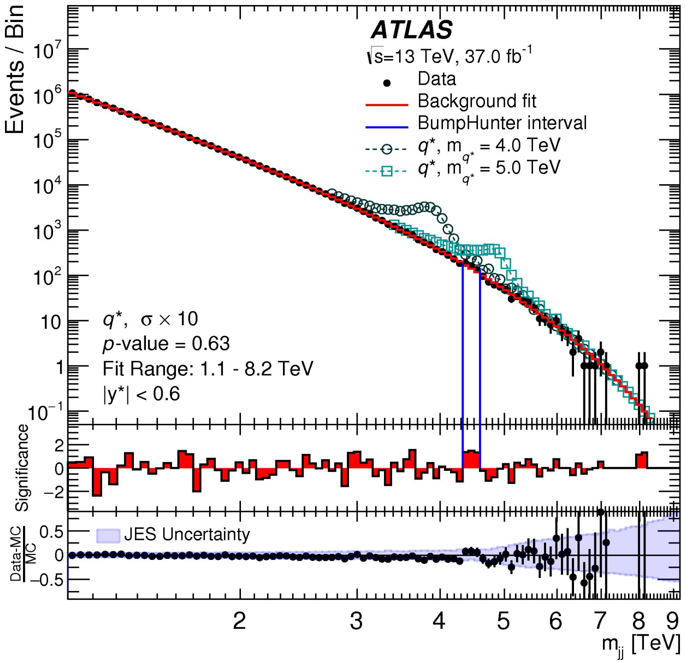
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-21/ (Phys. Rev. D 96, 052004)



Signature/Selection

> 1 jet with p_T > 440 (60) GeV

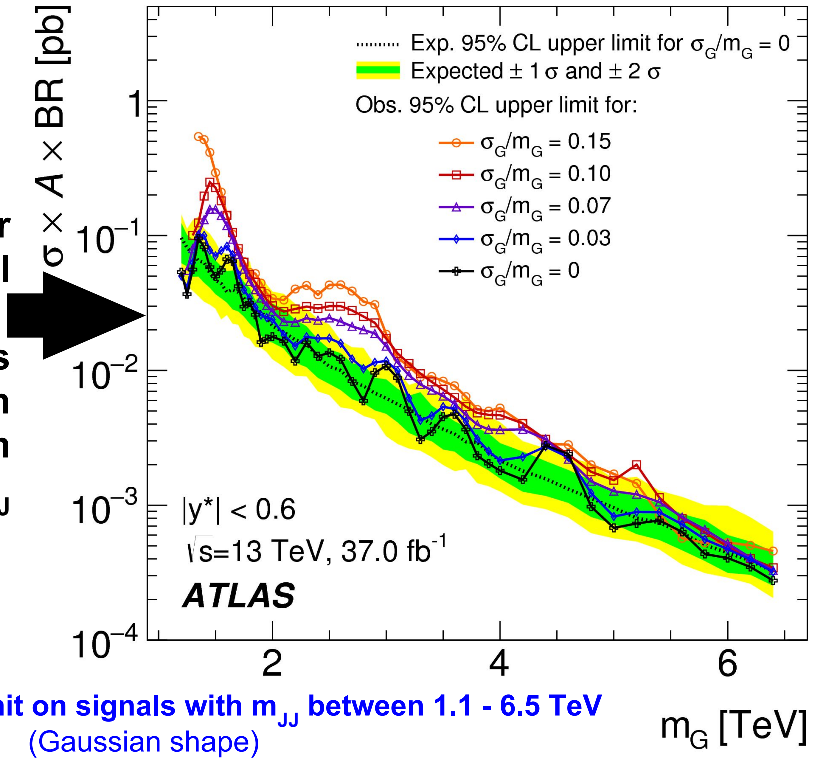
$|y^*| < 0.6$ where y* is the rapidity difference = (y1 − y2)/2 of the jets



No excess found in data

Expected limits for a narrow signal

Observed limits for signal with width ranges from 0 to 15% m_{JJ}



model-independent limit on signals with m_{JJ} between 1.1 - 6.5 TeV
(Gaussian shape)

Important: Limits have been extracted on specific models as well, please check the reference for more details!

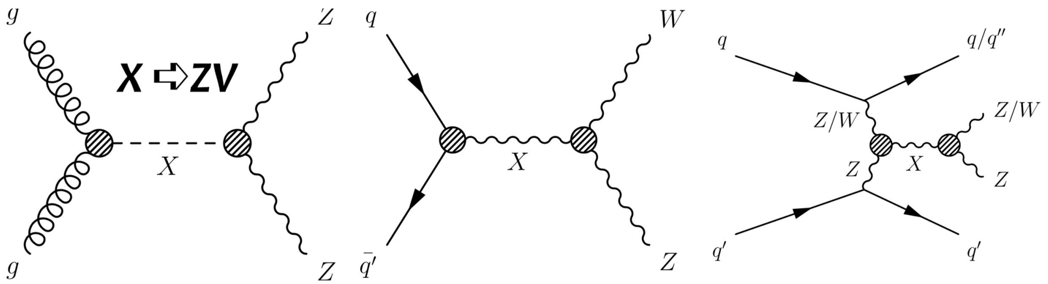
Diboson Searches

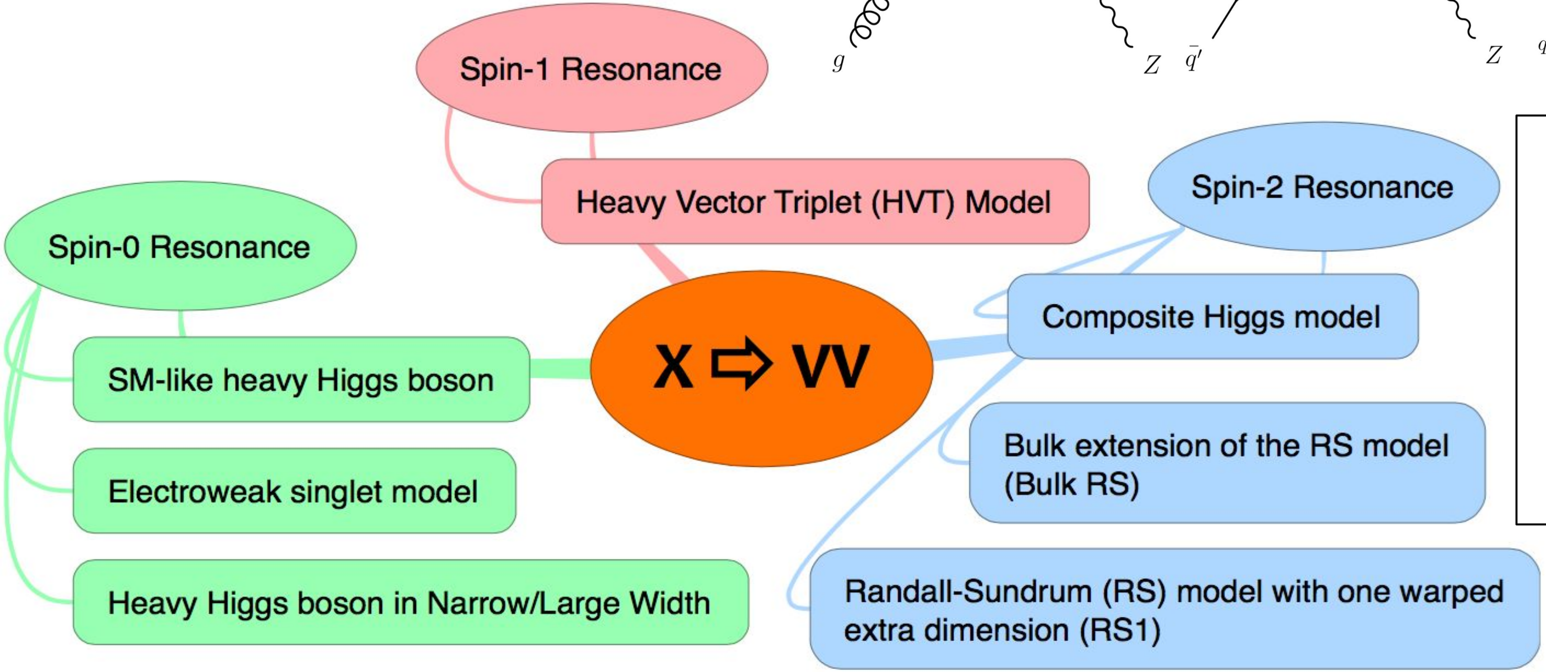
Motivations

The existence of new heavy resonance will be able to help to

- **resolve Hierarchy problem**
- **understand the mechanism of EWSB**
- **understand flavour structure of the SM**

3 types of productions

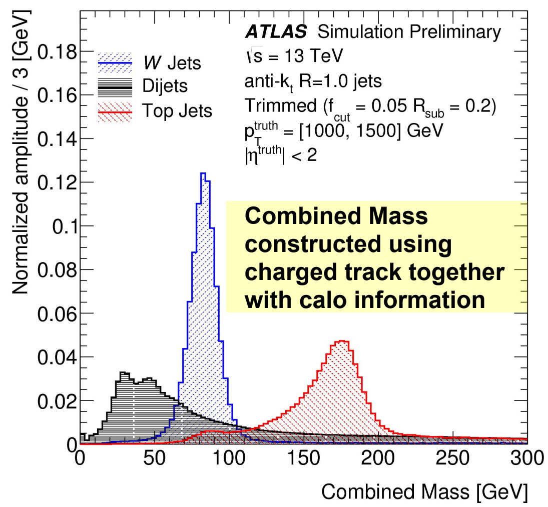


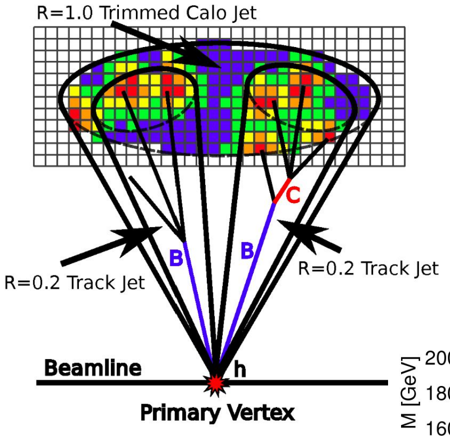


Many models predict the existence of new heavy resonances decaying into diboson!

Jet Tagging of W/Z/H bosons

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/PERF-2015-03/ (Eur. Phys. J. C (2016) 76)



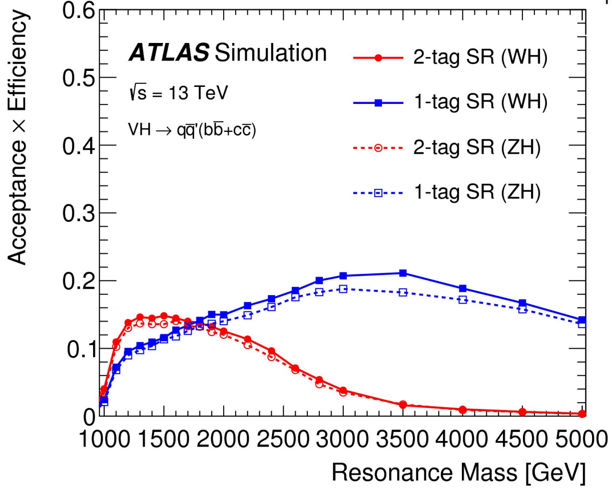


Resolved (2 small-R jets)

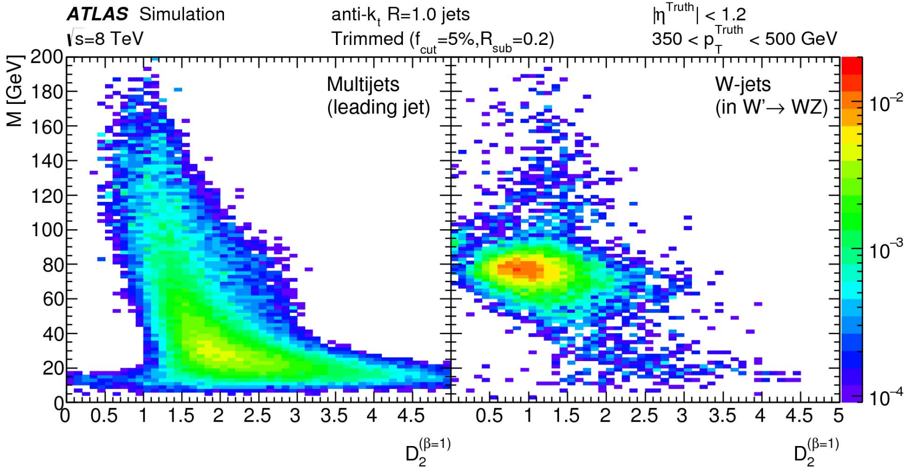
- Excellent precision on jet energy scale (even at very high p_T)

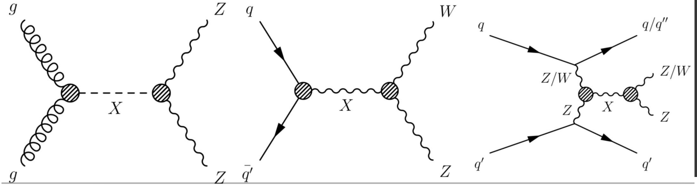
Boost (collimated 1 large-R jet)

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



For Higgs-jet: b-hadron identification (R=0.2 b-tagged jet)





$X \to Z[W,Z] \to llqq, \nu\nu qq$ (2)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-29/ (arXiv:1708.09638)

No evidence of the production of heavy resonance is observed

Other (4l) results in https://arxiv.org/abs/1712.06386

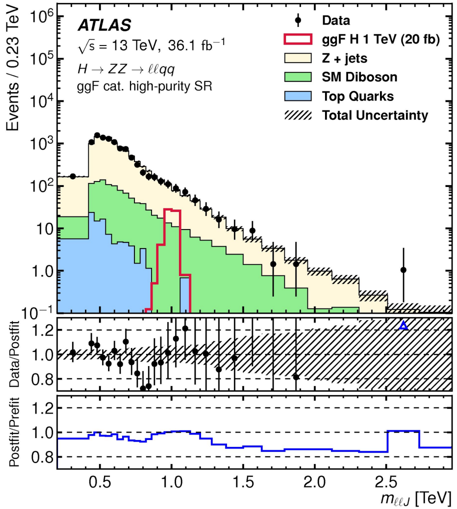
Main background

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

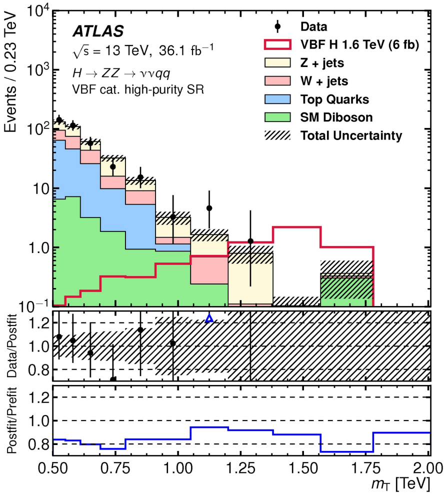
Systematic Uncertainties

- Background modelling (llqq: shape difference in CR, vvqq: PDF + α's variations)
- Large-R jet energy resolution

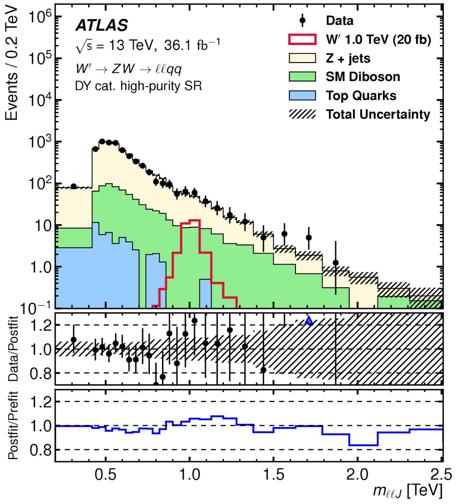
$X \to ZZ \to llqq$



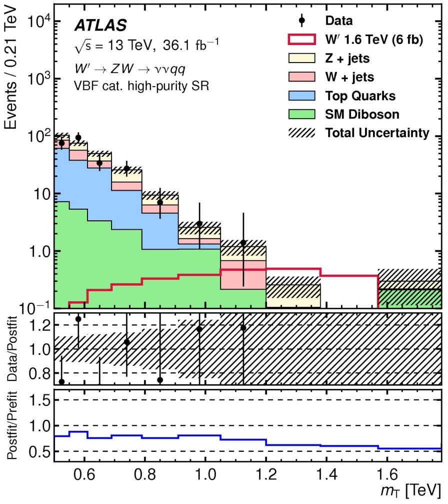
$X \to ZZ \to \nu\nu qq$



$X \to ZW \to llqq$



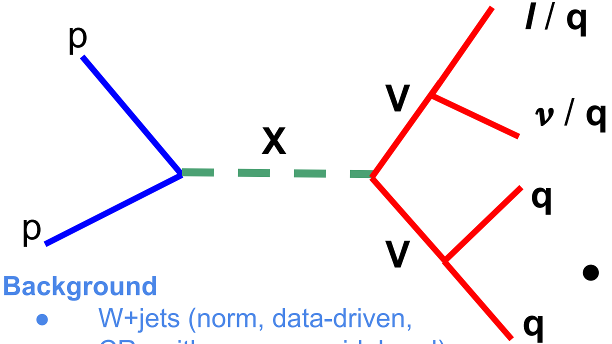
$X \to ZW \to \nu\nu qq$



$X \rightarrow W[W,Z] \rightarrow l\nu qq$, $X \rightarrow VV \rightarrow JJ$

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-19/ (Phys. Lett. B 777 (2017) 91)

http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-28/ (arXiv:1710.07235)



Background

- W+jets (norm, data-driven, CRs with m_J or m_{JJ} sideband)

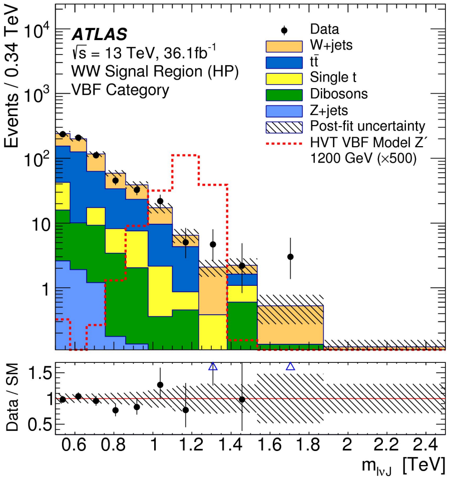
Systematic uncertainties

- W+jets modeling (PDF+α's variations)
- large-R jet mass/D2 resolution

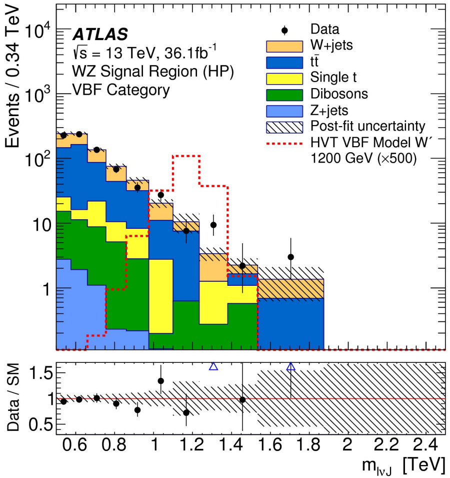
Signatures

- 2 large-R jets from hadronic W/Z boson decay
- 1 lepton and Missing E_T from W and hadronic decay of W/Z

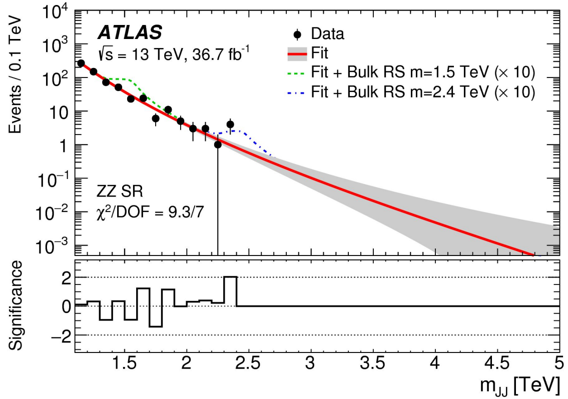
$X \rightarrow WW \rightarrow l\nu qq$



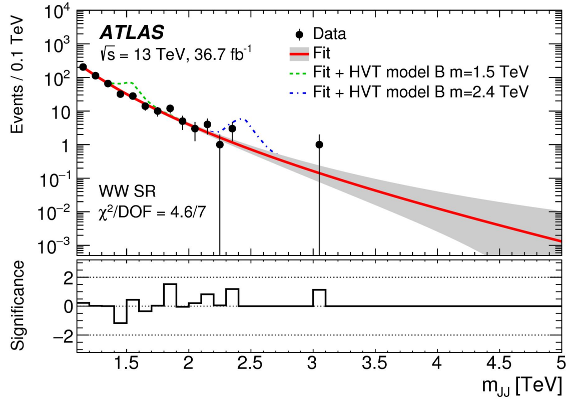
$X \rightarrow WZ \rightarrow l\nu qq$



$X \rightarrow WW \rightarrow JJ$



$X \rightarrow ZZ \rightarrow JJ$



Background

- di-jet, fitting from data

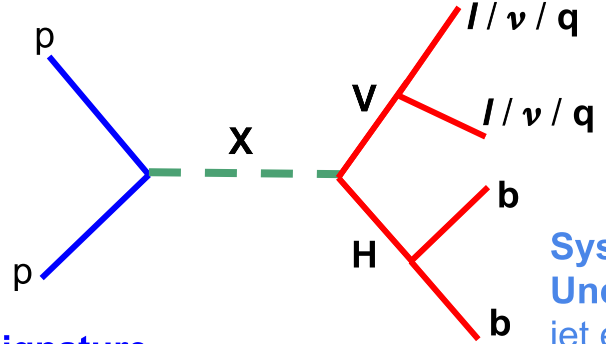
Systematic uncertainties

- large-R jet energy scale and resolution

No evidence of the production of heavy resonance is observed

X → V(ll,lν,νν,qq)H(bb)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-12/ (Phys. Lett. B 774)(2017) 494)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-10/ (arXiv:1712.06518)



Signature

Use of H→bb as a tag (bbH)

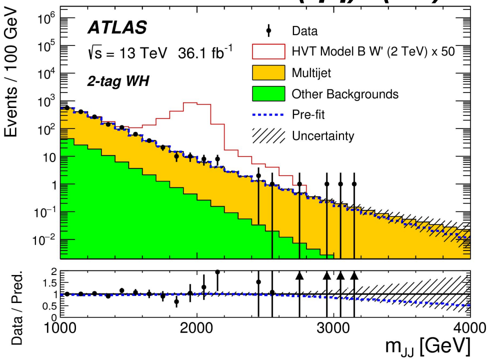
Backgrounds

- ttbar (V→lν, νν), and Z+jets (V→ll), 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

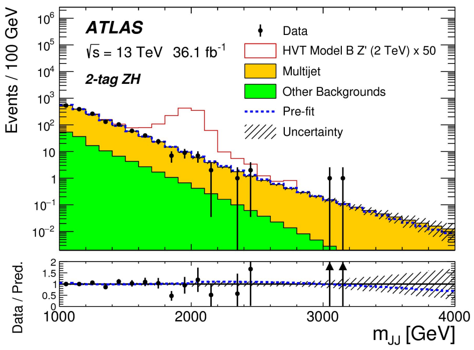
Systematics Uncertainties

jet energy scale/resolution, b-tagging, ttbar/Multi-jet and V+jets normalisations

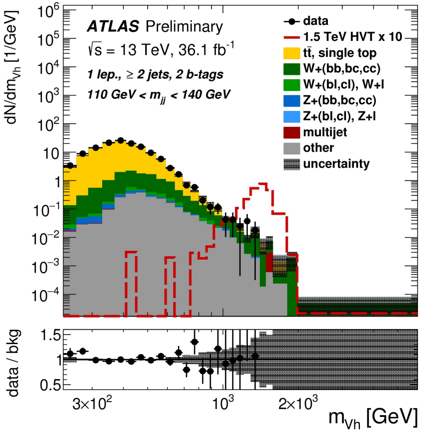
X → WH → J(qq)J(bb)



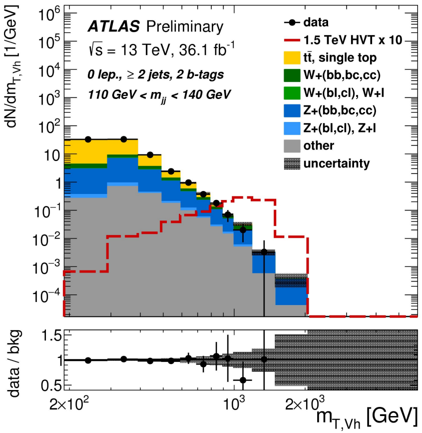
X → ZH → J(qq)J(bb)



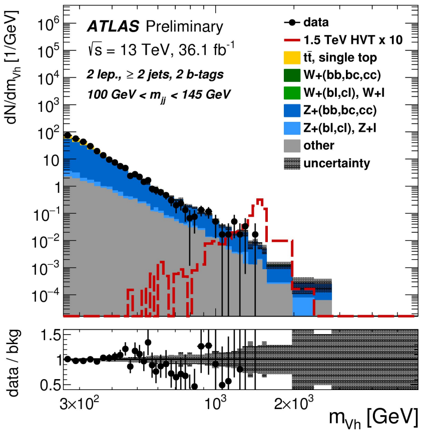
X → WH → lνbb



X → ZH → ννbb



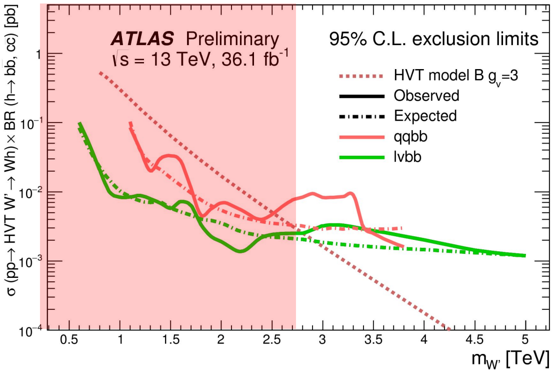
X → ZH → llbb



No evidence of heavy resonance is observed

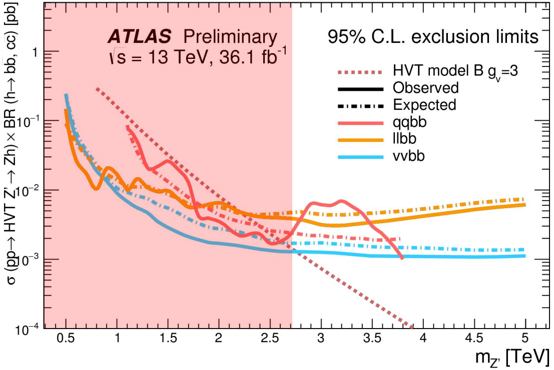
Diboson: limits summary

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

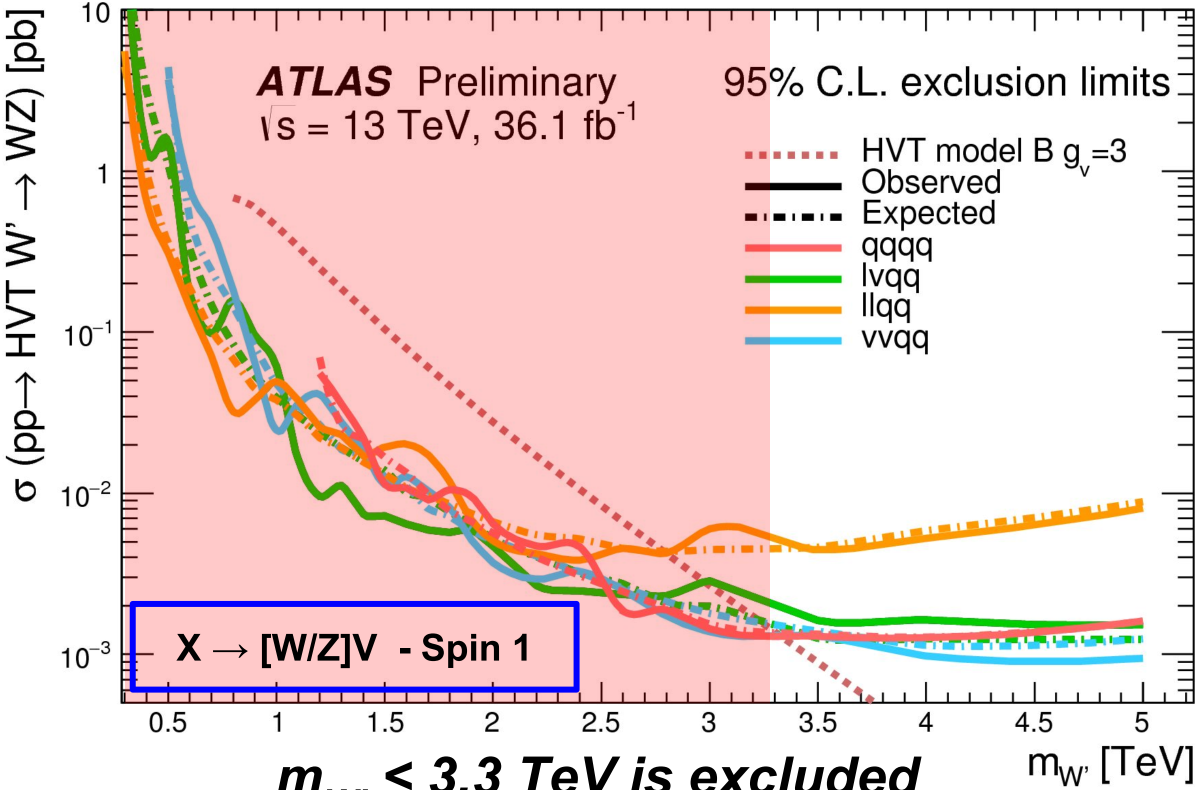


$m_{W'}$ < 2.8 TeV is excluded

X → VH(*bb*)



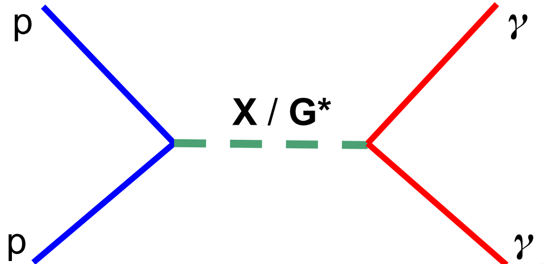
$m_{Z'}$ < 2.7 TeV is excluded



$m_{W'}$ < 3.3 TeV is excluded

Diphoton Resonances

http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2016-17/ (PHys. Lett. B 775 (2017) 105)



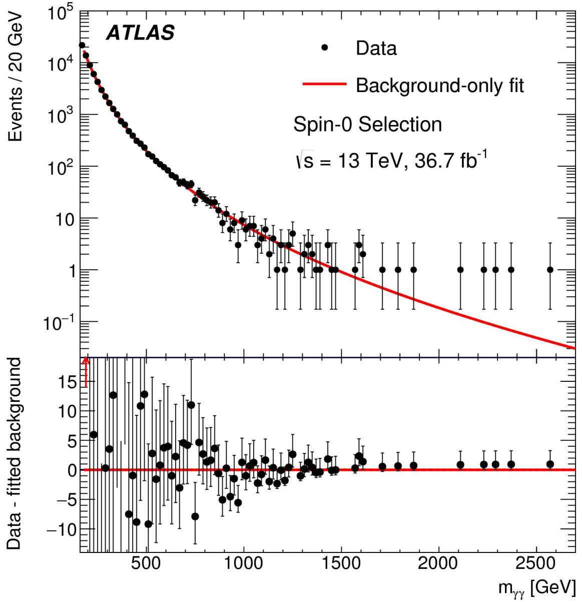
Two selection have been optimised for

Spin-0: "heavy Higgs"

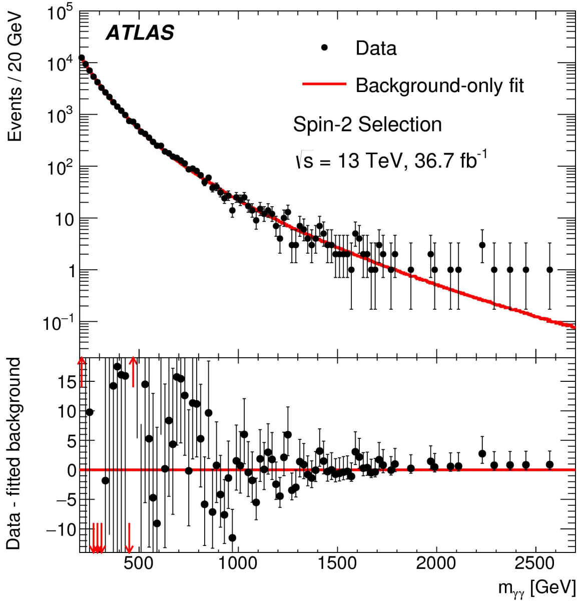
- $E_T > 0.4\ m_{\gamma\gamma}$ for the leading γ
- $E_T > 0.3\ m_{\gamma\gamma}$ for the subleading γ

Spin-2: resonant RS1 and non-resonant ADD graviton

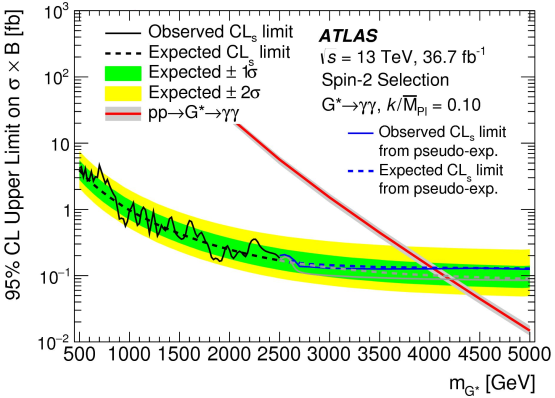
- $E_T > 55$ GeV for the two γ's



Spin-0 selection



Spin-2 selection



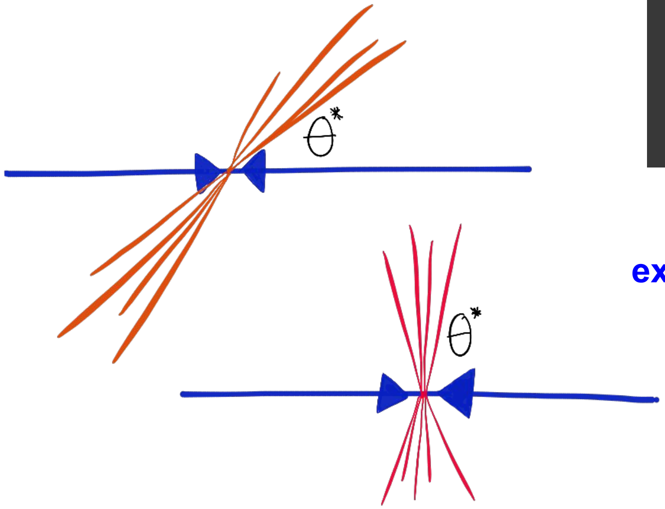
Upper limits on the production x-section times branching ratio of two γ @13 TeV of the lightest KK graviton as a function of its mass m_{G^*} for $k/\overline{M}_{Pl}=0.1$

No significant excess found in data

Non-resonant Searches

Dijet: Angular Analysis

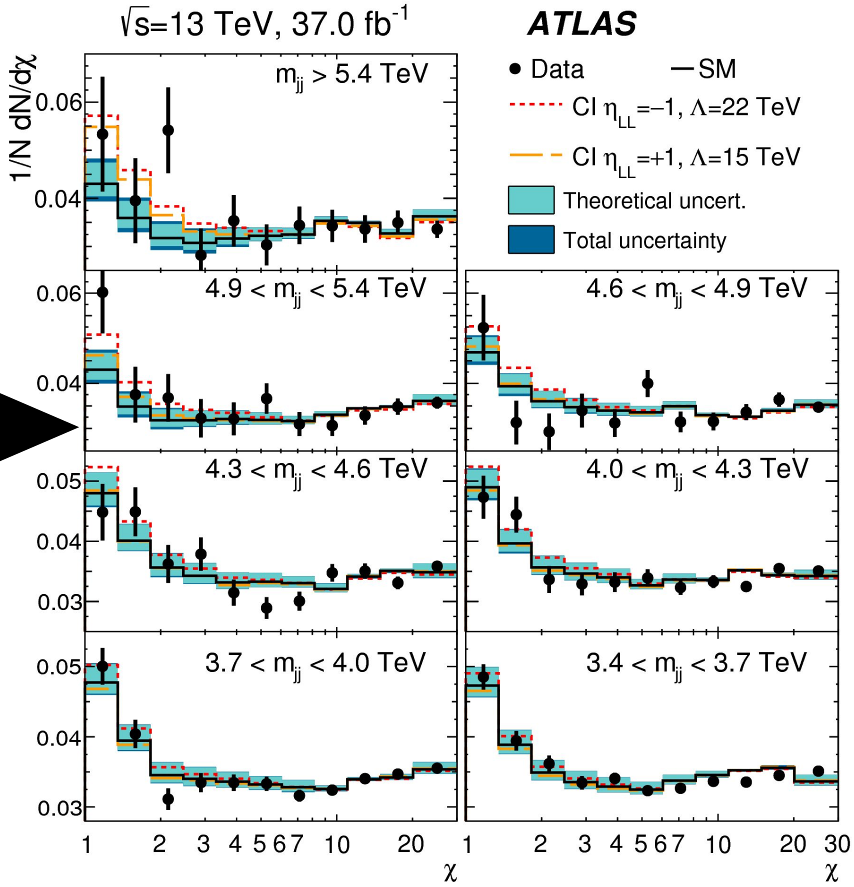
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-21/ (Phys. Rev. D 96, 052004)



$$\chi = e^{2|y^*|} \sim \frac{1+\cos\theta^*}{1-\cos\theta^*}$$

BSM signal is expected to be more prominent at low χ

Limits for a four-fermion EFT (contact interaction) model, and Λ scale of ~30TeV



- Looking for deviations in angular distributions
- 7 signal regions with m_{JJ} above 3.4 TeV

Main uncertainties

- Jet energy scale and factorisation & renormalisation scales

No significant deviations found in data

Vector-Like Quarks (1)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2016-104/ (Phys. Lett. B 774)(2017) 494)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-15/ (ATLAS-CONF-2017-055)

Vector-Like quarks (VLQ)

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

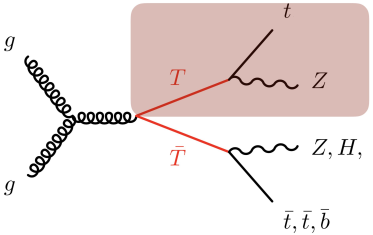
Composite Higgs models | Little Higgs models | Warped or universal extra-dimensions

- 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, they have both **charged-current decays (T → W*b*; B → Wt)** and **neutral current decays (T → Zt; B → Z*b*; H*b*)**
- **Contrary to sequential fourth generation**

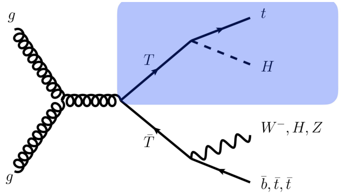
Vector-Like Quarks (2)

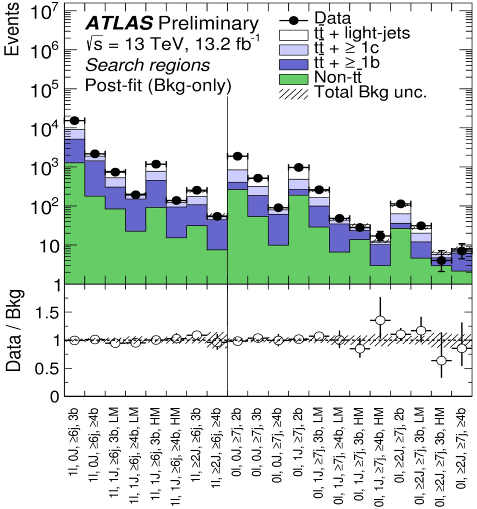
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2016-104/ (Phys. Lett. B 774)(2017) 494)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-15/ (ATLAS-CONF-2017-055)

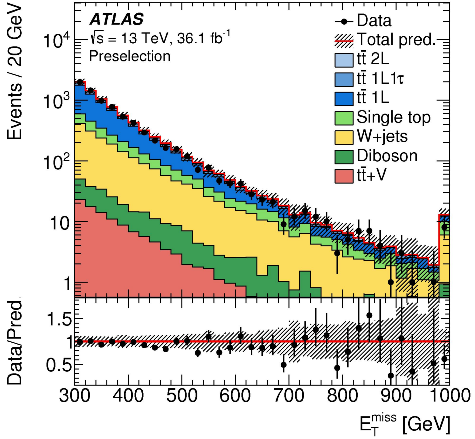
TT → **Z(νν)t** + X: 1 lepton, jets, MET



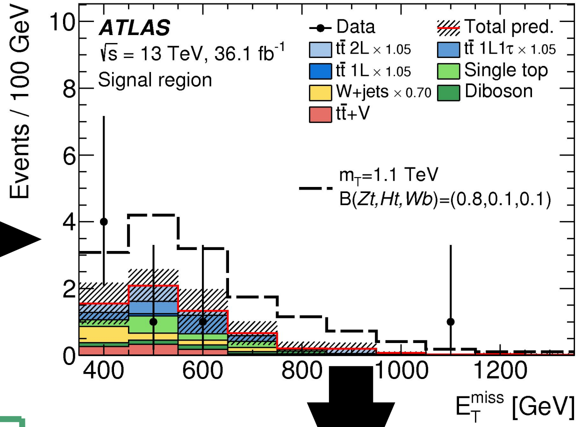
TT → **H(*bb*)t** + X: 0/1 lepton, jets, *b*-jets



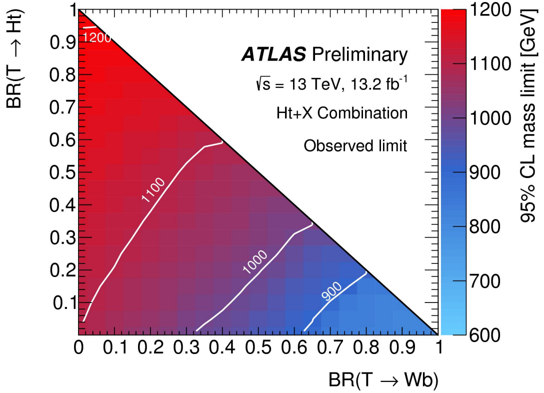


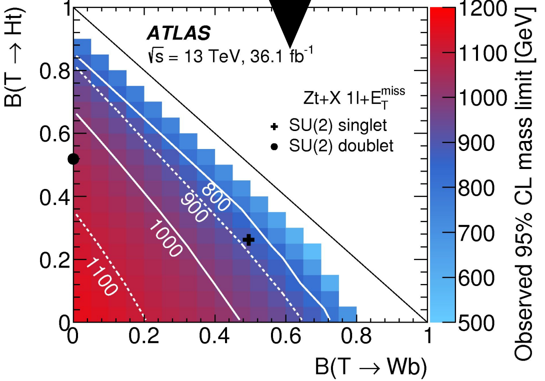


No excess found in data



Analysis with 20 Signal regions and 15 Validation regions combined Fit!

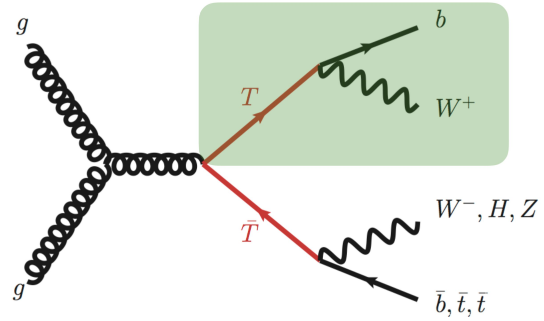




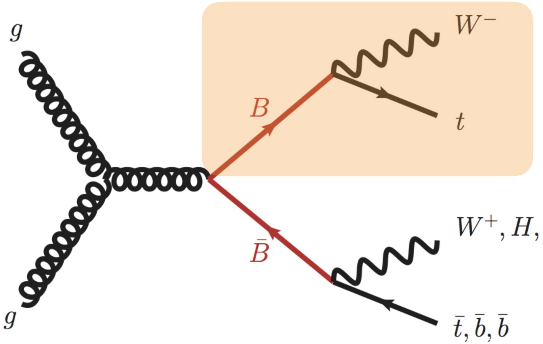
Vector-Like Quarks (3)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2016-104/ (Phys. Lett. B 774)(2017) 494)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-15/ (ATLAS-CONF-2017-055)

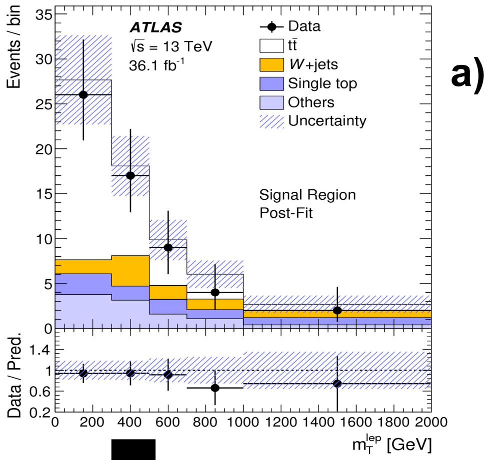
a) TT → **W(qq)*b*** + X: 1 lepton, 1 large-R W tagged jet, >1 b-tagged Small-R jets, MET

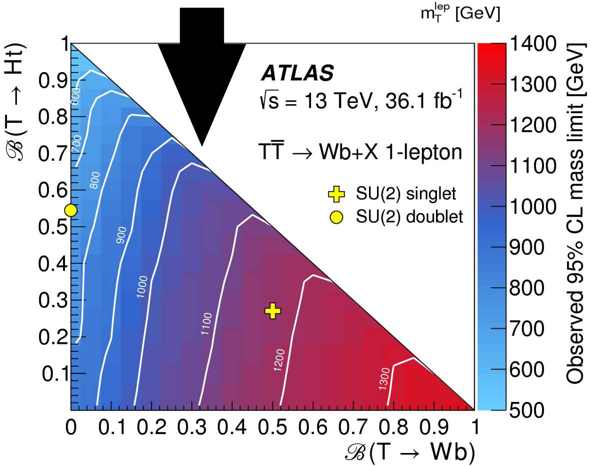


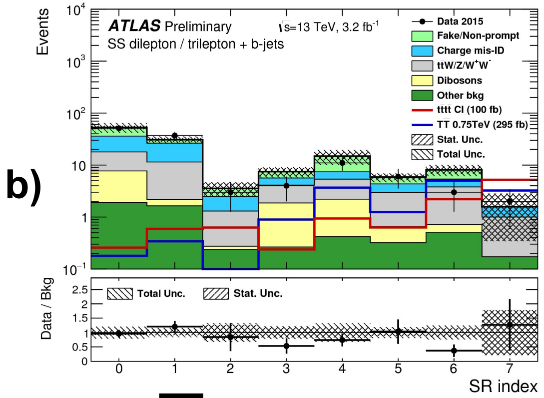
b) BB → **W$^-$tW$^+$t / W$^-$tZ*b***: > 1 same-sign leptons, > 1 jets, >0 b-tagged Small-R jets

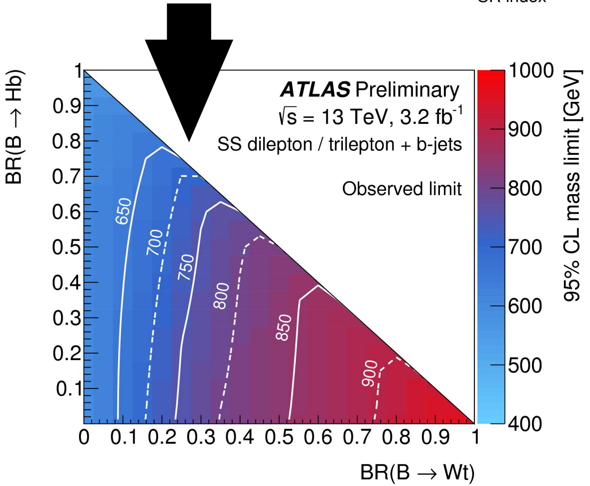


No excess found in data

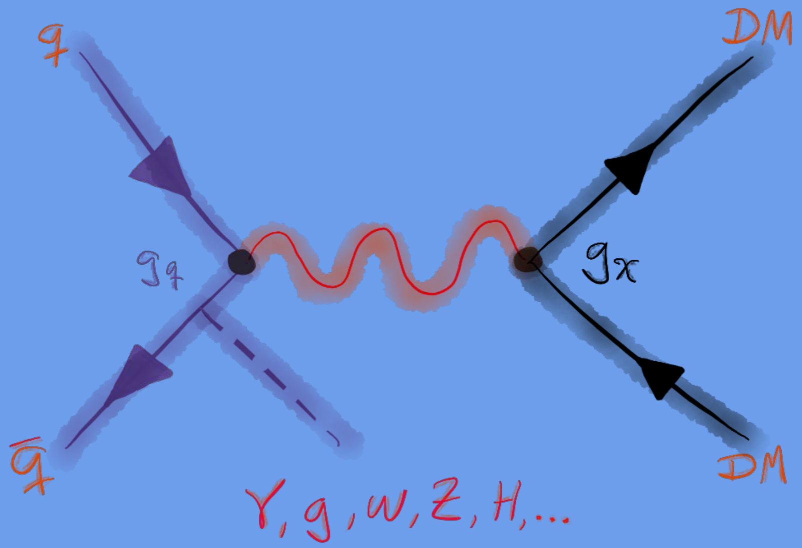








Dark Matter Searches



ATLAS-CMS (LHC) Dark Matter (DM) Forum
arXiv:1507.00966
define benchmark models for kinematically distinct signals for the so-called Run-2 searches:

LHC Run-1: “traditional" Effective Field Theory (**EFT**) approach ***(some searches on Run-2)***

- Assume mediator too heavy to be produced
- 2 parameters: WIMP mass (**m_χ**) & suppression scale (M*)
- Some comparisons to simplified models

For Run-2: benchmark **Simplified Models***

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

Mostly 4 parameters:

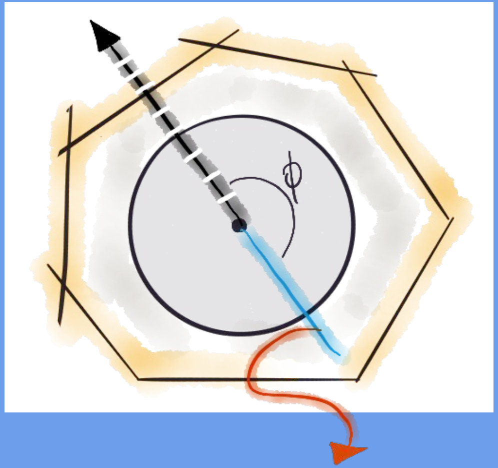
- mediator mass (M_{Med})
- WIMP mass (m_χ)
- 2 couplings (g_q,g_χ), typically (1, 0.25)

Different types of mediators, minimal width

*(where possible)

General Analyses Remarks

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



X (γ, jet, $W^{\pm}$, Z, h)

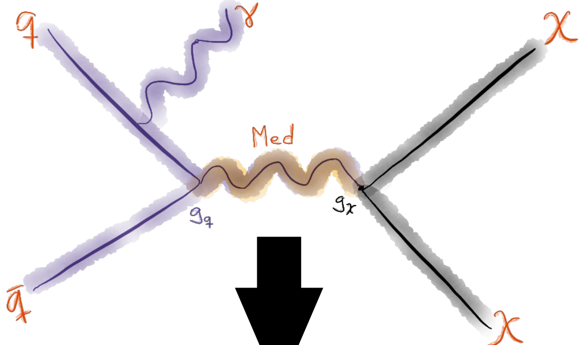
Similar strategy in all the mono-X searches:

- Event Selection
  - High MET, compatible with $\chi\chi$ production
  - If X=γ, jet → high pT(X) with quality criteria
  - If X=W, Z, h → reconstruct mass within a windows
  - Large $\Delta\phi$(X,MET)
  - Veto events with other "good" physics objects, like leptons

Finally, 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

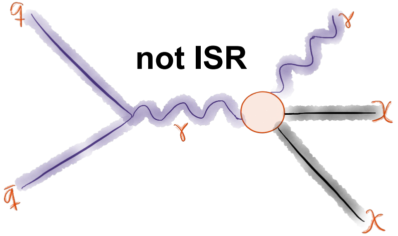
Mono-Photon + X (1)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-32/ (Eur. Phys. J. C 77 (2017) 393)



Signature

High p_T γ + MET (+ < 2 jets)

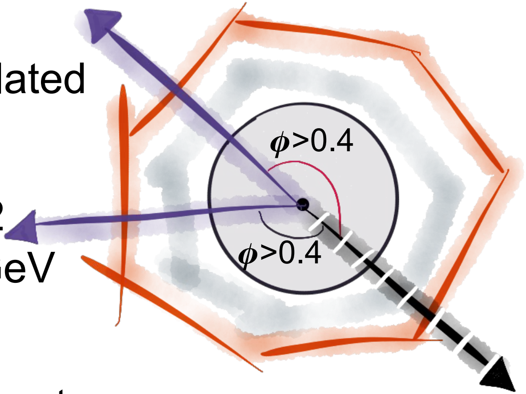


Main bkgs normalized to data in specific CRs:

- $Z \rightarrow \nu\nu + \gamma$ → 2μCR + 2eCR
- $W \rightarrow l\nu + \gamma$ → 1μCR
- γ + jets → γ + jetCR

γ: p_T > 150 GeV
|η| <2.37
Tight, isolated

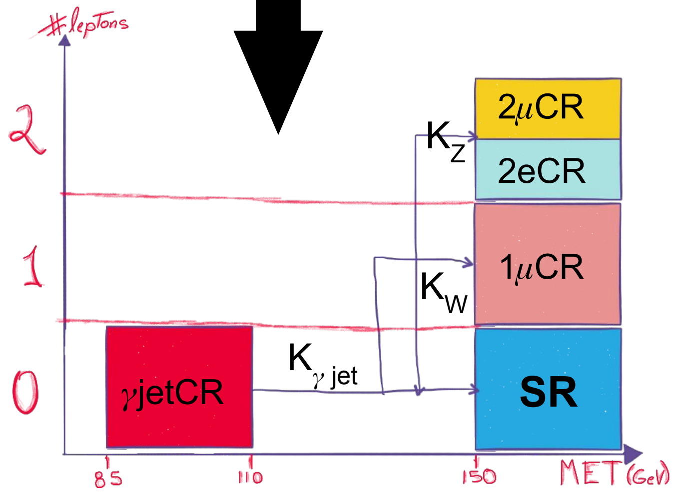
Jet: # < 2
p_T > 30 GeV



μ/e veto

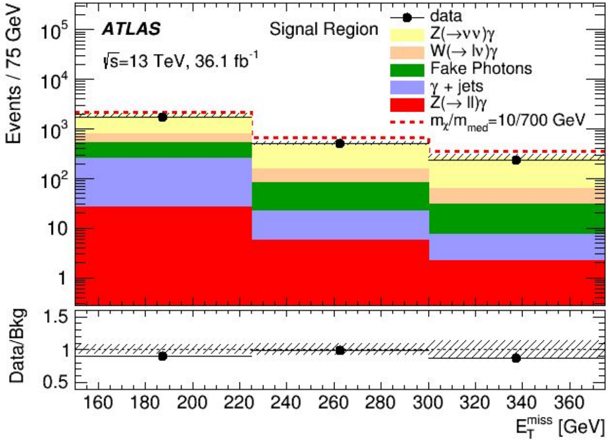
MET > 150 GeV

- **SR:** μ and e veto
- **Bkg in SR derived:** simultaneous single-bin fit to CRs
- **Statistically limited:** 4-10% stat. uncertainty from CRs (total: 6-14%)

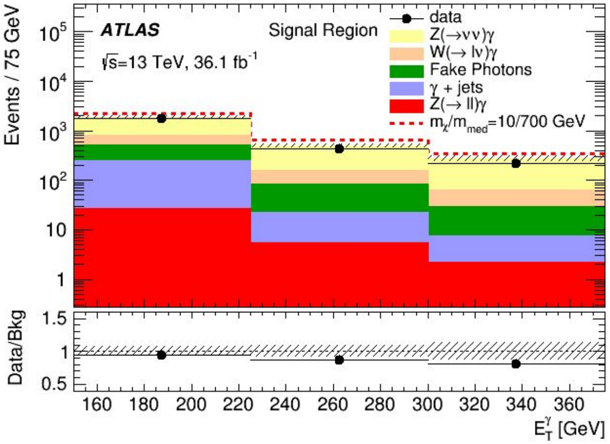


Mono-Photon + X (2)

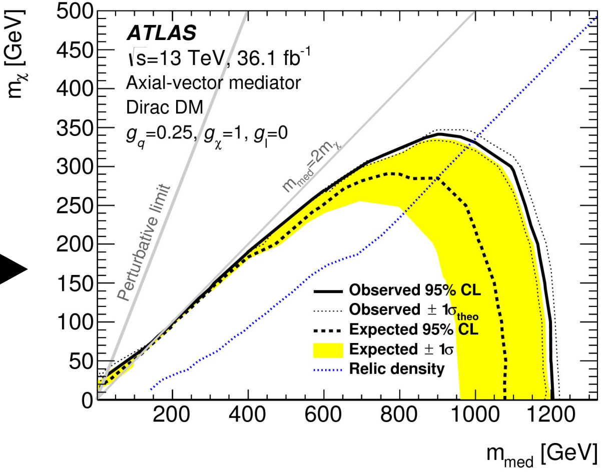
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-32/ (Eur. Phys. J. C 77 (2017) 393)



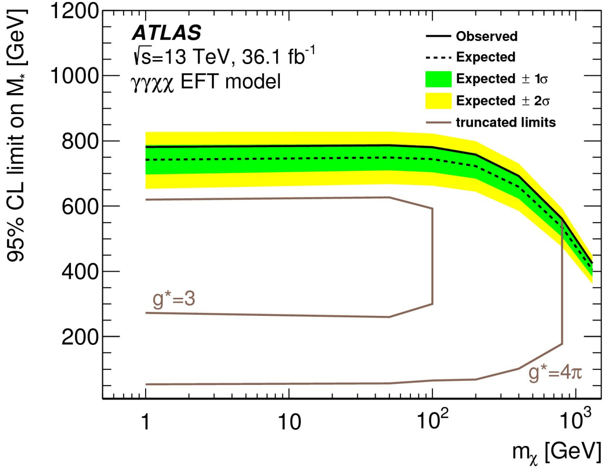
MET (GeV)



E^{γ}_{T} (GeV)



Simplified Model:
Axial-vector mediator
95% CL exclusion limit on (m_{χ}, m_{med}) plane, excluding the area of m_{med} < 1200 GeV, m_{χ} <340 GeV

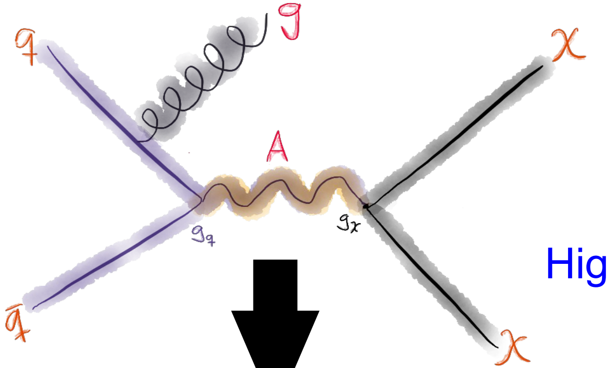


EFT Model:
Lower limit for M* (eff. mass scale) as function of m_{χ}: M* < 790 GeV excluded
Truncation: remove events with $\sqrt{s}$ > gM* for various values of g

No excess found in data

Mono-Jet + X (1)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-27/ (JHEP 01 (2018) 126)

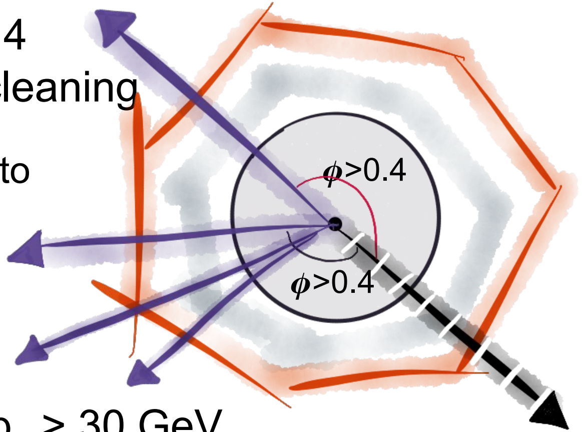


Signature

High p_T Jet + MET (+ < 4 jets)

Jet: p_T > 250 GeV
|η| < 2.4
Tight cleaning

***μ*/e veto**



Jets:
< 4 p_T > 30 GeV

MET > 150 GeV

Main bkgs normalized to data in specific CRs:

- $Z \to \nu\nu$ + jets, $W \to \mu\nu$ +jets → 1μCR
- $W \to e\nu$ $(\tau\nu)$ + jets, $Z \to \tau\tau$ + jets → 1eCR
- $Z \to \mu\mu$ + jets → 2μCR

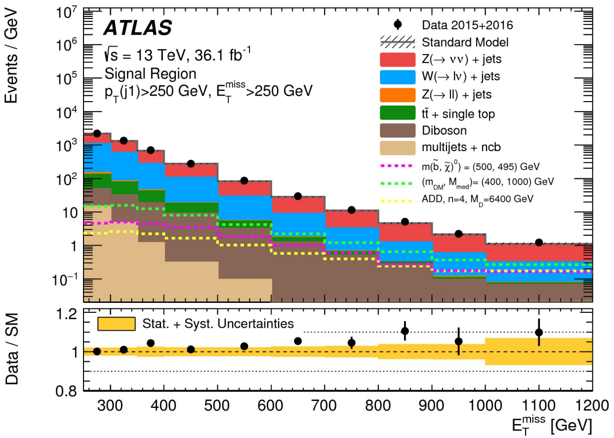
- **SR:** μ and e veto
- **Bkg in SR derived:** simultaneous single-bin fit to CRs
- **SRs and CRs divided** into exclusive/inclusive MET bins
  - exclusive regions (e.g. bins) for limits on DM model
  - inclusive regions for model independent limits

Theory corrections are used to reweight V+jets backgrounds

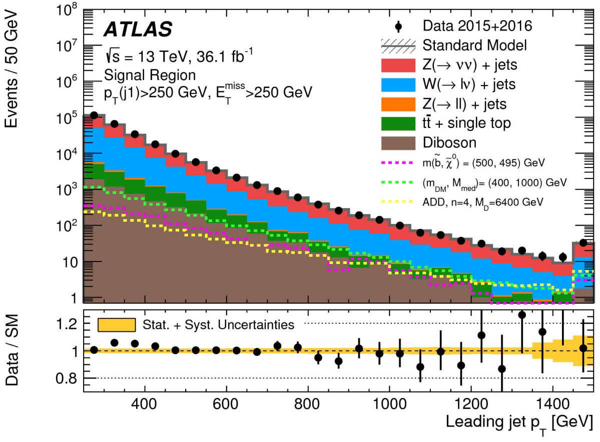
- **Largest uncertainties:**
  - Data statistics in CRs: up to 5%
  - Theory uncertainties: < 6%
  - Others in others of 0.5% to 2%

Mono-Jet + X (2)

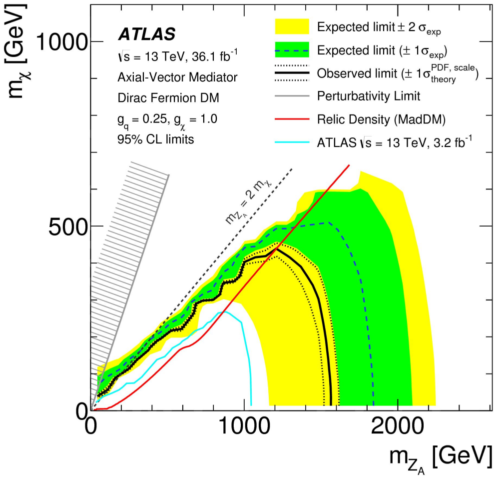
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-27/ (JHEP 01 (2018) 126)



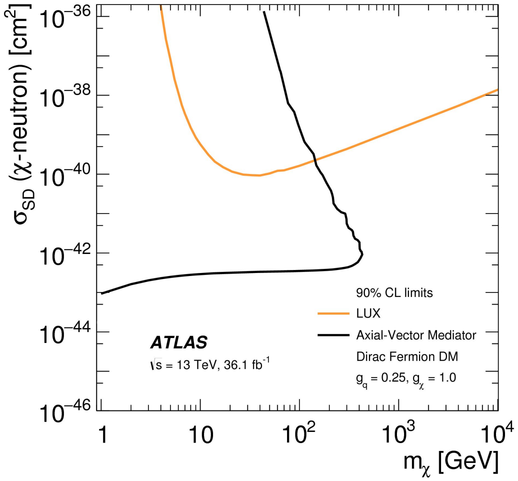
MET (GeV)



Leading $\mathbf{p^{jet}_T}$ (GeV)



Simplified Model:
Axial-vector mediator
95% CL exclusion limit on (m_χ, m_{med}) plane, excluding the area of
m_{med} < 1 TeV, m_χ <250 GeV

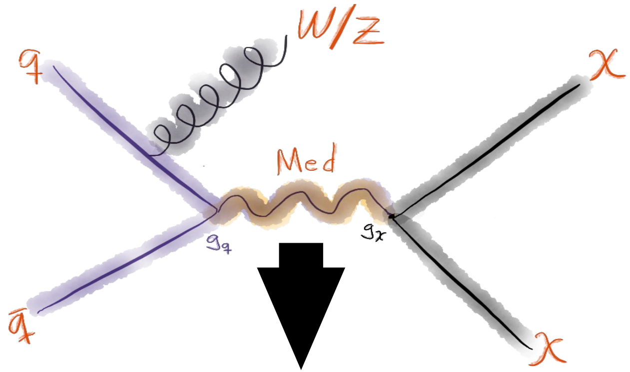


Complementary w/direct detection
90% CL exclusion limit on the spin-dependent χ-proton scattering σ:
- model dependent,
- excluding $\sigma_{SD}(\chi\text{-p}) > 10^{-42}$cm, low m_χ

No excess found in data

Mono-W/Z + X (1)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2015-08/ (Phys. Lett. B 763 (2016) 251)

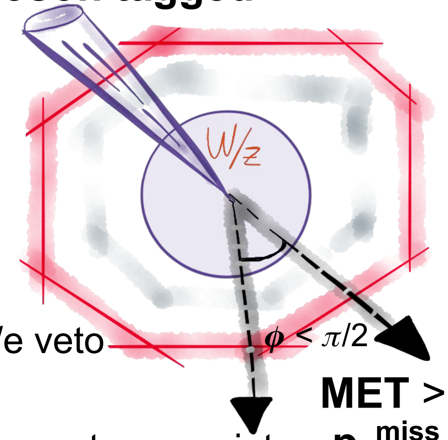


Signature

High p_T large-R Jet + MET

Large R Jet: p_T > 200 GeV

Boson tagged



μ/e veto

nearest narrow jet

MET > 250 GeV

$\mathbf{p_T^{miss}}$ > 30 GeV

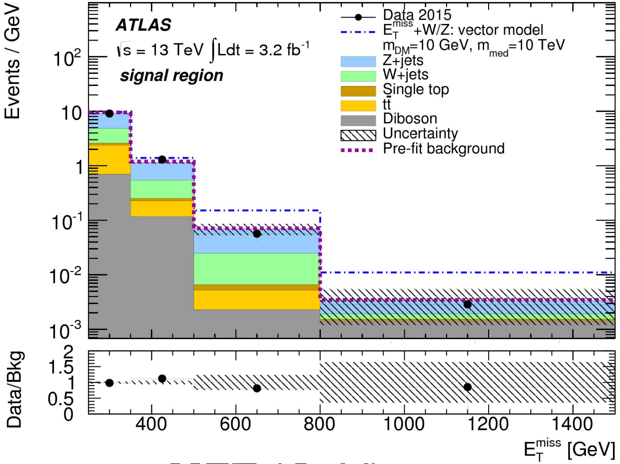
Main bkgs normalized to data in specific CRs:

- Z + jets → 2μCR
- W + jets → 1μCR, not *b*-jets
- ttbar → 1μCR + < 2 *b*-jets

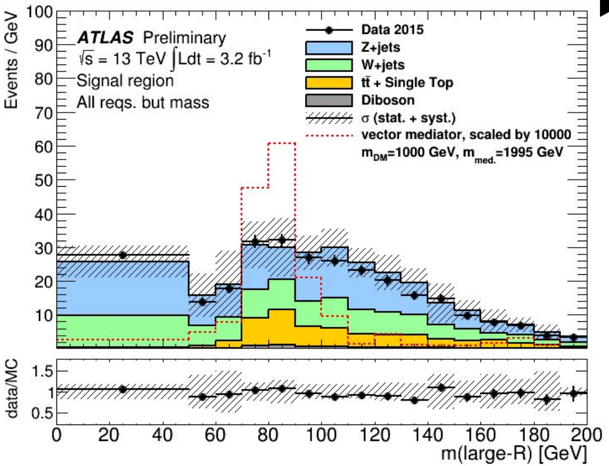
- **SR:** μ and e veto
- **Bkg in SR derived:** simultaneous single-bin fit to CRs
- **W / Z / ttbar CRs:** leptons selected, relaxed mass cuts, (anti-)b-tagging, MET > 200 GeV
- **Largest uncertainties:**
  - Large-R jet parameter modelling: ~10%
- **Simultaneous fit** with the three normalization factors coming from the CRs.
- **Boson Tagging algorithms are used to identify the W/Z** independently. Based in the internal structure of the large-R jet

Mono-W/Z + X (2)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2015-08/ (Phys. Lett. B 763 (2016) 251)

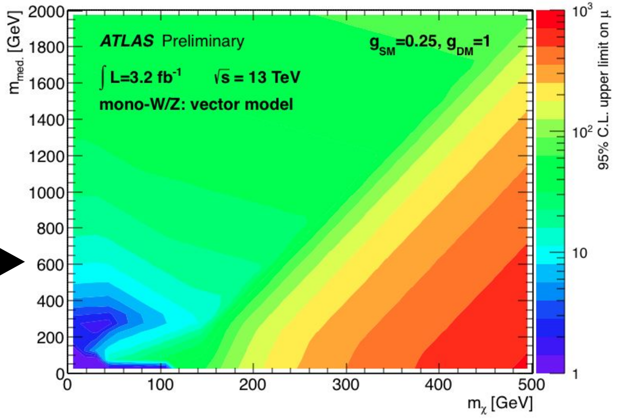


MET (GeV)

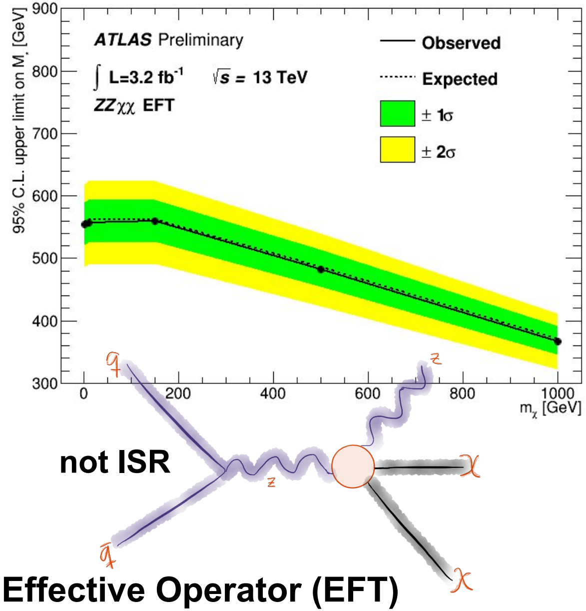


Large-R jet **mass** (GeV)

old but interesting analysis



Simplified Model:
Axial-vector mediator
Exclusion limit on signal strength
(m_χ, m_{med}) plane.
For g_q = 0.25 and g_χ = 1

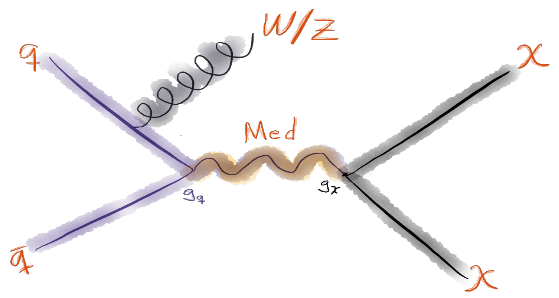


Effective Operator (EFT)
95% CL exclusion limit

No excess found in data

Mono-Z (l^+l^-) + X

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2016-28/ (PLB 776 (2017) 318)

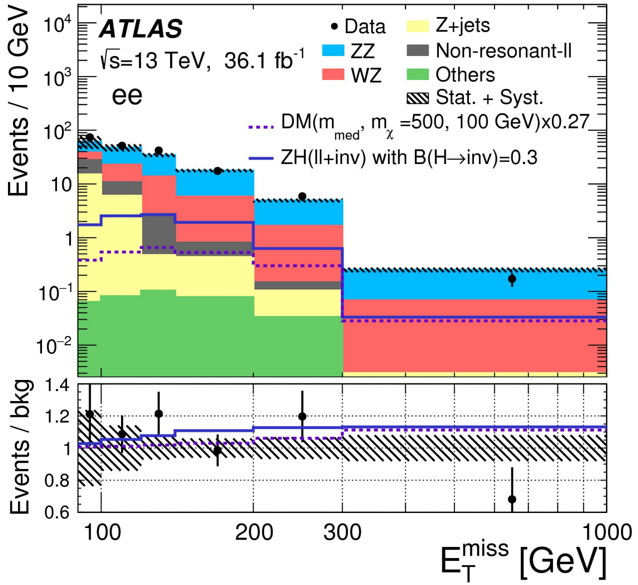


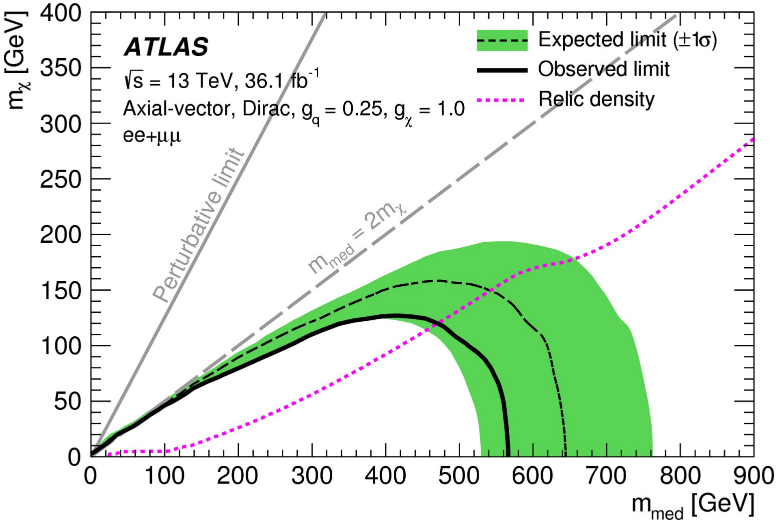
Signature

a Z(l+l-) boson with a large MET

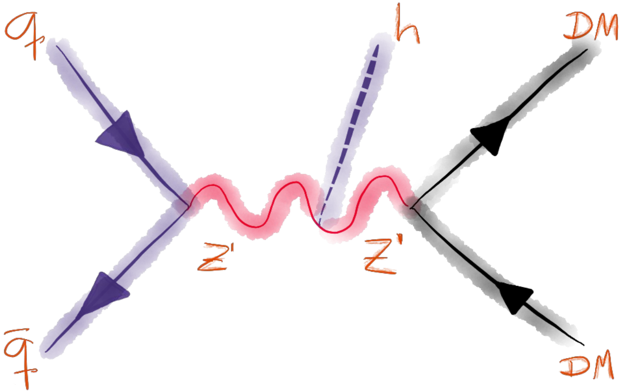
Backgrounds

- ZZ: MC estimated; WZ: data-driven
- Z/γ^*+jets: fake MET from instrumental effects extrapolate from 2D sideband regions using MET and MET/HT (50-90% systematic)
- Top/WW/Z → τ+τ-: estimated from e/mu events in data (systematic uncertainties: 14%)





No excess found in data

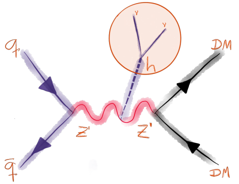


Mono-Higgs + X (1)

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2015-08/ (Phys. Lett. B 763 (2016) 251)

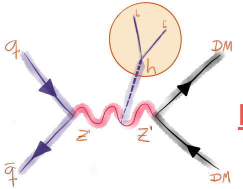
Models in which the higgs couples to dark sector particles, e.g. higgs couplings to the mediator

Multiple mono-H final states



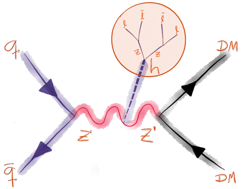
$H \rightarrow \gamma\gamma$

Phys. Rev. D 96 (2017) 112004



$H \rightarrow bb$

Phys. Rev. Lett. 119 (2017) 181804



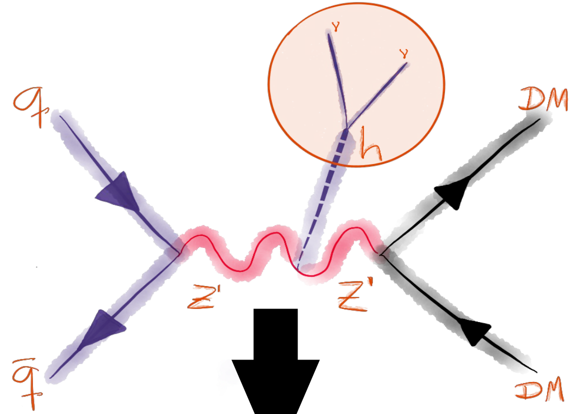
$H \rightarrow ZZ^{*} \rightarrow 4l$

JHEP 10 (2017) 132

- **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...**

Mono-Higgs($\gamma\gamma$) + X

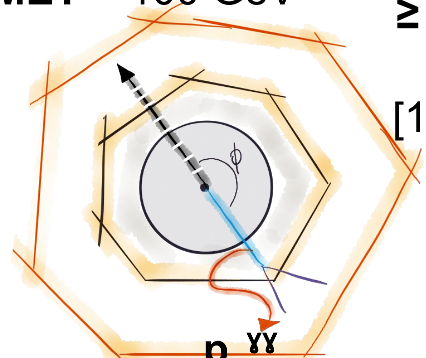
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2016-18/ (Phys. Rev. D 96 (2017) 112004)



Signature

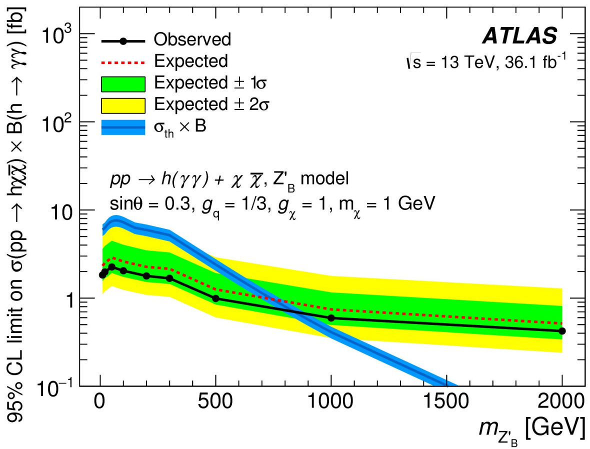
Two γ + MET

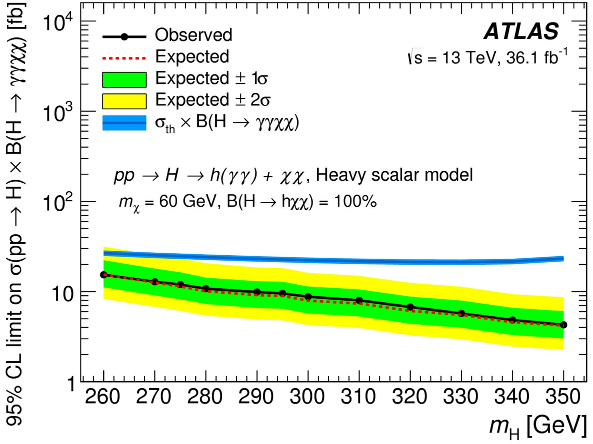
MET > 100 GeV



$p_T^{\gamma\gamma}$ > 100 GeV

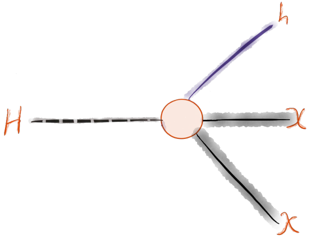
≥ 2γ with $m_{\gamma\gamma}$ [105,160] GeV





Simplified Model: Vector mediator
4 categories: cuts on MET, $p_T^{\gamma\gamma}$, p_T [γ's , jets]
Largest uncertainties: vertex selection and MET estimation
95% CL exclusion limit on m_{med}

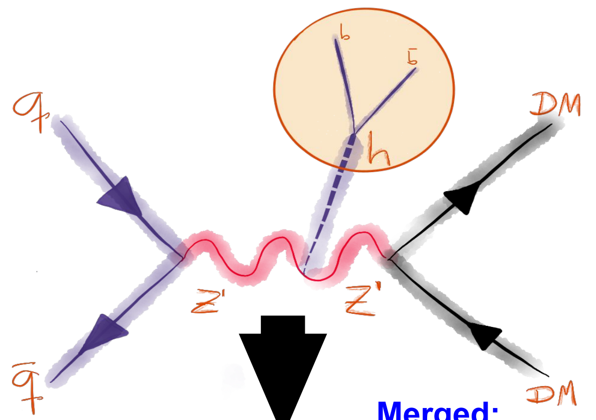
EFT model:
In both model cases a simultaneous fit to all regions was applied



No excess found in data

Mono-Higgs(*bb*) + X

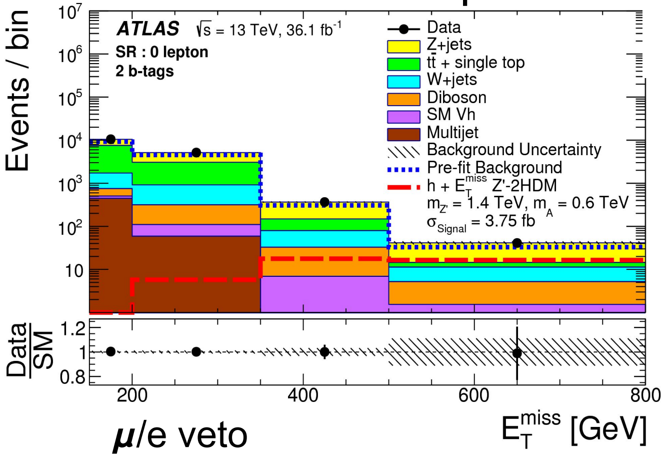
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-25/ (Phys. Rev. Lett. 119 (2017) 181804)



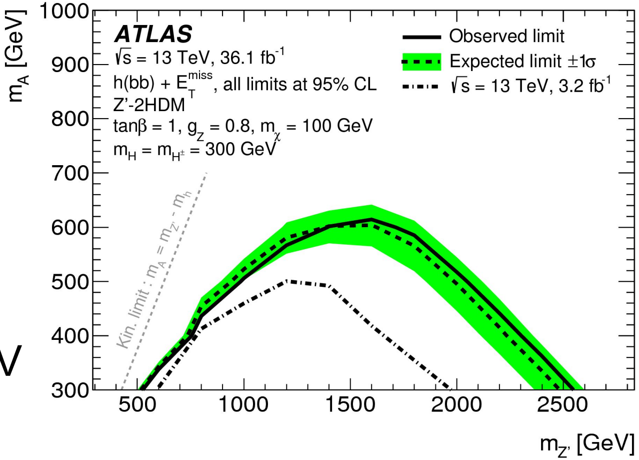
Resolved:
2 small-R (0.4) jets

Merged:
1 large-R (1.0) jet
+ 2 track jets

MET > 150 GeV , **p$_T$** > 30 GeV

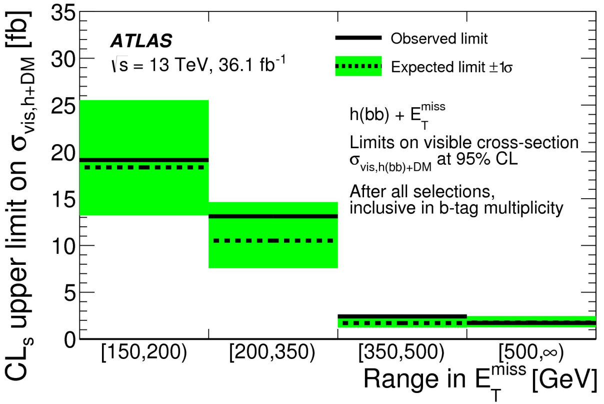


***μ*/e veto**



Exclusion contours for

- The Z′-2HDM exclusion contour in the ($m_{Z'}$,m_A) plane for tanβ = 1, $g_{Z'}$=0.8 and m_χ = 100,GeV

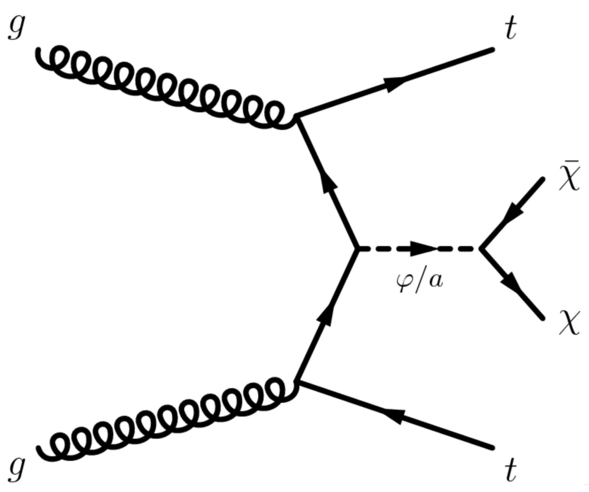


Upper limits at 95% CL on $\sigma_{vis,h(bb)+DM}$ of h+DM events with h→ bb in the four E_T^{miss} regions at detector level

No excess found in data

ttbar + X

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/SUSY-2016-18/ (Eur. Phys. J. C 78 (2018) 18)



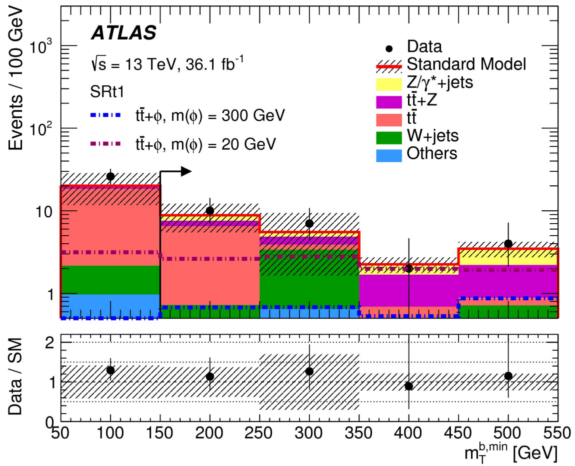
Selection

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

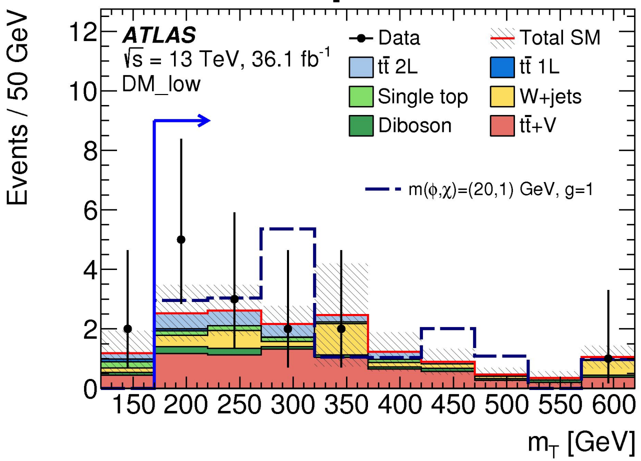
Main backgrounds

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

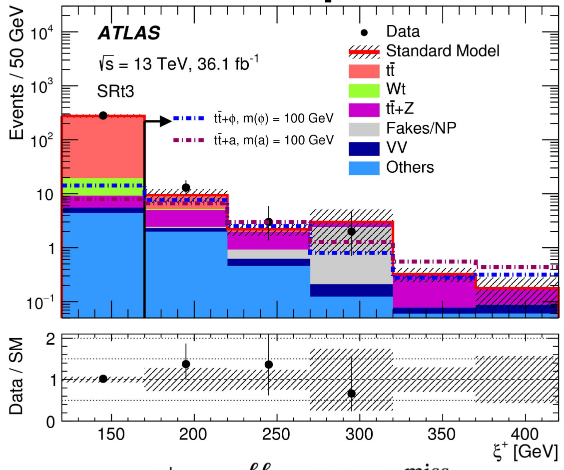
0 lepton



1 lepton



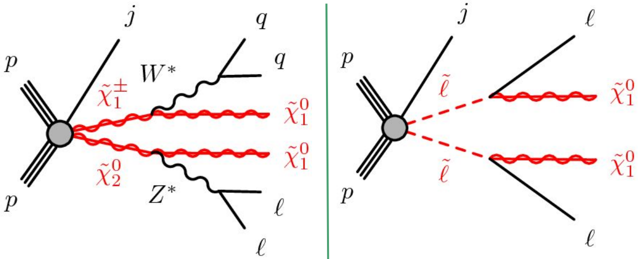
2 leptons

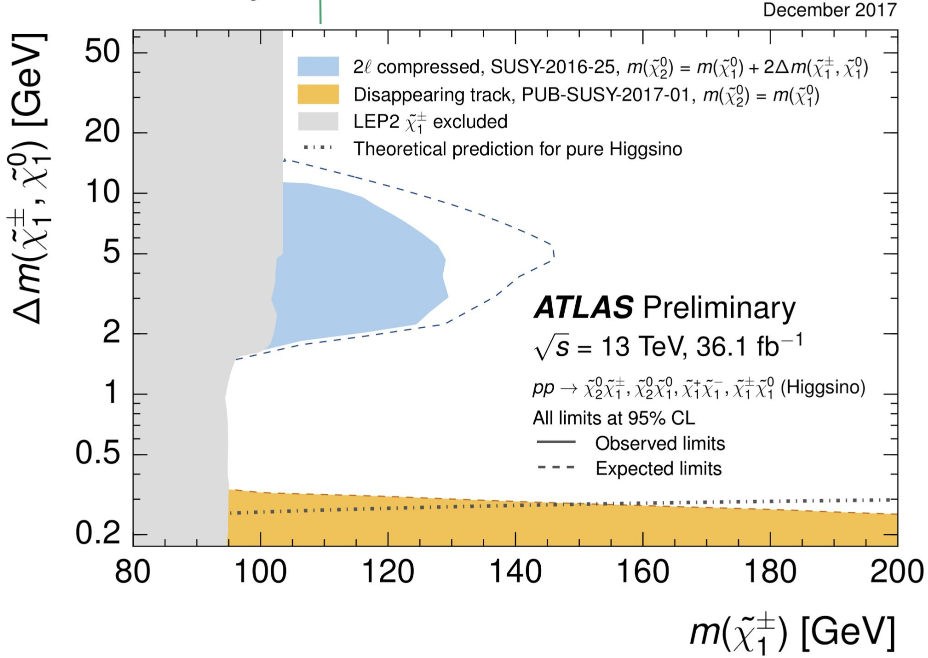


$$\xi^{+} = m_{\mathrm{T2}}^{\ell\ell} + 0.2 \cdot E_{\mathrm{T}}^{\mathrm{miss}}$$

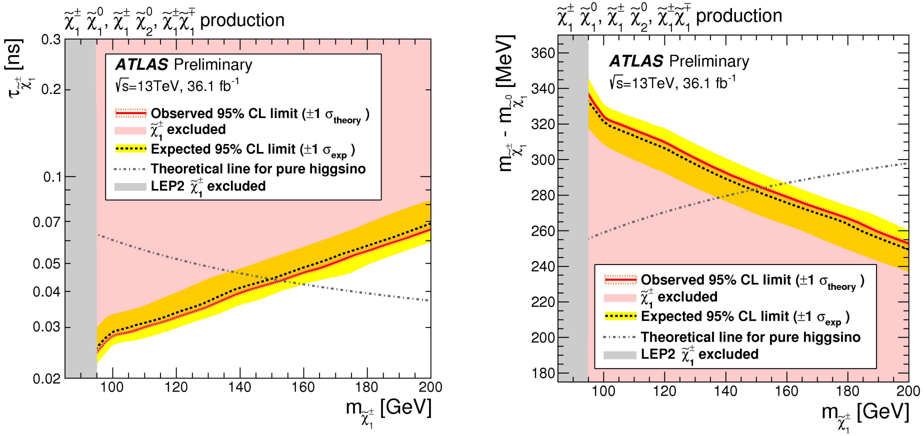
some SUSY

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/SUSY-2016-25/ (arXiv:1712.08119)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PUBNOTES/ATL-PHYS-PUB-2017-019/ (ATL-PHYS-PUB-2017-019)





Exclusion limits at 95% CL for higgsino pair production $\chi_1^+\chi_1^-$, $\chi_1^\pm\chi_1^0$, $\chi_1^\pm\chi_2^0$, and $\chi_1^0\chi_2^0$ with off-shell SM-boson-mediated decays to the lightest neutralino, χ_1^0, as a function of the $\chi_1^\pm$ and χ_1^0masses. The production cross-section is for pure higgsinos.



Expected (black dashed) and observed (red solid) 95% CL exclusion limit in the plane of (left) the chargino mass and its lifetime, and (right) the chargino mass and the mass-splitting between the chargino and the LSP. The pink-coloured region is excluded The black dot-dashed curve crossing over the exclusion line shows a theoretical prediction in the pure-higgsino scenario.

No significant excess is observed over the estimated SM backgrounds. Exclusion limits at 95% CL are derived for direct production of higgsinos. Chargino masses up to 152 GeV are excluded in the pure-higgsino LSP model.

ATLAS SUSY Searches* - 95% CL Lower Limits

December 2017

ATLAS Preliminary

$\sqrt{s}$ = 7, 8, 13 TeV

$\sqrt{s}$ = 7, 8 TeV | $\sqrt{s}$ = 13 TeV

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt [fb^{-1}]$	Mass limit		Reference
Inclusive Searches	$\tilde{q}\tilde{q}$, $\tilde{q}\to q\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{q}$ 1.57 TeV	m($\tilde{\chi}_1^0$)<200 GeV, m(1st gen. $\tilde{q}$)=m(2nd gen. $\tilde{q}$)	1712.02332
	$\tilde{q}\tilde{q}$, $\tilde{q}\to q\tilde{\chi}_1^0$ (compressed)	mono-jet	1-3 jets	Yes	36.1	$\tilde{q}$ 710 GeV	m($\tilde{q}$)-m($\tilde{\chi}_1^0$)<5 GeV	1711.03301
	$\tilde{g}\tilde{g}$, $\tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{g}$ 2.02 TeV	m($\tilde{\chi}_1^0$)<200 GeV	1712.02332
	$\tilde{g}\tilde{g}$, $\tilde{g}\to qq\tilde{\chi}_1^\pm\to qqW^\pm\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	$\tilde{g}$ 2.01 TeV	m($\tilde{\chi}_1^0$)<200 GeV, m($\tilde{\chi}^\pm$)=0.5(m($\tilde{\chi}_1^0$)+m($\tilde{g}$))	1712.02332
	$\tilde{g}\tilde{g}$, $\tilde{g}\to q\bar{q}(\ell\ell)\tilde{\chi}_1^0$	$ee, \mu\mu$	2 jets	Yes	14.7	$\tilde{g}$ 1.7 TeV	m($\tilde{\chi}_1^0$)<300 GeV,	1611.05791
	$\tilde{g}\tilde{g}$, $\tilde{g}\to qq(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	3 e,μ	4 jets	-	36.1	$\tilde{g}$ 1.87 TeV	m($\tilde{\chi}_1^0$)=0 GeV	1706.03731
	$\tilde{g}\tilde{g}$, $\tilde{g}\to qqWZ\tilde{\chi}_1^0$	0	7-11 jets	Yes	36.1	$\tilde{g}$ 1.8 TeV	m($\tilde{\chi}_1^0$) <400 GeV	1708.02794
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	3.2	$\tilde{g}$ 2.0 TeV		1607.05979
	GGM (bino NLSP)	2 γ	-	Yes	36.1	$\tilde{g}$ 2.15 TeV	$c\tau$(NLSP)<0.1 mm	ATLAS-CONF-2017-080
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	36.1	$\tilde{g}$ 2.05 TeV	m($\tilde{\chi}_1^0$)=1700 GeV, $c\tau$(NLSP)<0.1 mm, μ>0	ATLAS-CONF-2017-080
	Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale 865 GeV	m($\tilde{G}$)>1.8 × 10^{-4} eV, m($\tilde{g}$)=m($\tilde{q}$)=1.5 TeV	1502.01518
3rd gen. $\tilde{g}$ med.	$\tilde{g}\tilde{g}$, $\tilde{g}\to b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	$\tilde{g}$ 1.92 TeV	m($\tilde{\chi}_1^0$)<600 GeV	1711.01901
	$\tilde{g}\tilde{g}$, $\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	36.1	$\tilde{g}$ 1.97 TeV	m($\tilde{\chi}_1^0$)<200 GeV	1711.01901
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1$, $\tilde{b}_1\to b\tilde{\chi}_1^0$	0	2 b	Yes	36.1	$\tilde{b}_1$ 950 GeV	m($\tilde{\chi}_1^0$)<420 GeV	1708.09266
	$\tilde{b}_1\tilde{b}_1$, $\tilde{b}_1\to t\tilde{\chi}_1^\pm$	2 e,μ (SS)	1 b	Yes	36.1	$\tilde{b}_1$ 275-700 GeV	m($\tilde{\chi}_1^0$)<200 GeV, m($\tilde{\chi}_1^\pm$)= m($\tilde{\chi}_1^0$)+100 GeV	1706.03731
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\to b\tilde{\chi}_1^\pm$	0-2 e,μ	1-2 b	Yes	4.7/13.3	$\tilde{t}_1$ 117-170 GeV; 200-720 GeV	m($\tilde{\chi}_1^\pm$) = 2m($\tilde{\chi}_1^0$), m($\tilde{\chi}_1^0$)=55 GeV	1209.2102, ATLAS-CONF-2016-077
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\to Wb\tilde{\chi}_1^0$ or $t\tilde{\chi}_1^0$	0-2 e,μ	0-2 jets/1-2 b	Yes	20.3/36.1	$\tilde{t}_1$ 90-198 GeV; 0.195-1.0 TeV	m($\tilde{\chi}_1^0$)=1 GeV	1506.08616, 1709.04183, 1711.11520
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\to c\tilde{\chi}_1^0$	0	mono-jet	Yes	36.1	$\tilde{t}_1$ 90-430 GeV	m($\tilde{t}_1$)-m($\tilde{\chi}_1^0$)=5 GeV	1711.03301
	$\tilde{t}_1\tilde{t}_1$ (natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$ 150-600 GeV	m($\tilde{\chi}_1^0$)>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2$, $\tilde{t}_2\to\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	36.1	$\tilde{t}_2$ 290-790 GeV	m($\tilde{\chi}_1^0$)=0 GeV	1706.03986
	$\tilde{t}_2\tilde{t}_2$, $\tilde{t}_2\to\tilde{t}_1+h$	1-2 e,μ	4 b	Yes	36.1	$\tilde{t}_2$ 320-880 GeV	m($\tilde{\chi}_1^0$)=0 GeV	1706.03986
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}$, $\tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e,μ	0	Yes	36.1	$\tilde{\ell}$ 90-500 GeV	m($\tilde{\chi}_1^0$)=0	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	36.1	$\tilde{\chi}_1^\pm$ 750 GeV	m($\tilde{\chi}_1^0$)=0, m($\tilde{\ell}$, $\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_2^0$, $\tilde{\chi}_1^+\to\tilde{\tau}\nu(\tau\tilde{\nu})$, $\tilde{\chi}_2^0\to\tilde{\tau}\tau(\nu\tilde{\nu})$	2 τ	-	Yes	36.1	$\tilde{\chi}_1^\pm$ 760 GeV	m($\tilde{\chi}_1^0$)=0, m($\tilde{\tau}$, $\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	1708.07875
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu)$, $\ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	36.1	$\tilde{\chi}_1^\pm$, $\tilde{\chi}_2^0$ 1.13 TeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, m($\tilde{\ell}$, $\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	2-3 e,μ	0-2 jets	Yes	36.1	$\tilde{\chi}_1^\pm$, $\tilde{\chi}_2^0$ 580 GeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, $\tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\to W\tilde{\chi}_1^0h\tilde{\chi}_1^0$, $h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e,μ,γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^\pm$, $\tilde{\chi}_2^0$ 270 GeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, $\tilde{\ell}$ decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0$, $\tilde{\chi}_{2,3}^0\to\tilde{\ell}_R\ell$	4 e,μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 635 GeV	m($\tilde{\chi}_2^0$)=m($\tilde{\chi}_3^0$), m($\tilde{\chi}_1^0$)=0, m($\tilde{\ell}$, $\tilde{\nu}$)=0.5(m($\tilde{\chi}_2^0$)+m($\tilde{\chi}_1^0$))	1405.5086
	GGM (wino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	1 e,μ + γ	-	Yes	20.3	$\tilde{W}$ 115-370 GeV	$c\tau$<1 mm	1507.05493
	GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0\to\gamma\tilde{G}$	2 γ	-	Yes	36.1	$\tilde{W}$ 1.06 TeV	$c\tau$<1 mm	ATLAS-CONF-2017-080
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	Yes	36.1	$\tilde{\chi}_1^\pm$ 460 GeV	m($\tilde{\chi}_1^\pm$)-m($\tilde{\chi}_1^0$)~160 MeV, τ($\tilde{\chi}_1^\pm$)=0.2 ns	1712.02118
	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	dE/dx trk	-	Yes	18.4	$\tilde{\chi}_1^\pm$ 495 GeV	m($\tilde{\chi}_1^\pm$)-m($\tilde{\chi}_1^0$)~160 MeV, τ($\tilde{\chi}_1^\pm$)<15 ns	1506.05332
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	27.9	$\tilde{g}$ 850 GeV	m($\tilde{\chi}_1^0$)=100 GeV, 10 μs<τ($\tilde{g}$)<1000 s	1310.6584
	Stable $\tilde{g}$ R-hadron	trk	-	-	3.2	$\tilde{g}$ 1.58 TeV		1606.05129
	Metastable $\tilde{g}$ R-hadron	dE/dx trk	-	-	3.2	$\tilde{g}$ 1.57 TeV	m($\tilde{\chi}_1^0$)=100 GeV, τ>10 ns	1604.04520
	Metastable $\tilde{g}$ R-hadron, $\tilde{g}\to qq\tilde{\chi}_1^0$	displ. vtx	-	Yes	32.8	$\tilde{g}$ 2.37 TeV	τ($\tilde{g}$)=0.17 ns, m($\tilde{\chi}_1^0$) = 100 GeV	1710.04901
	GMSB, stable $\tilde{\tau}$, $\tilde{\chi}_1^0\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$ 537 GeV	10<tanβ<50	1411.6795
	GMSB, $\tilde{\chi}_1^0\to\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$ 440 GeV	1<τ($\tilde{\chi}_1^0$)<3 ns, SPS8 model	1409.5542
	$\tilde{g}\tilde{g}$, $\tilde{\chi}_1^0\to ee\nu/e\mu\nu/\mu\mu\nu$	displ. $ee/e\mu/\mu\mu$	-	-	20.3	$\tilde{\chi}_1^0$ 1.0 TeV	7 <$c\tau$($\tilde{\chi}_1^0$)< 740 mm, m($\tilde{g}$)=1.3 TeV	1504.05162
RPV	LFV $pp\to\tilde{\nu}_\tau+X$, $\tilde{\nu}_\tau\to e\mu/e\tau/\mu\tau$	$e\mu$,$e\tau$,$\mu\tau$	-	-	3.2	$\tilde{\nu}_\tau$ 1.9 TeV	λ'_{311}=0.11, $\lambda_{132/133/233}$=0.07	1607.08079
	Bilinear RPV CMSSM	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{q}$, $\tilde{g}$ 1.45 TeV	m($\tilde{q}$)=m($\tilde{g}$), $c\tau_{LSP}$<1 mm	1404.2500
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\to W\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\to ee\nu, e\mu\nu, \mu\mu\nu$	4 e,μ	-	Yes	13.3	$\tilde{\chi}_1^\pm$ 1.14 TeV	m($\tilde{\chi}_1^0$)>400GeV, $\lambda_{12k}\neq0$ (k = 1, 2)	ATLAS-CONF-2016-075
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\to W\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\to\tau\tau\nu_e, e\tau\nu_\tau$	3 e,μ + τ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 450 GeV	m($\tilde{\chi}_1^0$)>0.2×m($\tilde{\chi}_1^\pm$), $\lambda_{133}\neq0$	1405.5086
	$\tilde{g}\tilde{g}$, $\tilde{g}\to qq\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\to qqq$	0	4-5 large-R jets	-	36.1	$\tilde{g}$ 1.875 TeV	m($\tilde{\chi}_1^0$)=1075 GeV	SUSY-2016-22
	$\tilde{g}\tilde{g}$, $\tilde{g}\to t\bar{t}\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\to qqq$	1 e,μ	8-10 jets/0-4 b	-	36.1	$\tilde{g}$ 2.1 TeV	m($\tilde{\chi}_1^0$)= 1 TeV, $\lambda_{112}\neq0$	1704.08493
	$\tilde{g}\tilde{g}$, $\tilde{g}\to\tilde{t}_1t$, $\tilde{t}_1\to bs$	1 e,μ	8-10 jets/0-4 b	-	36.1	$\tilde{g}$ 1.65 TeV	m($\tilde{t}_1$)= 1 TeV, $\lambda_{323}\neq0$	1704.08493
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\to bs$	0	2 jets + 2 b	-	36.7	$\tilde{t}_1$ 100-470 GeV; 480-610 GeV		1710.07171
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\to b\ell$	2 e,μ	2 b	-	36.1	$\tilde{t}_1$ 0.4-1.45 TeV	BR($\tilde{t}_1\to be/\mu$)>20%	1710.05544
Other	Scalar charm, $\tilde{c}\to c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	$\tilde{c}$ 510 GeV	m($\tilde{\chi}_1^0$)<200 GeV	1501.01325

10^{-1} — 1 — Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

Key References

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/SUSY-2016-25/

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PUBNOTES/ATL-PHYS-PUB-2017-019/

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

ATLAS Exotics Searches* - 95% CL Upper Exclusion Limits

Status: July 2017

ATLAS Preliminary

$\int \mathcal{L}\, dt = (3.2 - 37.0)\ \text{fb}^{-1}$ $\sqrt{s} = 8, 13$ TeV

	Model	ℓ, γ	Jets†	E_T^{miss}	$\int \mathcal{L}\, dt[\text{fb}^{-1}]$	Limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	$0\ e, \mu$	1 – 4 j	Yes	36.1	M_D 7.75 TeV	$n = 2$	ATLAS-CONF-2017-060
	ADD non-resonant $\gamma\gamma$	$2\ \gamma$	–	–	36.7	M_S 8.6 TeV	$n = 3$ HLZ NLO	CERN-EP-2017-132
	ADD QBH	–	2 j	–	37.0	M_{th} 8.9 TeV	$n = 6$	1703.09217
	ADD BH high $\sum p_T$	$\geq 1\ e, \mu$	≥ 2 j	–	3.2	M_{th} 8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1606.02265
	ADD BH multijet	–	≥ 3 j	–	3.6	M_{th} 9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \to \gamma\gamma$	$2\ \gamma$	–	–	36.7	G_{KK} mass 4.1 TeV	$k/\overline{M}_{Pl} = 0.1$	CERN-EP-2017-132
	Bulk RS $G_{KK} \to WW \to qq\ell\nu$	$1\ e, \mu$	1 J	Yes	36.1	G_{KK} mass 1.75 TeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2017-051
	2UED / RPP	$1\ e, \mu$	≥ 2 b, ≥ 3 j	Yes	13.2	KK mass 1.6 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \to tt) = 1$	ATLAS-CONF-2016-104
Gauge bosons	SSM $Z' \to \ell\ell$	$2\ e, \mu$	–	–	36.1	Z' mass 4.5 TeV		ATLAS-CONF-2017-027
	SSM $Z' \to \tau\tau$	$2\ \tau$	–	–	36.1	Z' mass 2.4 TeV		ATLAS-CONF-2017-050
	Leptophobic $Z' \to bb$	–	2 b	–	3.2	Z' mass 1.5 TeV		1603.08791
	Leptophobic $Z' \to tt$	$1\ e, \mu$	≥ 1 b, ≥ 1J/2j	Yes	3.2	Z' mass 2.0 TeV	$\Gamma/m = 3\%$	ATLAS-CONF-2016-014
	SSM $W' \to \ell\nu$	$1\ e, \mu$	–	Yes	36.1	W' mass 5.1 TeV		1706.04786
	HVT $V' \to WV \to qqqq$ model B	$0\ e, \mu$	2 J	–	36.7	V' mass 3.5 TeV	$g_V = 3$	CERN-EP-2017-147
	HVT $V' \to WH/ZH$ model B	multi-channel			36.1	V' mass 2.93 TeV	$g_V = 3$	ATLAS-CONF-2017-055
	LRSM $W'_R \to tb$	$1\ e, \mu$	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV		1410.4103
	LRSM $W'_R \to tb$	$0\ e, \mu$	≥ 1 b, 1 J	–	20.3	W' mass 1.76 TeV		1408.0886
CI	CI $qqqq$	–	2 j	–	37.0	Λ 21.8 TeV η_{LL}^-		1703.09217
	CI $\ell\ell qq$	$2\ e, \mu$	–	–	36.1	Λ 40.1 TeV η_{LL}^-		ATLAS-CONF-2017-027
	CI $uutt$	2(SS)/$\geq$3 e,μ	$\geq$1 b, $\geq$1 j	Yes	20.3	Λ 4.9 TeV	$\lvert C_{RR} \rvert = 1$	1504.04605
DM	Axial-vector mediator (Dirac DM)	$0\ e, \mu$	1 – 4 j	Yes	36.1	m_{med} 1.5 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 400$ GeV	ATLAS-CONF-2017-060
	Vector mediator (Dirac DM)	$0\ e, \mu$, $1\ \gamma$	≤ 1 j	Yes	36.1	m_{med} 1.2 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 480$ GeV	1704.03848
	$VV\chi\chi$ EFT (Dirac DM)	$0\ e, \mu$	1 J, ≤ 1 j	Yes	3.2	M_* 700 GeV	$m(\chi) < 150$ GeV	1608.02372
LQ	Scalar LQ 1st gen	$2\ e$	≥ 2 j	–	3.2	LQ mass 1.1 TeV	$\beta = 1$	1605.06035
	Scalar LQ 2nd gen	$2\ \mu$	≥ 2 j	–	3.2	LQ mass 1.05 TeV	$\beta = 1$	1605.06035
	Scalar LQ 3rd gen	$1\ e, \mu$	$\geq$1 b, $\geq$3 j	Yes	20.3	LQ mass 640 GeV	$\beta = 0$	1508.04735
Heavy quarks	VLQ $TT \to Ht + X$	0 or 1 e, μ	≥ 2 b, ≥ 3 j	Yes	13.2	T mass 1.2 TeV	$\mathcal{B}(T \to Ht) = 1$	ATLAS-CONF-2016-104
	VLQ $TT \to Zt + X$	$1\ e, \mu$	≥ 1 b, ≥ 3 j	Yes	36.1	T mass 1.16 TeV	$\mathcal{B}(T \to Zt) = 1$	1705.10751
	VLQ $TT \to Wb + X$	$1\ e, \mu$	≥ 1 b, ≥ 1J/2j	Yes	36.1	T mass 1.35 TeV	$\mathcal{B}(T \to Wb) = 1$	CERN-EP-2017-094
	VLQ $BB \to Hb + X$	$1\ e, \mu$	≥ 2 b, ≥ 3 j	Yes	20.3	B mass 700 GeV	$\mathcal{B}(B \to Hb) = 1$	1505.04306
	VLQ $BB \to Zb + X$	2/$\geq$3 e, μ	$\geq$2/$\geq$1 b	–	20.3	B mass 790 GeV	$\mathcal{B}(B \to Zb) = 1$	1409.5500
	VLQ $BB \to Wt + X$	$1\ e, \mu$	≥ 1 b, ≥ 1J/2j	Yes	36.1	B mass 1.25 TeV	$\mathcal{B}(B \to Wt) = 1$	CERN-EP-2017-094
	VLQ $QQ \to WqWq$	$1\ e, \mu$	≥ 4 j	Yes	20.3	Q mass 690 GeV		1509.04261
Excited fermions	Excited quark $q^* \to qg$	–	2 j	–	37.0	q^* mass 6.0 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1703.09127
	Excited quark $q^* \to q\gamma$	$1\ \gamma$	1 j	–	36.7	q^* mass 5.3 TeV	only u^* and d^*, $\Lambda = m(q^*)$	CERN-EP-2017-148
	Excited quark $b^* \to bg$	–	1 b, 1 j	–	13.3	b^* mass 2.3 TeV		ATLAS-CONF-2016-060
	Excited quark $b^* \to Wt$	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
	Excited lepton ℓ^*	$3\ e, \mu$	–	–	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0$ TeV	1411.2921
	Excited lepton ν^*	$3\ e, \mu, \tau$	–	–	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6$ TeV	1411.2921
Other	LRSM Majorana ν	$2\ e, \mu$	2 j	–	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4$ TeV, no mixing	1506.06020
	Higgs triplet $H^{\pm\pm} \to \ell\ell$	2,3,4 e, μ (SS)	–	–	36.1	$H^{\pm\pm}$ mass 870 GeV	DY production	ATLAS-CONF-2017-053
	Higgs triplet $H^{\pm\pm} \to \ell\tau$	$3\ e, \mu, \tau$	–	–	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, $\mathcal{B}(H_L^{\pm\pm} \to \ell\tau) = 1$	1411.2921
	Monotop (non-res prod)	$1\ e, \mu$	1 b	Yes	20.3	spin-1 invisible particle mass 657 GeV	$a_{\text{non-res}} = 0.2$	1410.5404
	Multi-charged particles	–	–	–	20.3	multi-charged particle mass 785 GeV	DY production, $\lvert q \rvert = 5e$	1504.04188
	Magnetic monopoles	–	–	–	7.0	monopole mass 1.34 TeV	DY production, $\lvert g \rvert = 1 g_D$, spin 1/2	1509.08059

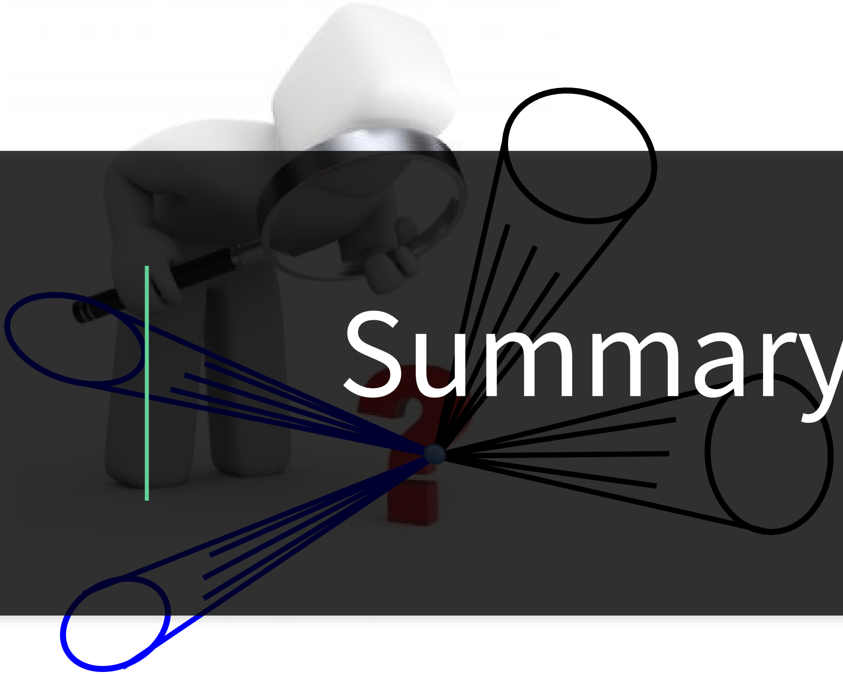
Legend: $\sqrt{s} = 8$ TeV (green) · $\sqrt{s} = 13$ TeV (yellow)

Mass scale [TeV] (axis: 10^{-1}, 1, 10)

*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).

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



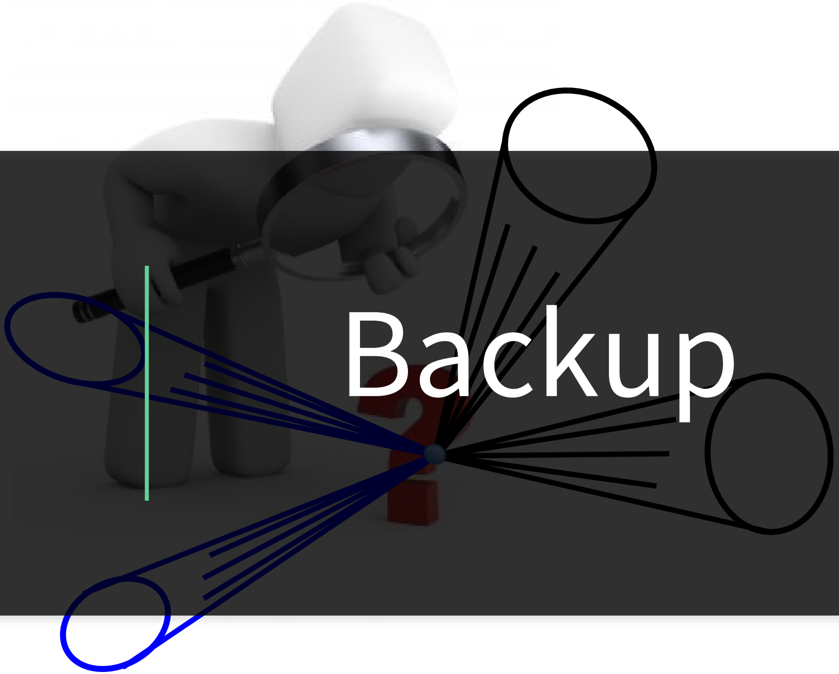
Summary

Summary

- ATLAS has a very extensive set of BSM analyses in place at 8 and 13 TeV
  - We presented here the latest exotic searches, particularly: Di-lepton, Di-jet, Di-photon, VV, VH, $\gamma\gamma$ VLQs and Dark Matter
  - Multiple models and analysis explore in direct way at the TeV scale
- New techniques are developed to probe high/low mass new physics with the increase in total luminosity wrt the previous results
  - Boosted object tagging, trigger-level analysis, combinations of searches regions,...
  - No evidence for any BSM physics at ATLAS yet
- In 2017 and 2018 more data is to be added (expected ~100fb^{-1})
  - Increasing the discovery and exclusion power of the current and future searches!

Thank You!

Backup

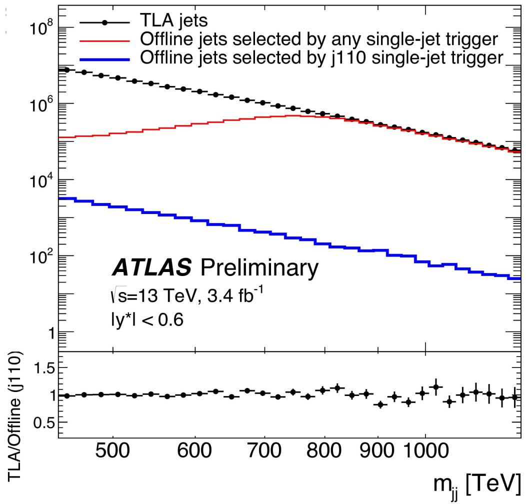


Dijet: Trigger Level Analysis

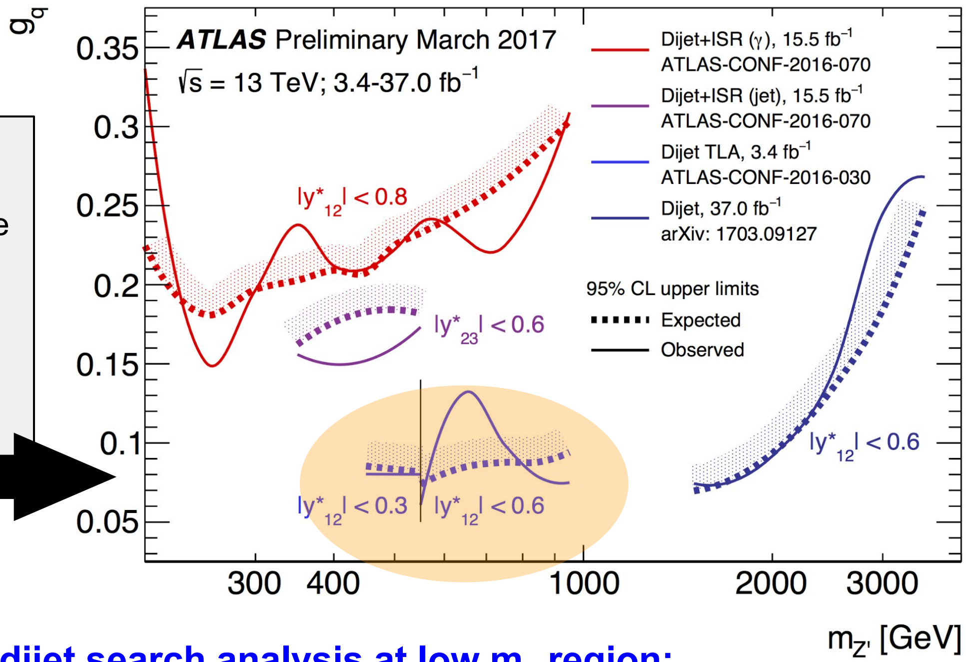
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2016-070/ (ATLAS-CONF-2016-070)
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/EXOTICS/

Trigger selection ISR objects to reach low m_{JJ} region

- JJ + γ: single-photon trigger (ET > 140 GeV)
- JJ + J: single-jet trigger (pT > 380 GeV)



Upper limits for a leptophobic **Z'** simplified model. The limits are obtained from the **m_{jj}** distribution on the coupling to quarks, **g_q**, as a function of the mass, **$m_{Z'}$**



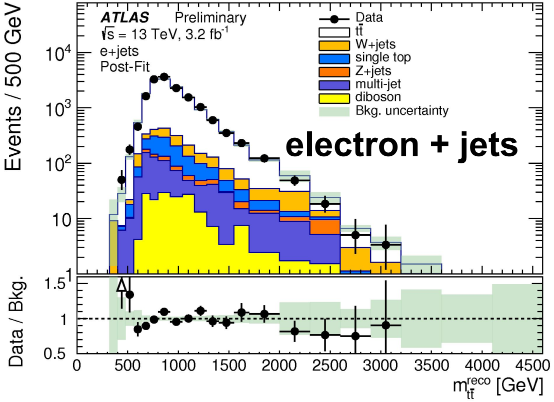
To expand the dijet search analysis at low m_{jj} region:

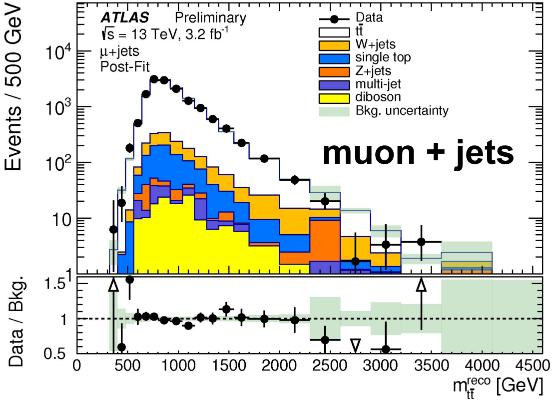
- Lower the jet thresholds @trigger level, but with and exponential increase of bandwidth.
- The limits are obtained from the **m_{jj}** distribution on the coupling to quarks, **g_q**, as a function of the mass, **$m_{Z'}$**

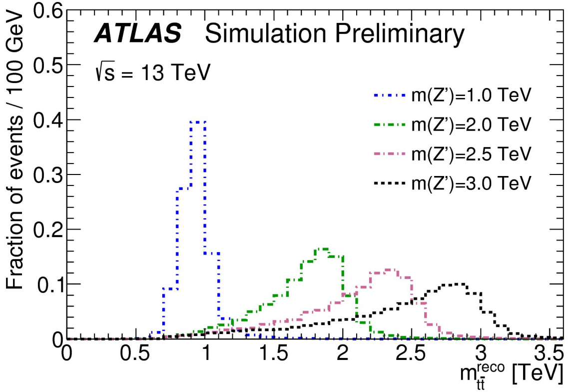
ttbar Resonances

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2016-014/ (ATLAS-CONF-2016-014)

- **Lepton-plus-jets topology: $t\rightarrow bW(l\nu)$, $t\rightarrow bW(qq)$**
- **~30% of ttbar events decay this way & the non-ttbar bkg is far smaller than in the all-hadronic topology.**
- **Bkgs: SM ttbar (MC estimated), W+jets, Multi-jets (data-driven)**

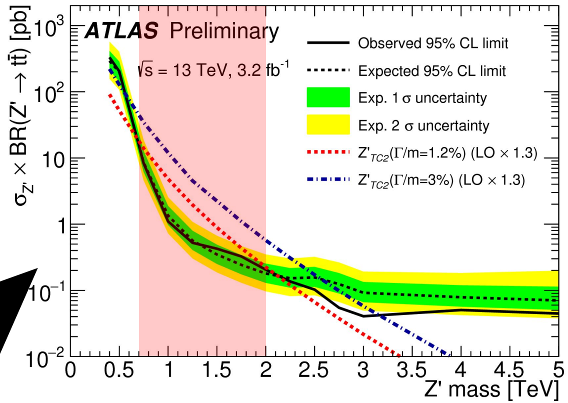






- **Systematic uncertainties: SM ttbar normalisation + shape (variation event generators, Parton shower, PDF, QCD radiation, EWK corrections)**
- **No excess is found in the reconstructed ttbar invariant mass spectrum**

$0.7 < m_{Z'} < 2.0$ TeV is excluded for $\Gamma/m = 1.2\%$

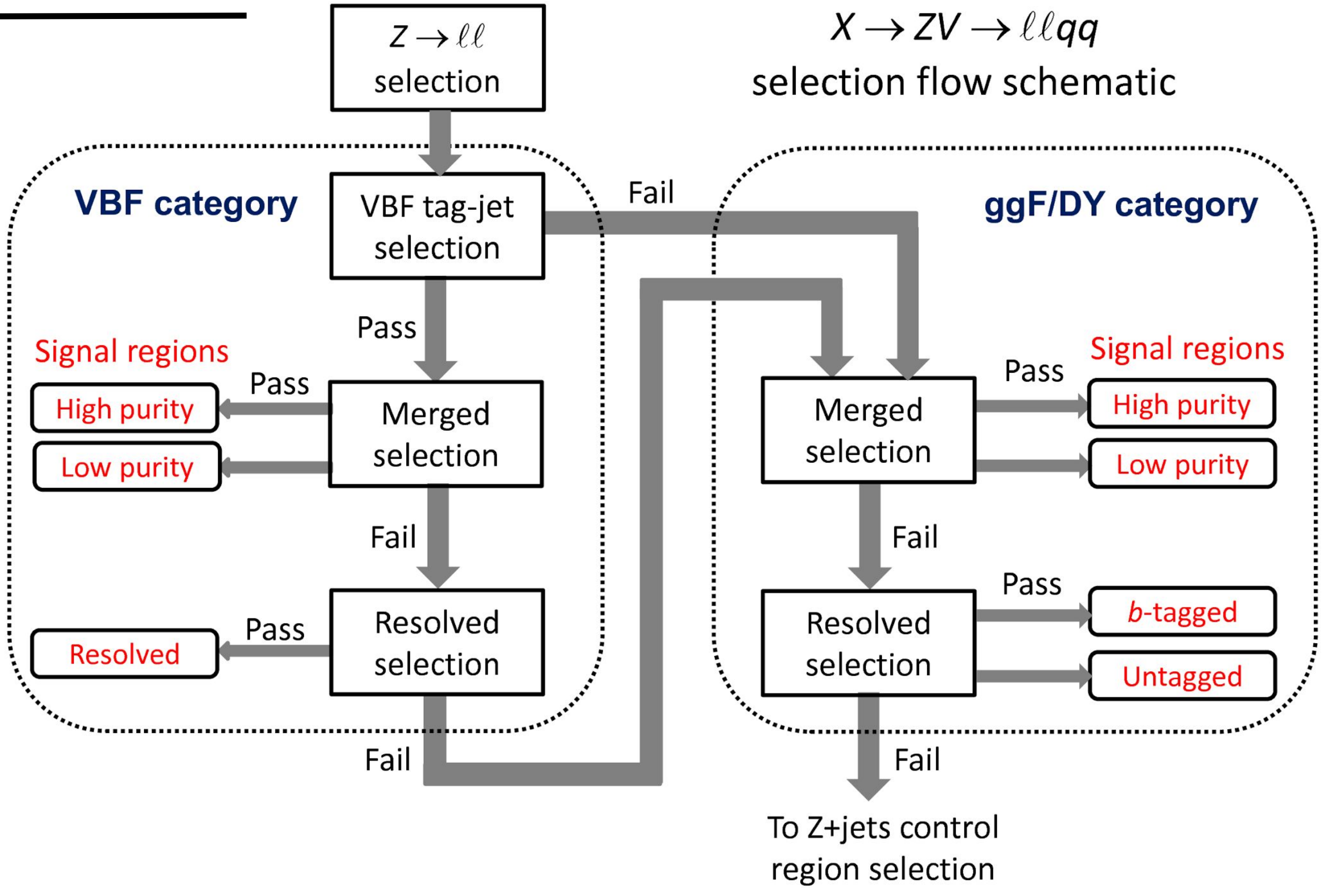


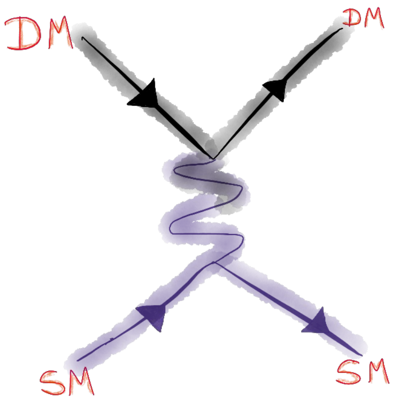
Analysis selection strategy

$X \rightarrow Z[W,Z] \rightarrow llqq, \nu\nu qq$ (1)

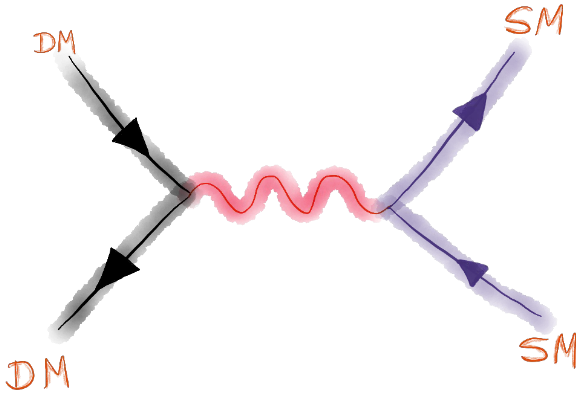
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/EXOT-2016-29/ (arXiv:1708.09638)

$X \rightarrow ZV \rightarrow \ell\ell qq$ selection flow schematic

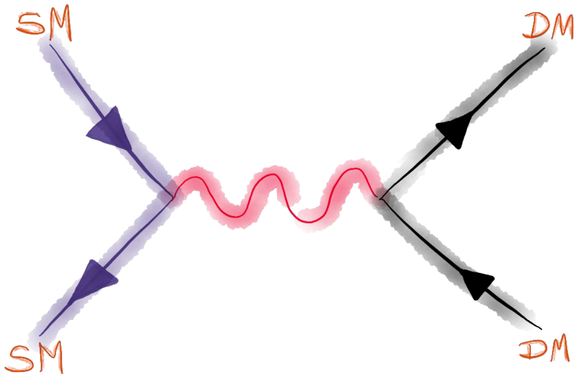




Direct Detection
DM-nucleon scattering

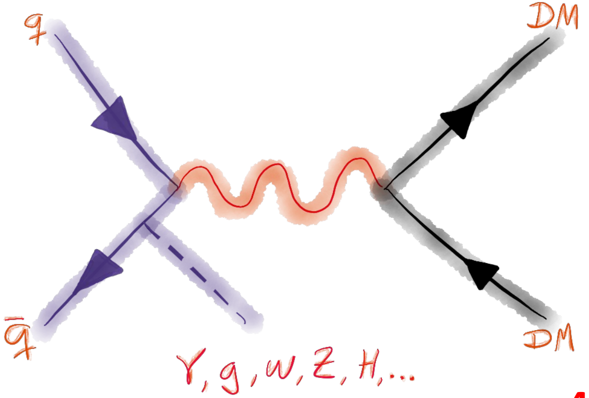


Indirect Detection
DM-DM annihilation



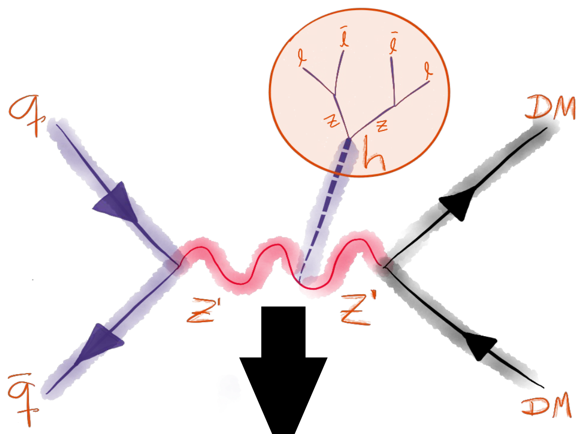
Production at Colliders

Mono-X Signatures
DM pair production in
association with **X**
(γ, jet, $W^{\pm}$, Z, h)
Where object **X** is needed for
event to be visible in the detector



Mono-Higgs(4*l*) + X

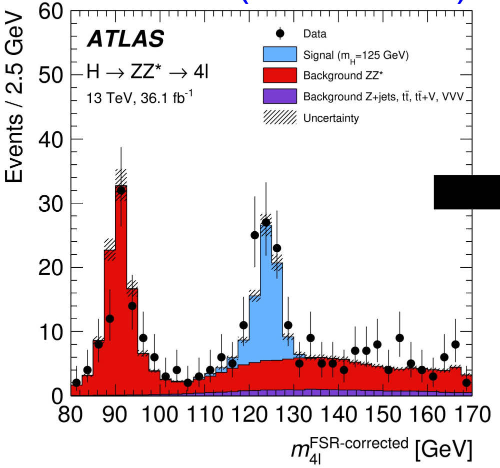
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2016-25/ (JHEP 10 (2017) 132)

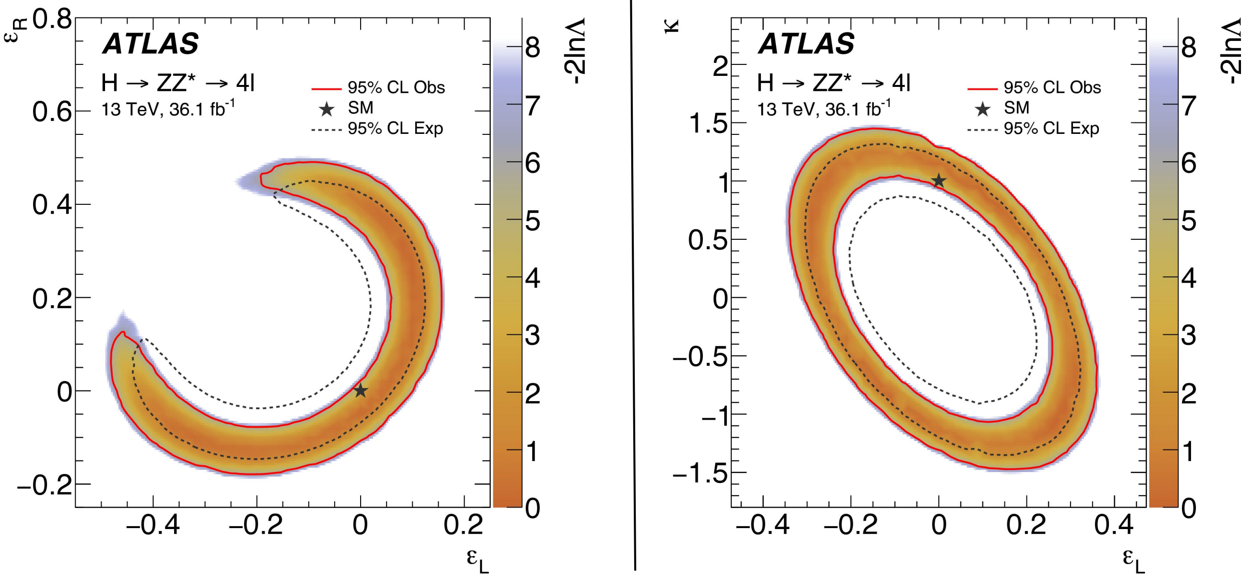


Signature

Four leptons (μ/e)

+ MET (> 100 GeV)





Limits on modified Higgs boson decays

- The limits are extracted in the plane of ϵ_L and ϵ_R
- The limits with tested parameters are ϵL and κ. The latter modifies the coupling of the Higgs boson to Z bosons.