

Hunting New Physics with ATLAS

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for the ATLAS Collaboration

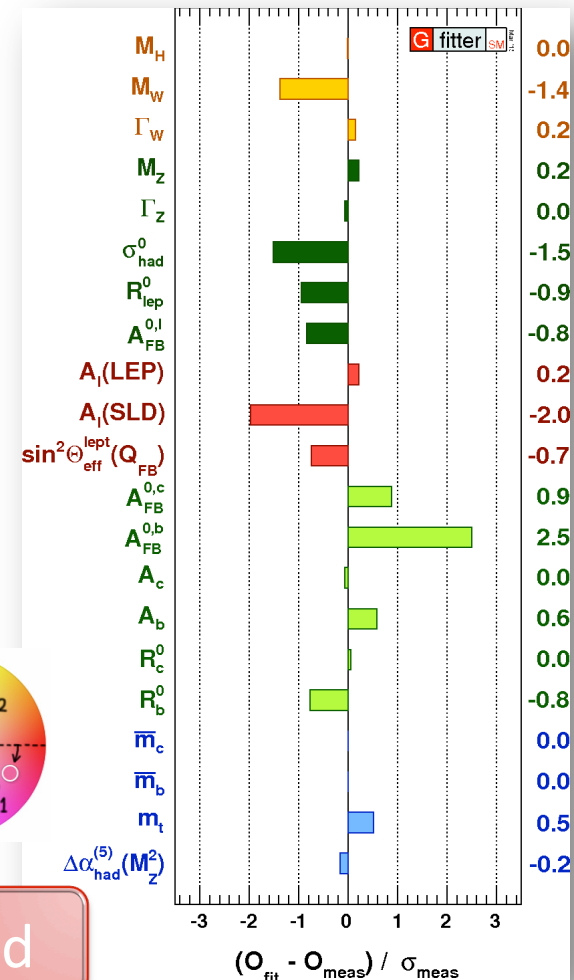
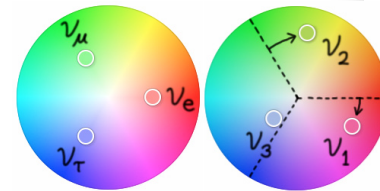
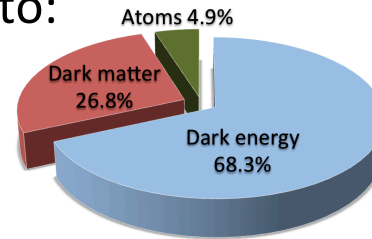
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ICNFP 2017**

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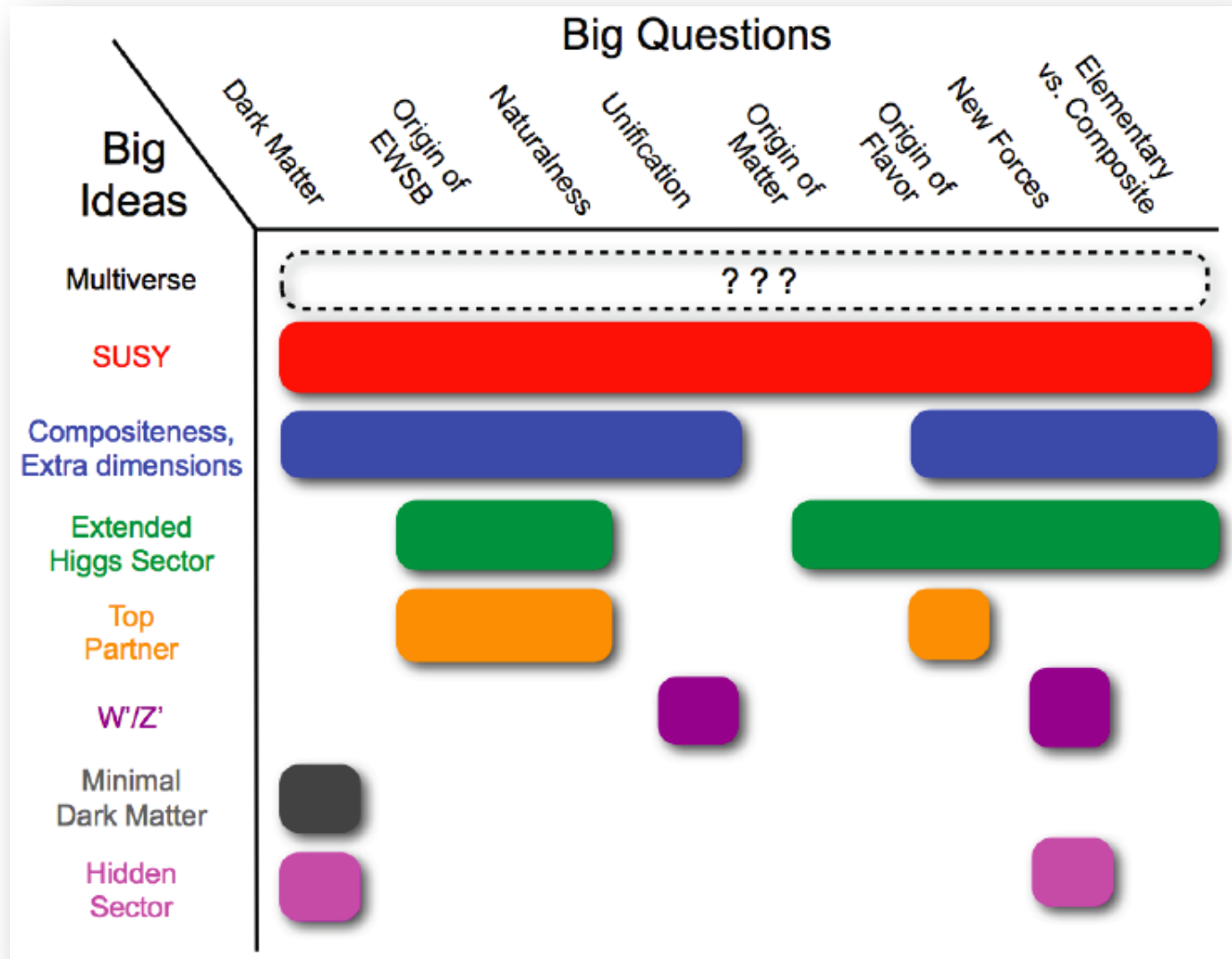
Why going beyond the Standard Model?

- SM provides an excellent description of the experimental data so far
 - QCD and hadronic structure
 - precision EW physics
 - top quark
 - flavour physics
- yet... it does not provide an answer to:
 - hierarchy / fine tuning problem
 - matter-antimatter asymmetry
 - dark matter & dark energy
 - neutrino masses
 - unification of EW interactions & QCD
 - gravitation
 - more than one fermion generation



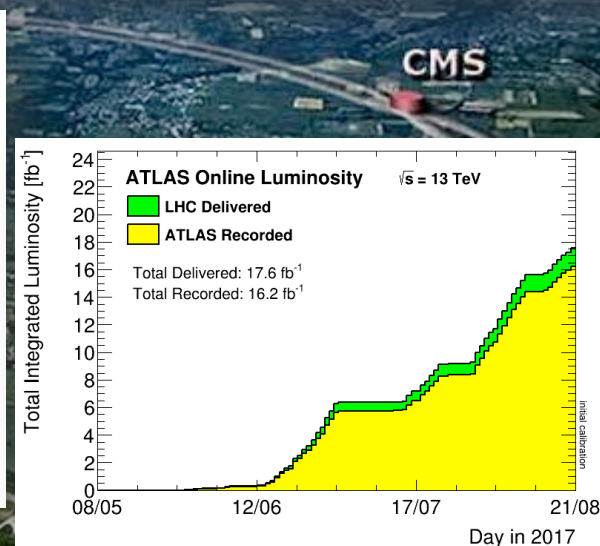
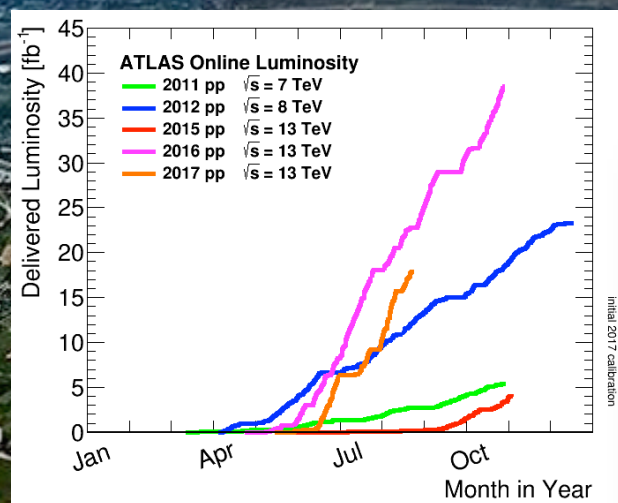
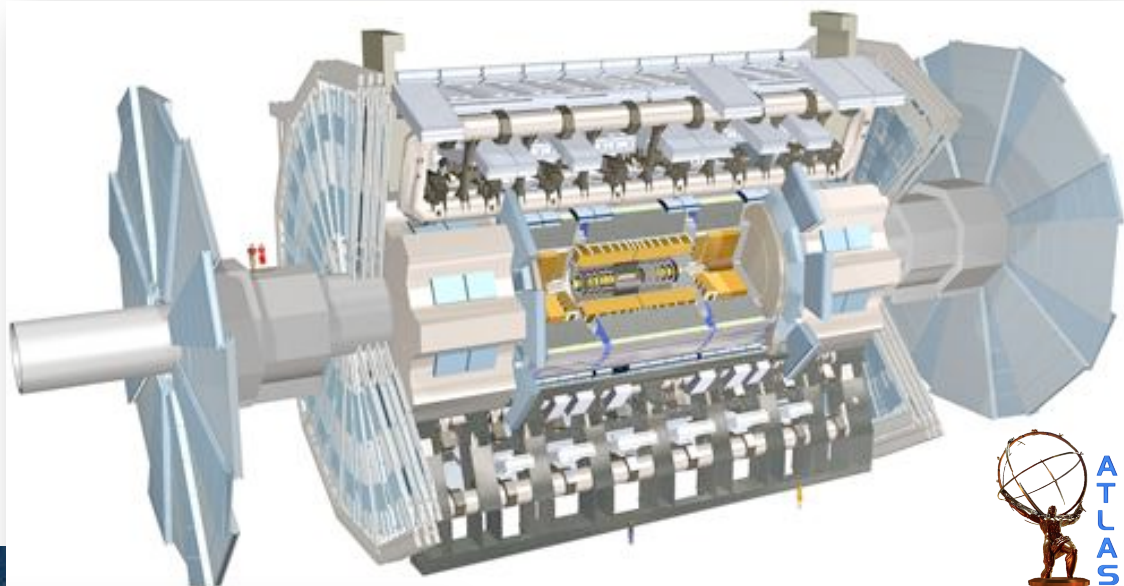
An extension of the Standard Model is needed

(some) ideas beyond Standard Model



ATLAS at the LHC

- Spectacular LHC performance
- Run 2: 2015 – ongoing
 - $\sqrt{s} = 13$ TeV
 - 2015-2016: $\sim 40 \text{ fb}^{-1}$ pp collisions recorded by ATLAS
 - 2017: $\sim 16 \text{ fb}^{-1}$ recorded so far



Beyond-SM searches strategy

- ① Pursue signature-driven analyses:
 - resonances: dileptons, jets, photons, ...
 - non-resonant: tails in kinematic distributions
 - special particles: slow-moving, long-lived, ...
 - ...
 - ② Search for excess of events over the expected SM background
 - in one or more *Signal Regions (SRs)*
 - ③ If no significant excess is observed
 - set cross-section upper limits
 - interpret in specific models to obtain limits on masses, couplings, ...
- 👉 **Background estimate:** data-driven techniques for main; MC for smaller
- measurement with data in *Control Regions (CRs)*, extrapolated to SRs
 - method validated in *Validation Regions (VRs)*
- 👉 **Blind analysis:** first define and validate analysis, then open signal box

Signatures probing models

- Resonances

- dileptons: $Z' \rightarrow \ell\ell, \dots$
- $W' \rightarrow \ell\nu$
- dibosons: $WW, WZ, \gamma\gamma, \dots$
- top/bottom: VLQs
- BSM Higgs, ...
- leptons+jets: leptoquarks, ...
- dijets

Pawel Bruckman's talk

- Non-resonant final states

- dileptons
- leptons+jets
- mono-X + E_T^{miss} , dark matter, ...
- ...

Yoram Rozen's talk

Cristiano Sebastiani's poster

- Long-lived particles

- high ionisation
- disappearing tracks
- displaced lepton jets, vertices



- SUSY-specific signatures: $E_T^{\text{miss}} + X$

- strong production
- 3rd-generation squarks
- electroweak production
- ...

Emphasis on most recent results

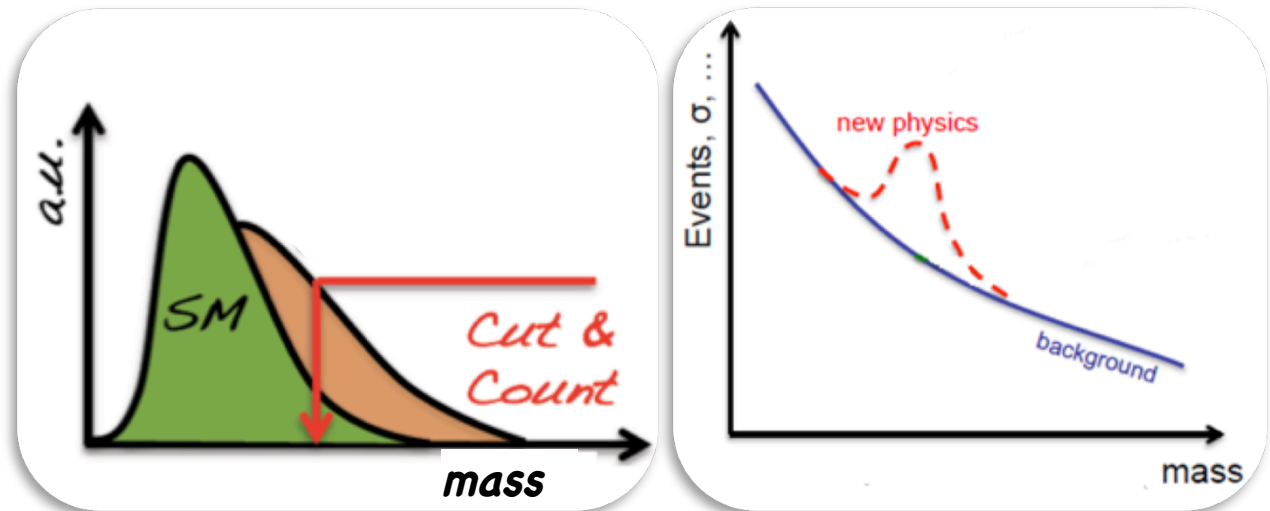
Signature-based searches cover multitude of theoretical scenarios

See talks by:

- *Andre Sopczak*
- *Shunsuke Adachi*
- *Nicolas Koehler*
- *Athina Kourkouveli*

Looking for resonances & tails in distributions

- Non-SUSY searches only presented here
- Detailed reviews for SUSY in other talks

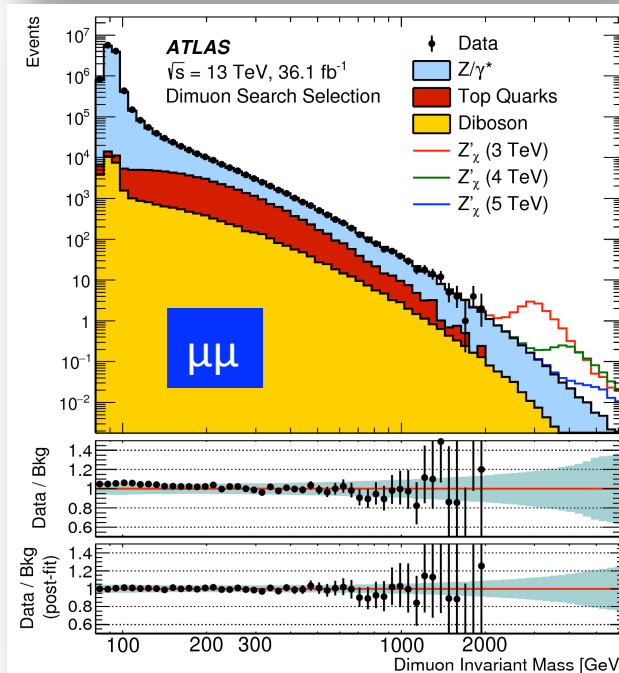
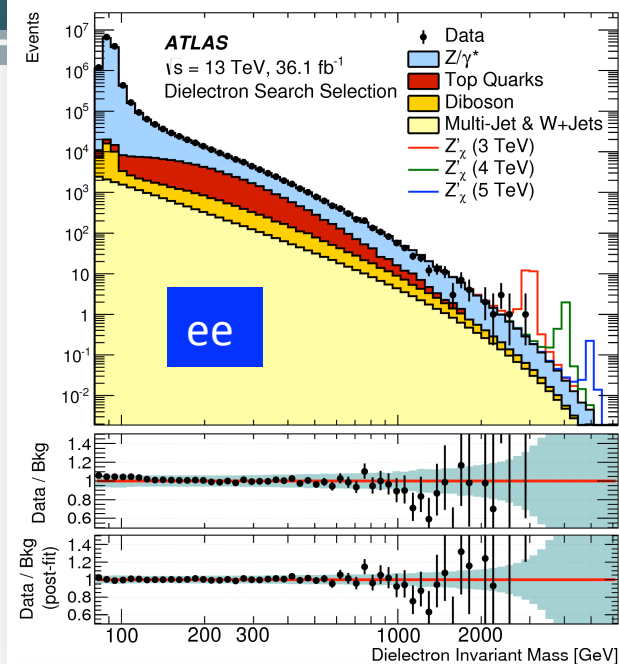


Dileptons (1/3)

- Selection
 - 2 opposite-sign (OS) isolated electrons OR muons with $p_T > 30$ GeV
 - Background
 - Drell-Yan (DY), diboson, top (pair & single)
 - DY fitted to data at Z-peak
 - fakes (QCD jets & W+jets) \rightarrow data-driven matrix method
 - Reconstruction of dilepton invariant mass

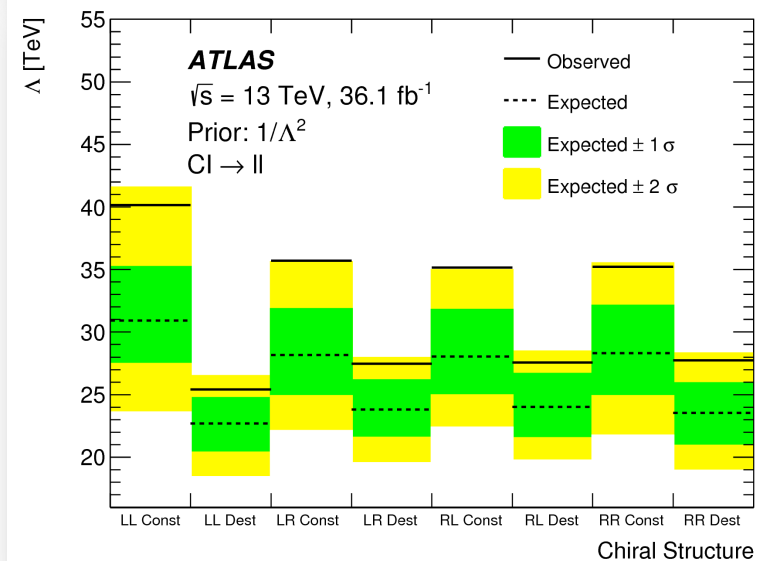
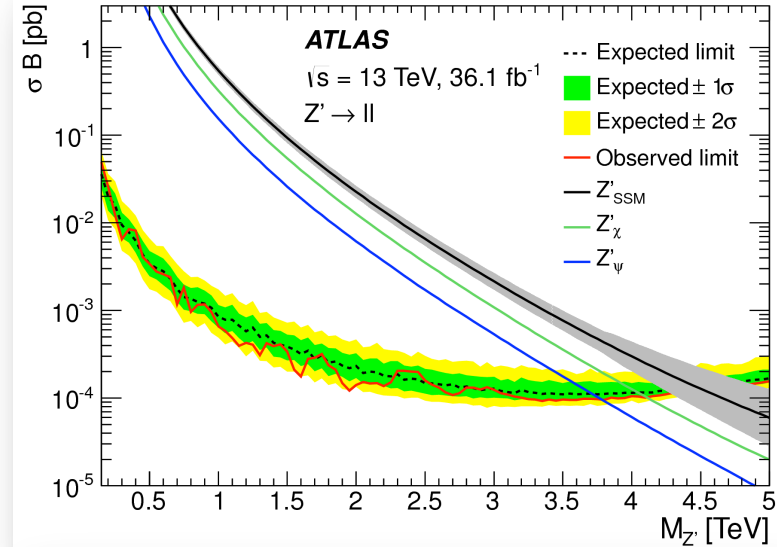
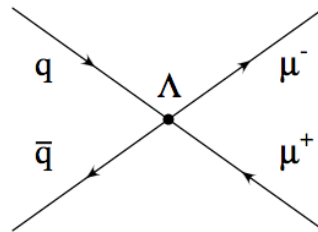
$m_{\ell\ell}$
 - Looking for narrow resonances OR broad excesses in the invariant mass distribution
- \rightarrow Data consistent with SM expectation

36.1 fb⁻¹ @ 13 TeV



Dileptons (2/3)

- **Z' resonances:** spin-1 neutral gauge bosons
 - Sequential SM (SSM): Z' with same couplings as SM Z
 - GUT models based on E_6 gauge group predict two additional U(1) gauge fields: Z'_ψ , Z'_χ
 - observable as narrow resonances in dilepton invariant mass spectrum
- **Contact Interactions (CI)**
 - probes quark and lepton compositeness, with binding energy scale Λ
 - different chiral structures considered
 - detectable as broad excess in dilepton invariant mass spectrum



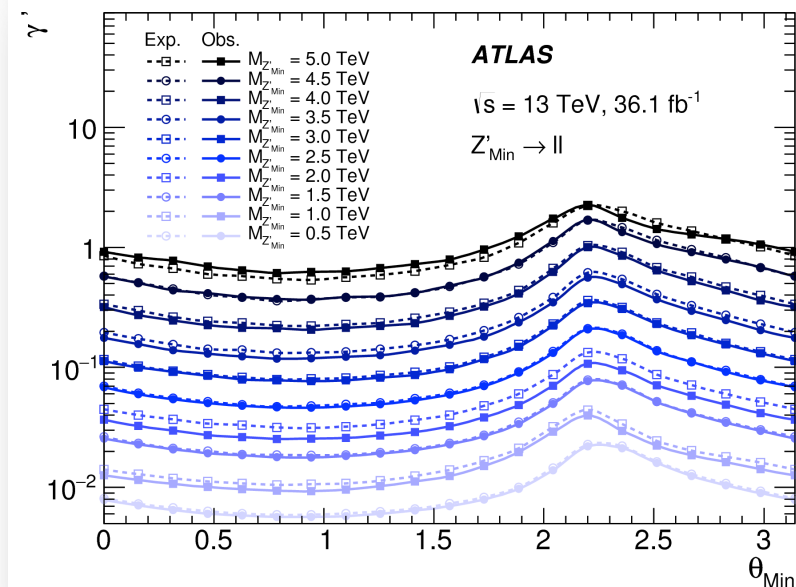
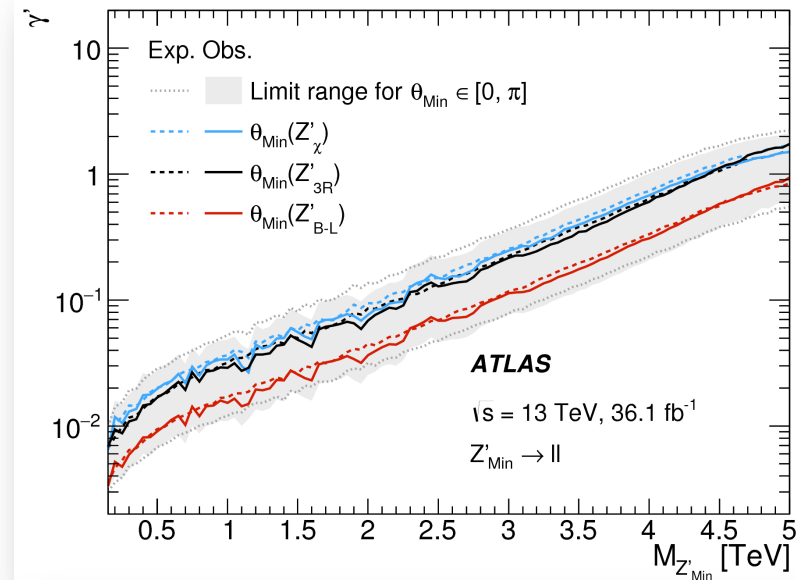
Dileptons (3/3)

- **Minimal Z' models** are characterized by three parameters:
 - Z' boson mass
 - γ' : strength of Z' boson coupling relative to SM Z
 - θ_{Min} : mixing angle between the generators of B-L (Baryon minus Lepton number) and the weak hypercharge gauge groups

Model	γ'	$\tan \theta_{\text{Min}}$	Lower limits on $M_{Z'_{\text{Min}}}$ [TeV]					
			ee		$\mu\mu$		$\ell\ell$	
			Obs	Exp	Obs	Exp	Obs	Exp
Z'_χ	$\sqrt{\frac{41}{24}} \sin \theta_{\text{Min}}$	$-\frac{4}{5}$	3.7	3.7	3.4	3.3	3.9	3.8
Z'_{3R}	$\sqrt{\frac{5}{8}} \sin \theta_{\text{Min}}$	-2	4.0	3.9	3.6	3.6	4.1	4.1
Z'_{B-L}	$\sqrt{\frac{25}{12}} \sin \theta_{\text{Min}}$	0	4.0	4.0	3.6	3.6	4.2	4.1

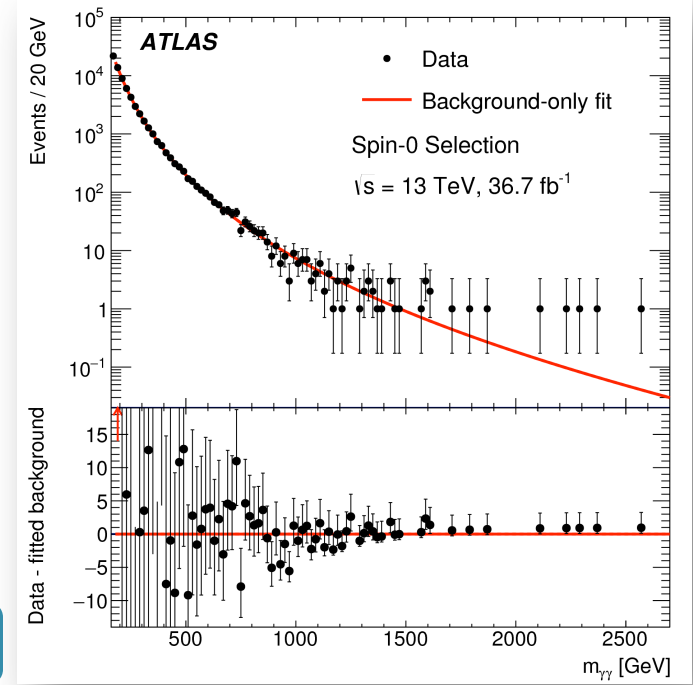
- Also obtained generic upper limits on visible σ in fiducial lepton p_T & η and mass-window for various widths (*not shown here*)

36.1 fb⁻¹ @ 13 TeV

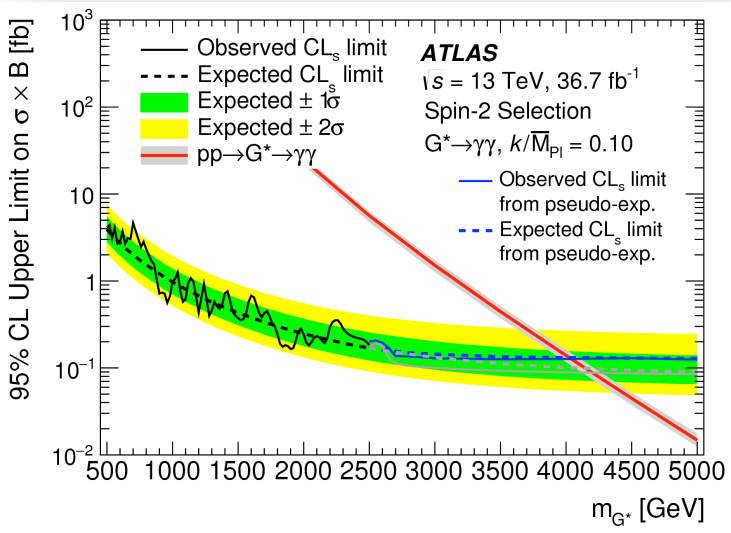


Diphotons

- Search for heavy resonant and non-resonant BSM physics decaying into diphoton final states
 - Event selection
 - ≥ 2 isolated photons with $E_T > 40$ GeV & 30 GeV
 - different kinematic selections applied for spin-0 vs. spin-2
 - narrow-width approximation (NWA) bump in $m_{\gamma\gamma}$
 - non-resonant: counting experiment for $m_{\gamma\gamma} > 2240$ GeV
- ➔ No significance excess observed up to diphoton masses of 2.7 TeV



36.7 fb⁻¹ @ 13 TeV

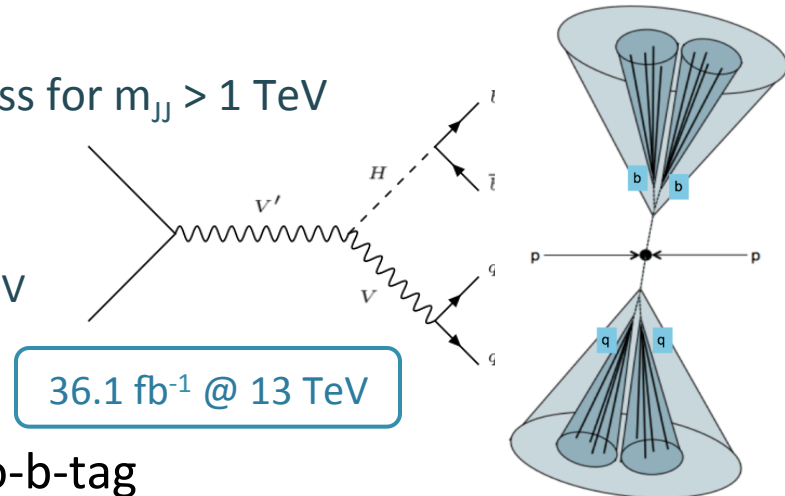


Limits set in various scenarios

- **Spin-0 resonance:** exclusion limits for NWA signal $\sigma \times BR(\gamma\gamma)$ range from **11.4 fb @ 200 GeV** to about **0.1 fb @ 2.7 TeV**
- Spin-2 resonance: **Randall-Sundrum (RS) graviton** with $k/M_{Pl}=0.1$ excluded below $m_{G^*}=4.1$ TeV
- Spin-2 non-resonant: lower limit on M_S placed between **5.7 TeV** and **8.6 TeV** on **ADD model** depending on formalism used and number of extra dimension assumed

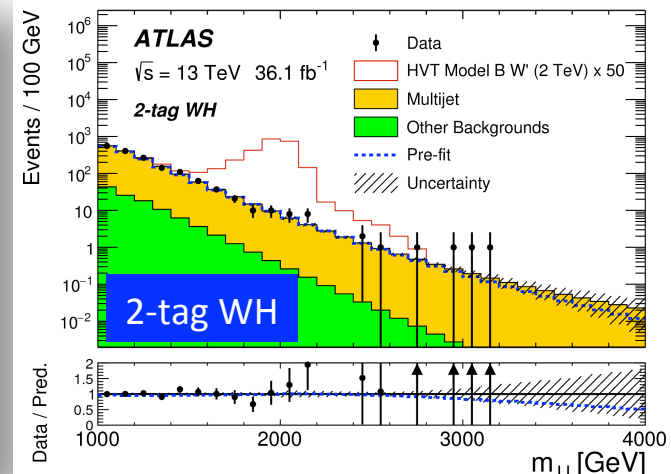
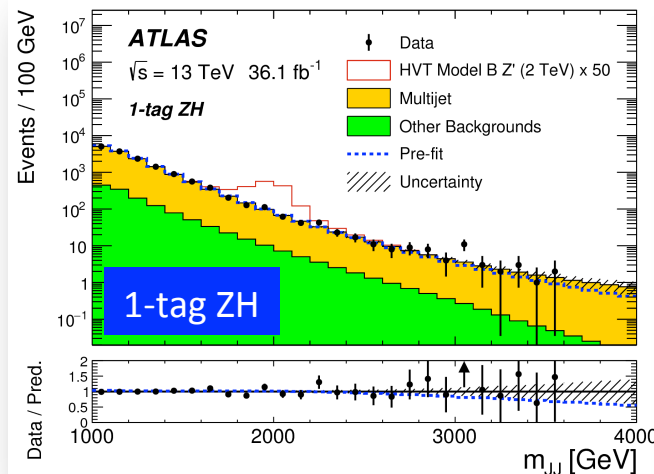
Dibosons: $V' \rightarrow VH \rightarrow q\bar{q}(\prime)b\bar{b}$ (1/2)

- Search for boosted heavy resonances decaying to VH in all-hadronic channel
 - final state composed of two large-R jets, J
 - narrow-width bumps at di-jet (m_{JJ}) invariant mass for $m_{JJ} > 1$ TeV
- Event selection
 - lepton veto; E_T^{miss} veto
 - ≥ 2 large-R jets with $p_T > 250$ GeV; leading $p_T > 450$ GeV
 - larger mass is H-jet; smaller is V-jet
 - W/Z and H mass window
- Background estimated by side band and/or no-b-tag



➔ Data compatible with SM hypothesis

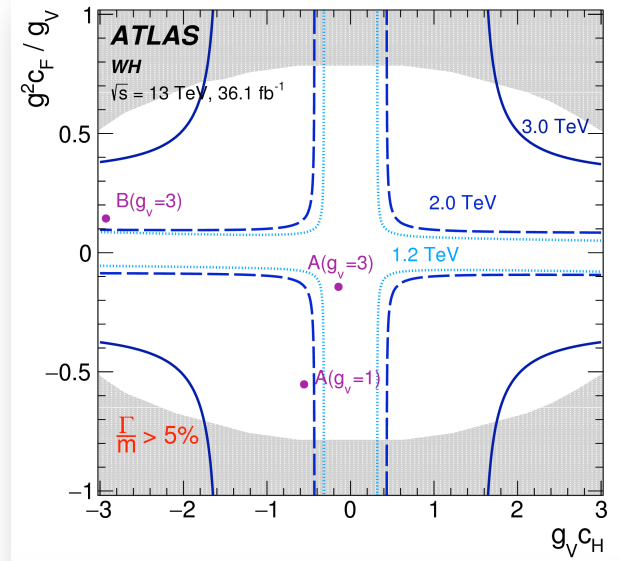
Largest deviation in ZH channel at $m_{JJ} \approx 3$ TeV with local (global) significance of 3.3σ (2.1σ)



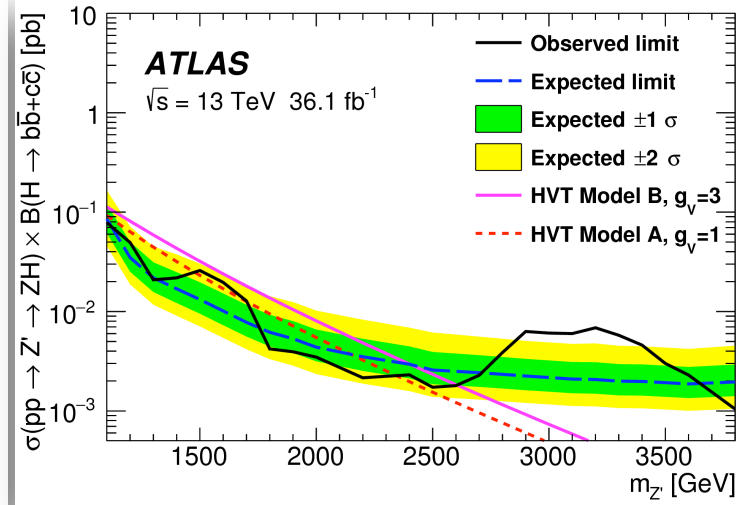
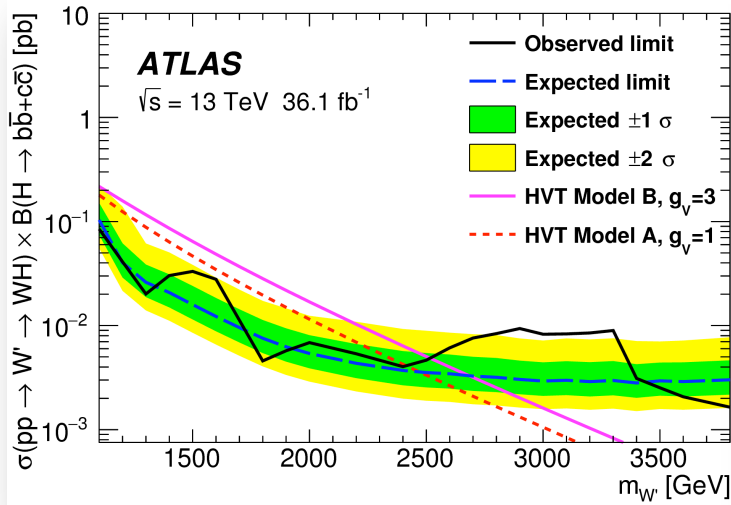
Dibosons: $V' \rightarrow VH \rightarrow q\bar{q}^{(\prime)}b\bar{b}$ (2/2)

- Candidate signal models:
 - Heavy Vector Triplet (HVT) W' and Z'
 - Model A: comparable BRs to fermions and gauge bosons
 - Model B: suppressed couplings to fermions
- Upper limits on $\sigma \times \text{BR}$ set for W' and Z' resonances:
 - HVT Model B resonances excluded in mass range 1100 - 2500 GeV for WH, and 1100 - 2600 GeV for ZH
 - HVT Model A resonances excluded in mass range 1100 - 2400 GeV for WH, and 1100 - 1480 GeV and 1700 - 2350 for ZH

36.1 fb⁻¹ @ 13 TeV



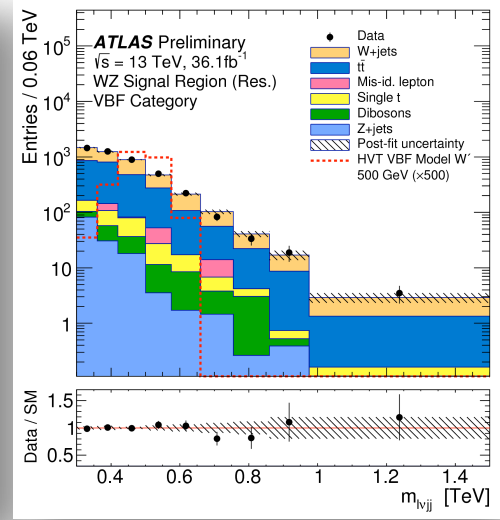
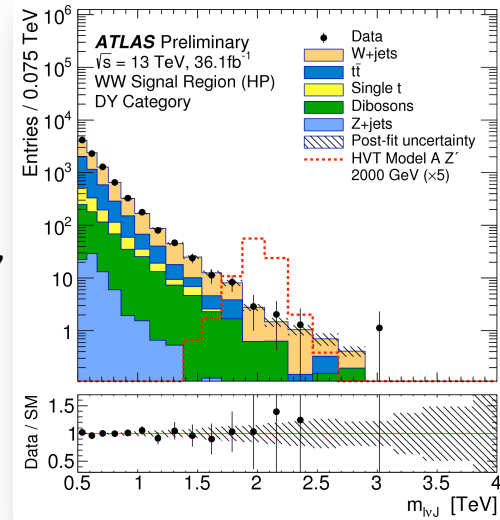
Note: there is a ~60% overlap of data between the WH and ZH selections, for both 1-tag and 2-tag regions



Dibosons: $X \rightarrow WV \rightarrow \ell\nu q\bar{q}$

36.1 fb⁻¹ @ 13 TeV

- Motivation:
 - Spin 0: **Composite Higgs** (ggF or VBF)
 - Spin 1: **Heavy Vector Triplet** (q \bar{q} or VBF)
 - Spin 2: **RS graviton** (ggF production)
- Consider both resolved (jj) and “merged” (J), if highly boosted, dijet system
- Events categorisation:
 - VBF or DY (includes ggF & q \bar{q})
 - (i) merged high purity (HP);
 - (ii) merged low purity (LP); (iii) resolved
 - WW or WZ (overlap)
- Search for bump in $m(\ell\nu jj)$ or $m(\ell\nu J)$ distributions

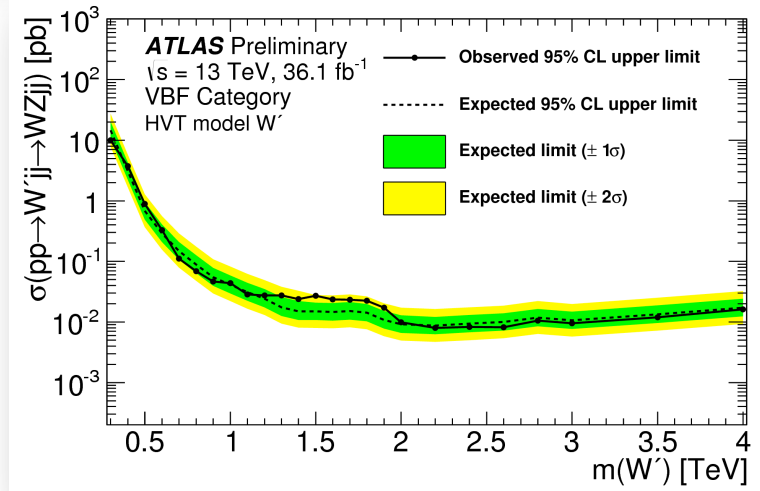


➔ No significance excess observed

➔ limits set in resonance masses for considered models

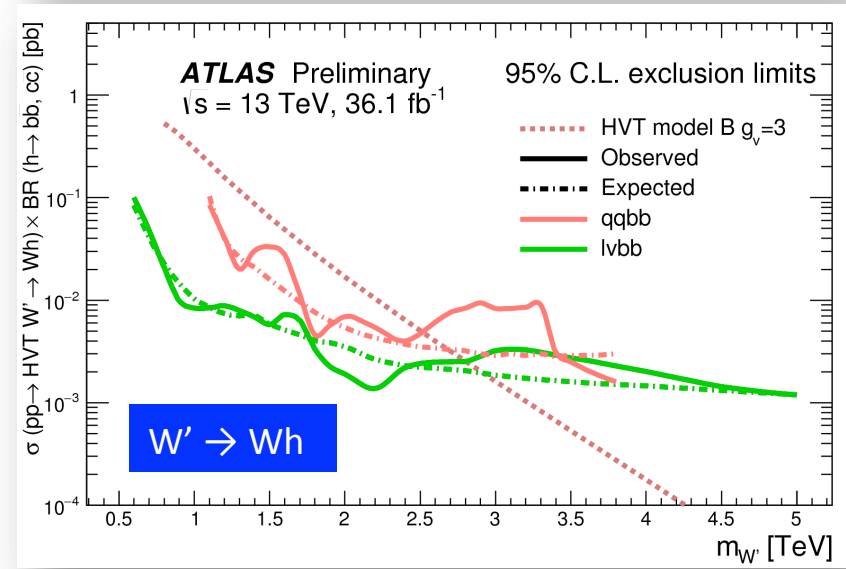
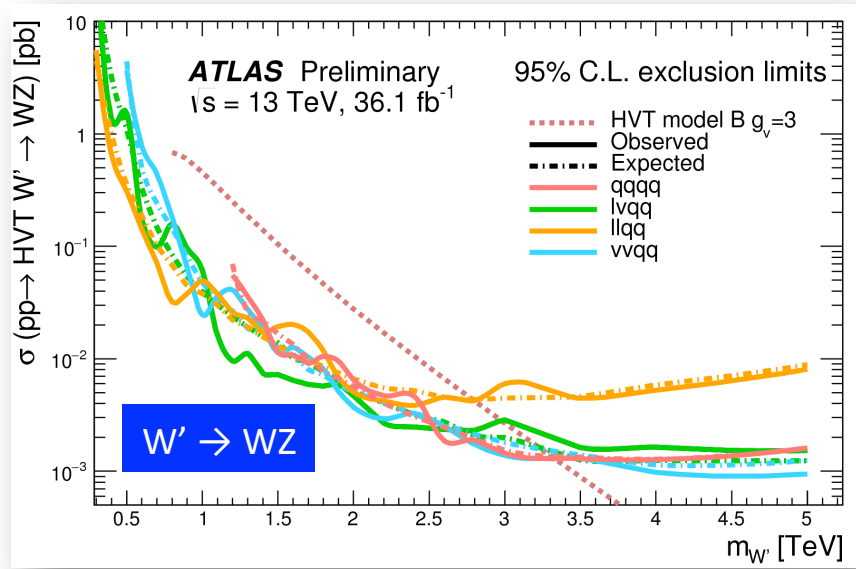
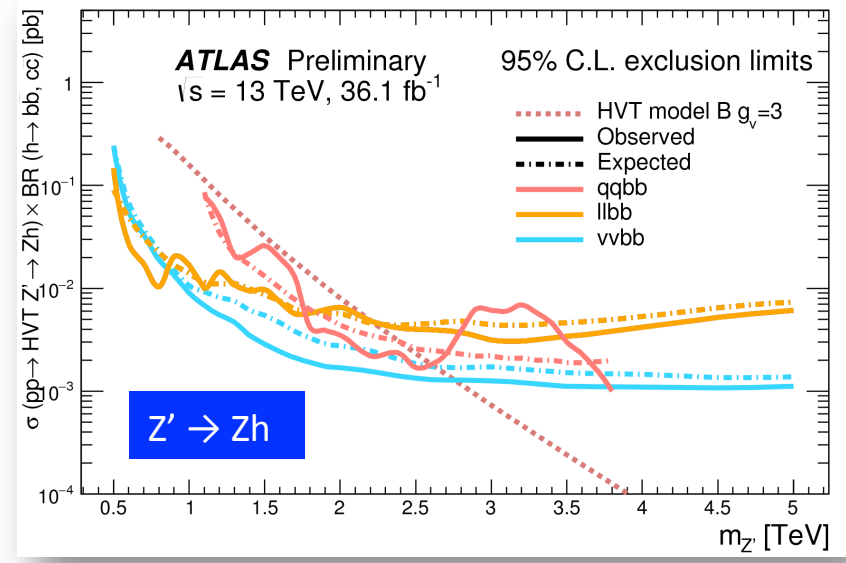
WW Selection				
Excluded Masses	HVT		RS G_{KK}	
	Model A	Model B	$k/\bar{M}_{Pl} = 1.0$	
Observed	<2750 GeV	<3090 GeV	<1760 GeV	
Expected	<2840 GeV	<3230 GeV	<1750 GeV	

WZ Selection			
Excluded Masses	HVT		
	Model A	Model B	
Observed	<2820 GeV	<2980 GeV	
Expected	<2890 GeV	<3240 GeV	

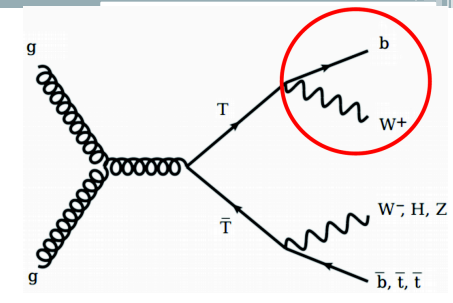


Dibosons – summary

$\sigma \times \text{BR}$ upper limits for Heavy Vector Triplets decaying to dibosons for different final states



Vector-Like Quarks (VLQs): $T \rightarrow Wb$

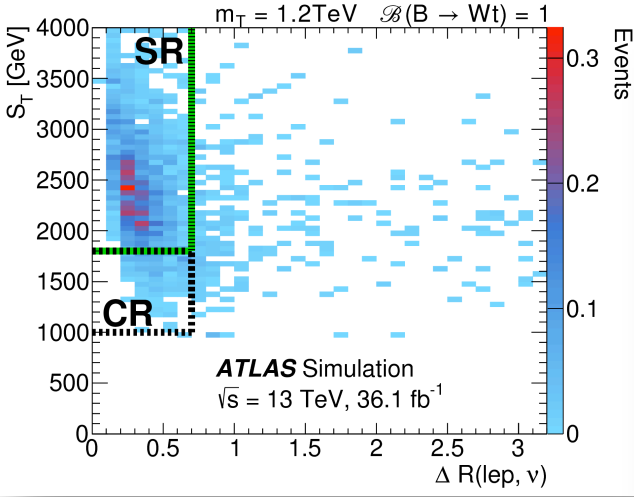


- VLQs proposed to cancel quadratic divergences in Higgs mass
- Predicted in Little/Composite Higgs
- Production: pair (QCD) or single (EW)
- Decays:
 - $T \rightarrow Wb / Zt / Ht$
 - $B \rightarrow Wt / Zb / Hb$

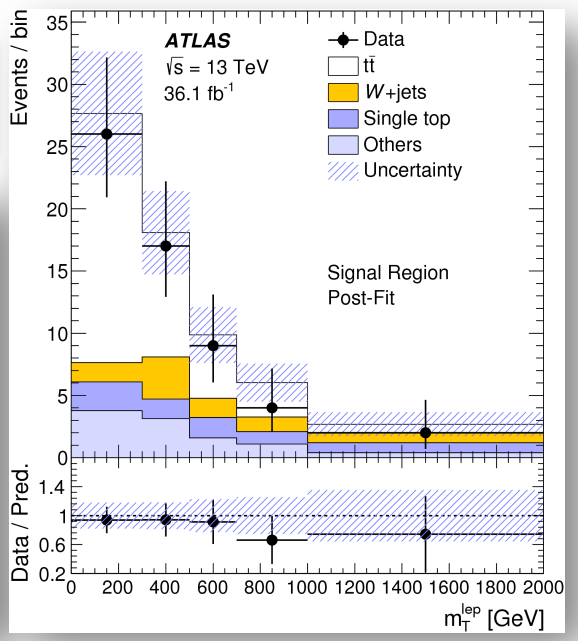
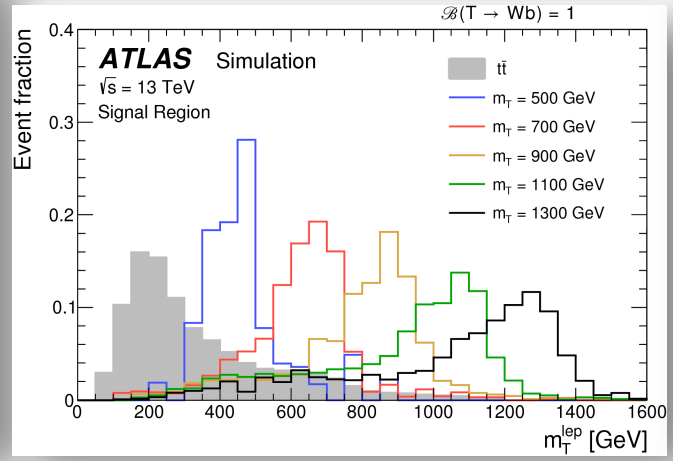
- $T \rightarrow Wb$ analysis**
 - 1 lepton, MET, ≥ 3 jets, ≥ 1 b-jet
 - ≥ 1 W-tagged large-R jet, no overlap with b-jet
- Full event reconstruction by minimising $|\Delta m_T|$
- Profile likelihood fit to improve BG modelling
 - $\Delta R(\ell, \nu)$ & S_T cut to define SR/CR
 - discriminating variable: m_T^{lep}

36.1 fb⁻¹ @ 13 TeV

[arXiv:1707.03347](https://arxiv.org/abs/1707.03347)



No significant deviation from SM expectation is observed



VLQs: $T \rightarrow Wb$ results

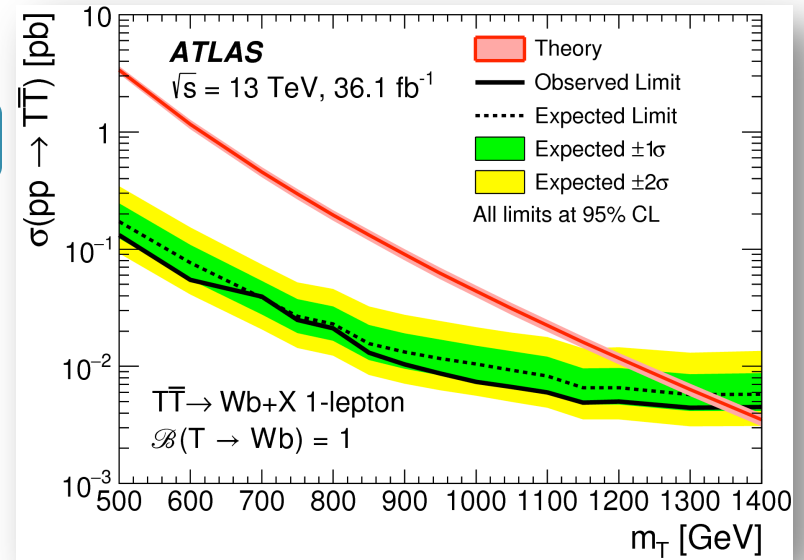
- Uncertainties

- dominated by low statistics
- main systematics: t & \bar{t} modelling

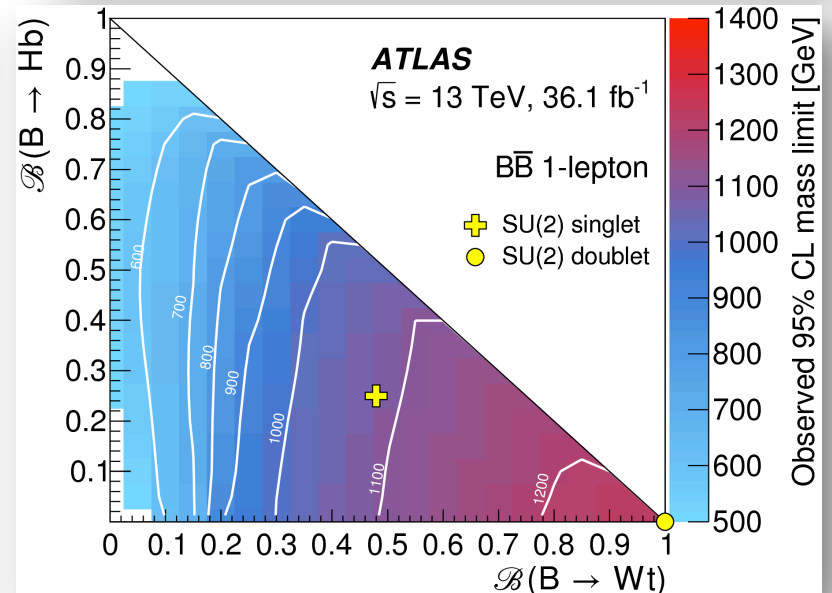
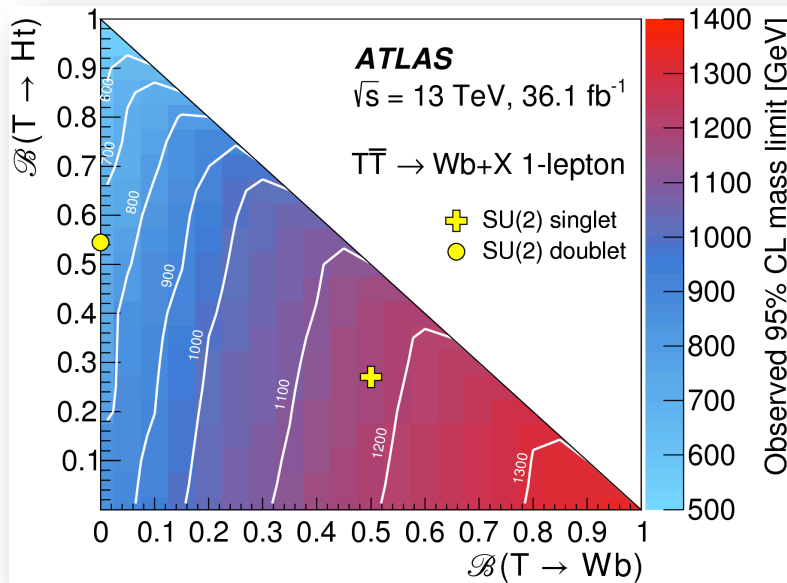
36.1 fb⁻¹ @ 13 TeV

- Significantly improved limits w.r.t. Run I

- $m_{T/Y} (BR_{Wb}=100\%) > 1350$ (782) GeV
- m_T (singlet) > 1170 GeV
- $m_{B/X} (BR_{Wt}=100\%) > 1250$ GeV
- m_B (singlet) > 1180 GeV

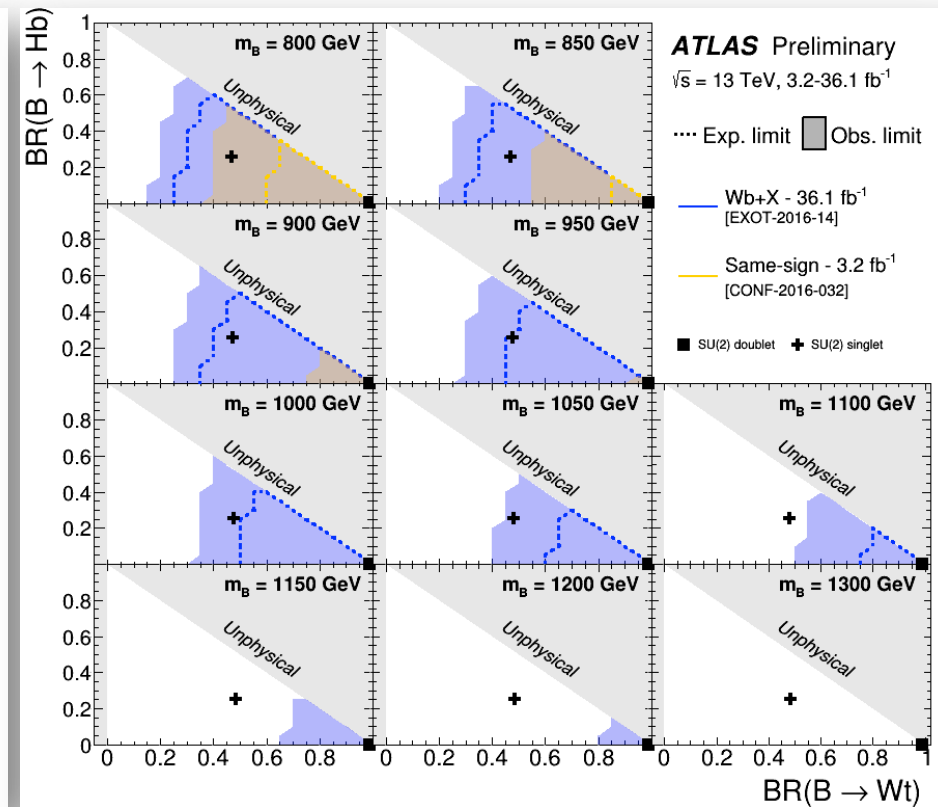
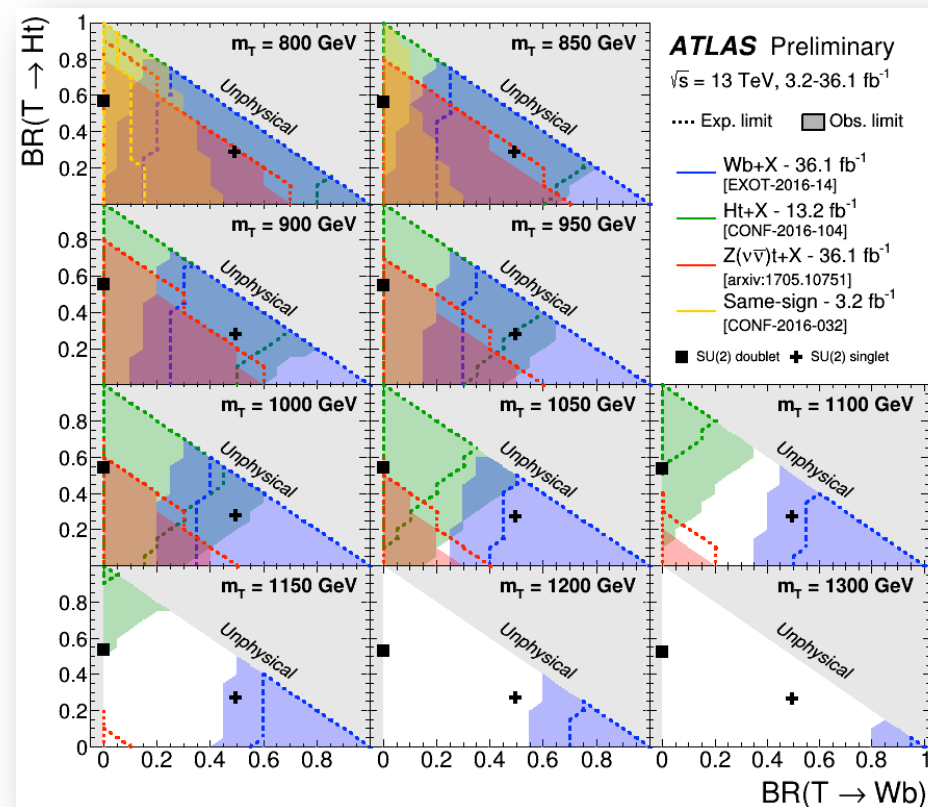


arXiv:1707.03347



VLQ summary

- All decays of vector-like T quark considered: **Wb** / **Zt** / **Ht**
- Vector-like B decays not yet fully covered: only **Wt** / **Hb** included
- Analyses make use of boosted decays at 13 TeV



... in a nutshell

ATLAS Exotics Searches* - 95% CL Upper Exclusion Limits

Status: July 2017

ATLAS Preliminary

$$\int \mathcal{L} dt = (3.2 - 37.0) \text{ fb}^{-1}$$

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

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 $\gamma\gamma$	2γ	-	-	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 Σp_T	$\geq 1 e, \mu$	$\geq 2 j$	-	3.2	M_{th} 8.2 TeV	$n = 6, M_D = 3 \text{ TeV}$, rot BH 1606.02265
	ADD BH multijet	-	$\geq 3 j$	-	3.6	M_{th} 9.55 TeV	$n = 6, M_D = 3 \text{ TeV}$, rot BH 1512.02586
	RS1 $G_{KK} \rightarrow \gamma\gamma$	2γ	-	-	36.7	G_{KK} mass 4.1 TeV	$k/\bar{M}_{Pl} = 0.1$ CERN-EP-2017-132
	Bulk RS $G_{KK} \rightarrow WW \rightarrow qq\ell\nu$	$1 e, \mu$	1 J	Yes	36.1	G_{KK} mass 1.75 TeV	$k/\bar{M}_{Pl} = 1.0$ ATLAS-CONF-2017-051
	2UED / RPP	$1 e, \mu$	$\geq 2 b, \geq 3 j$	Yes	13.2	KK mass 1.6 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \rightarrow t\bar{t}) = 1$ ATLAS-CONF-2016-104
Gauge bosons	SSM $Z' \rightarrow \ell\ell$	$2 e, \mu$	-	-	36.1	Z' mass 4.5 TeV	ATLAS-CONF-2017-027
	SSM $Z' \rightarrow \tau\tau$	2τ	-	-	36.1	Z' mass 2.4 TeV	ATLAS-CONF-2017-050
	Leptophobic $Z' \rightarrow bb$	-	2 b	-	3.2	Z' mass 1.5 TeV	1603.08791
	Leptophobic $Z' \rightarrow tt$	$1 e, \mu$	$\geq 1 b, \geq 1J/2j$	Yes	3.2	Z' mass 2.0 TeV	$\Gamma/m = 3\%$ ATLAS-CONF-2016-014
	SSM $W' \rightarrow \ell\nu$	$1 e, \mu$	-	-	36.1	W' mass 5.1 TeV	1706.04786
	HVT $V' \rightarrow WW \rightarrow qq\bar{q}q$ model B	$0 e, \mu$	2 J	-	36.7	V' mass 3.5 TeV	$g_V = 3$ CERN-EP-2017-147
	HVT $V' \rightarrow WH/ZH$ model B	multi-channel	-	-	36.1	V' mass 2.93 TeV	ATLAS-CONF-2017-055
	LRSM $W'_R \rightarrow tb$	$1 e, \mu$	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV	1410.4103
LRSM $W'_R \rightarrow tb$	$0 e, \mu$	$\geq 1 b, 1 J$	-	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 $uutt$	$2(SS) \geq 3 e, \mu \geq 1 b, \geq 1 j$	Yes	20.3	Λ 4.9 TeV	$ C_{RR} = 1$ 1504.04605	
DM	Axial-vector mediator (Dirac DM)	$0 e, \mu$	1-4 j	Yes	36.1	m_{med} 1.5 TeV	$g_q = 0.25, g_\tau = 1.0, m(\chi) < 400 \text{ GeV}$ ATLAS-CONF-2017-060
	Vector mediator (Dirac DM)	$0 e, \mu, 1 \gamma$	$\leq 1 j$	Yes	36.1	m_{med} 1.2 TeV	$g_q = 0.25, g_\tau = 1.0, m(\chi) < 480 \text{ GeV}$ 1704.03848
	VV $\chi\chi$ EFT (Dirac DM)	$0 e, \mu$	1 J, $\leq 1 j$	Yes	3.2	M_* 700 GeV	$m(\chi) < 150 \text{ GeV}$ 1608.02372
LQ	Scalar LQ 1 st gen	$2 e$	$\geq 2 j$	-	3.2	LQ mass 1.1 TeV	$\beta = 1$ 1605.06035
	Scalar LQ 2 nd gen	2μ	$\geq 2 j$	-	3.2	LQ mass 1.05 TeV	$\beta = 1$ 1605.06035
	Scalar LQ 3 rd gen	$1 e, \mu$	$\geq 1 b, \geq 3 j$	Yes	20.3	LQ mass 640 GeV	$\beta = 0$ 1508.04735
Heavy quarks	VLQ $TT \rightarrow Ht + X$	0 or $1 e, \mu$	$\geq 2 b, \geq 3 j$	Yes	13.2	T mass 1.2 TeV	$\mathcal{B}(T \rightarrow Ht) = 1$ ATLAS-CONF-2016-104
	VLQ $TT \rightarrow Zt + X$	$1 e, \mu$	$\geq 1 b, \geq 3 j$	Yes	36.1	T mass 1.16 TeV	$\mathcal{B}(T \rightarrow Zt) = 1$ 1705.10751
	VLQ $TT \rightarrow Wb + X$	$1 e, \mu$	$\geq 1 b, \geq 1J/2j$	Yes	36.1	T mass 1.35 TeV	$\mathcal{B}(T \rightarrow Wb) = 1$ CERN-EP-2017-094
	VLQ $BB \rightarrow Hb + X$	$1 e, \mu$	$\geq 2 b, \geq 3 j$	Yes	20.3	B mass 700 GeV	$\mathcal{B}(B \rightarrow Hb) = 1$ 1505.04306
	VLQ $BB \rightarrow Zb + X$	$2/\geq 3 e, \mu$	$\geq 2/\geq 1 b$	-	20.3	B mass 790 GeV	$\mathcal{B}(B \rightarrow Zb) = 1$ 1409.5500
	VLQ $BB \rightarrow Wt + X$	$1 e, \mu$	$\geq 1 b, \geq 1J/2j$	Yes	36.1	B mass 1.25 TeV	$\mathcal{B}(B \rightarrow Wt) = 1$ CERN-EP-2017-094
VLQ $QQ \rightarrow WqWq$	$1 e, \mu$	$\geq 4 j$	Yes	20.3	Q mass 690 GeV	1509.04261	
Excited fermions	Excited quark $q^* \rightarrow qg$	-	2 j	-	37.0	q^* mass 6.0 TeV	only u^* and d^* , $\Lambda = m(q^*)$ 1703.09127
	Excited quark $q^* \rightarrow q\gamma$	1γ	1 j	-	36.7	q^* mass 5.3 TeV	only u^* and d^* , $\Lambda = m(q^*)$ CERN-EP-2017-148
	Excited quark $b^* \rightarrow bg$	-	1 b, 1 j	-	13.3	b^* mass 2.3 TeV	ATLAS-CONF-2016-060
	Excited quark $b^* \rightarrow Wt$	1 or $2 e, \mu$	1 b, 2-0 j	Yes	20.3	b^* mass 1.5 TeV	$f_k = f_l = f_R = 1$ 1510.02664
	Excited lepton ℓ^*	$3 e, \mu$	-	-	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0 \text{ TeV}$ 1411.2921
	Excited lepton ν^*	$3 e, \mu, \tau$	-	-	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6 \text{ TeV}$ 1411.2921
Other	LRSM Majorana ν	$2 e, \mu$	2 j	-	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4 \text{ TeV}$, no mixing 1506.06020
	Higgs triplet $H^{\pm\pm} \rightarrow \ell\ell$	$2, 3, 4 e, \mu$ (SS)	-	-	36.1	$H^{\pm\pm}$ mass 870 GeV	DY production ATLAS-CONF-2017-053
	Higgs triplet $H^{\pm\pm} \rightarrow \ell\tau$	$3 e, \mu, \tau$	-	-	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, $\mathcal{B}(H^{\pm\pm} \rightarrow \tau\tau) = 1$ 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, $ q = 5e$ 1504.04188
	Magnetic monopoles	-	-	-	7.0	monopole mass 1.34 TeV	DY production, $ g = 1g_D$, spin 1/2 1509.08059

$\sqrt{s} = 8 \text{ TeV}$ $\sqrt{s} = 13 \text{ TeV}$

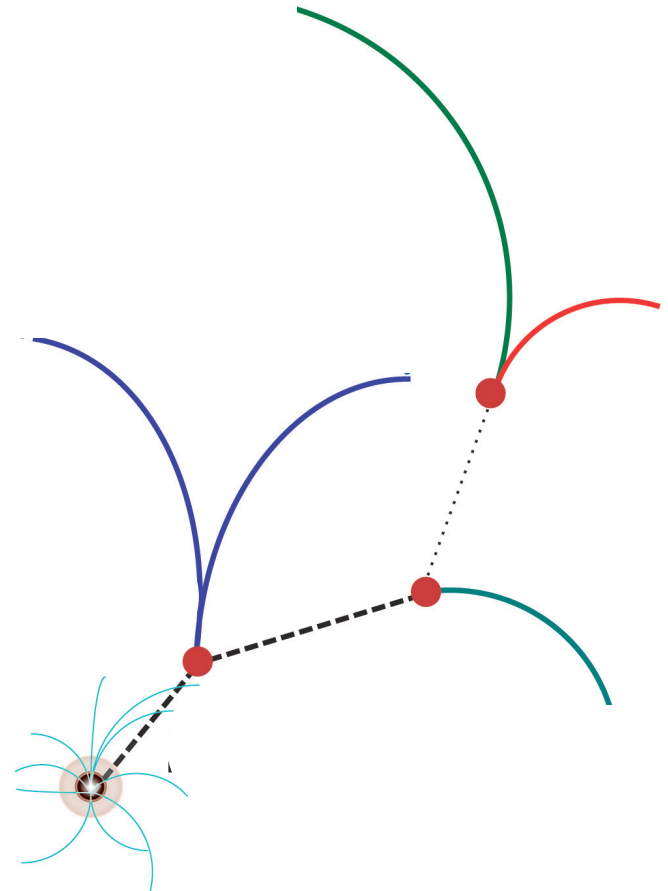
10⁻¹ 1 10 Mass scale [TeV]

*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).

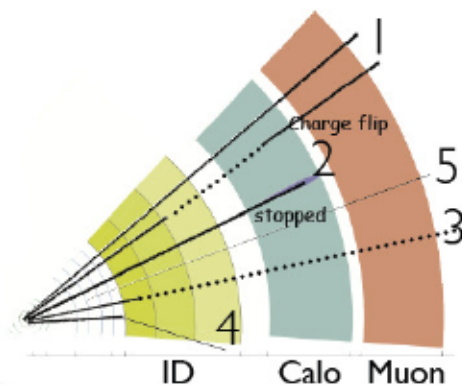
Long-lived particles

- Most recent results @ 13 TeV presented here
- Searches for supersymmetric particles
- Many more searches for non-SUSY are underway with 13 TeV data



Stable or metastable particles

- Long-lived decays of spartners possible in several frameworks, including
 - nearly conserved symmetry
 - e.g. long lived gluinos or squarks that hadronise before decaying
→ R-hadrons in Split SUSY
 - low coupling between the particle and the final state
 - e.g. weak R-parity violating (RPV) couplings in SUSY
 - mass degeneracy between the particle and the final state
- Depending on the lifetime, different detection techniques involving various objects: tracks, photons, leptons, ...



(1) **Slow, large dE/dx**

~ 1000 mm

(2) **Slow, stopped**

(3) **Disappearing track**

~ 100 mm

(4) **Kinked track**

(5) **displaced track**

~ 10 mm

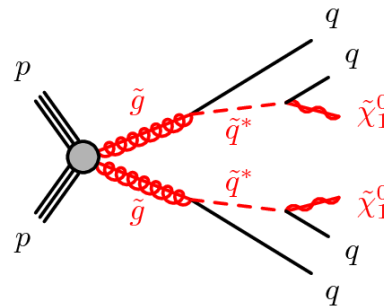


Longer lifetime

Displaced vertices (1/2)

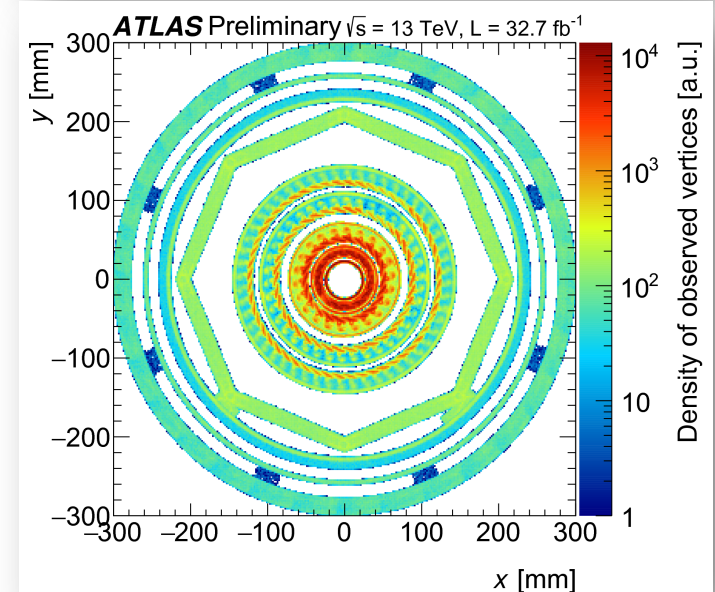
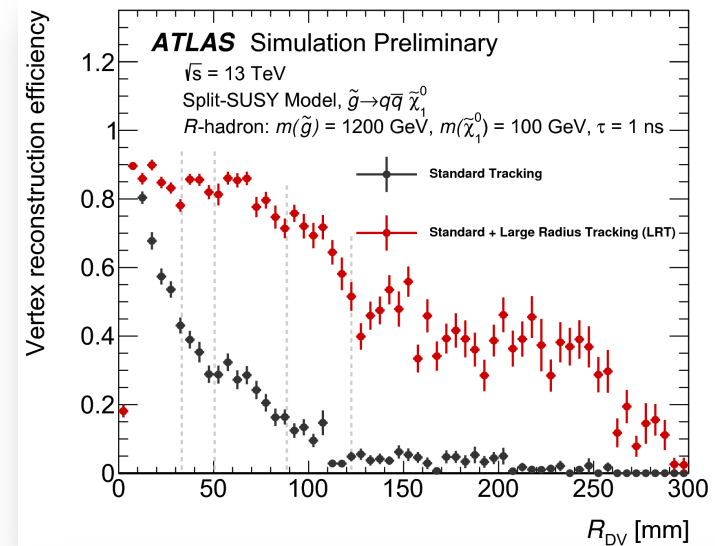
- Metastable particles decaying in the Inner Detector
 - predicted in models of RPV SUSY or split-SUSY
 - benchmark signal: gluino hadronising into an R-hadron

32.7 fb⁻¹ @ 13 TeV



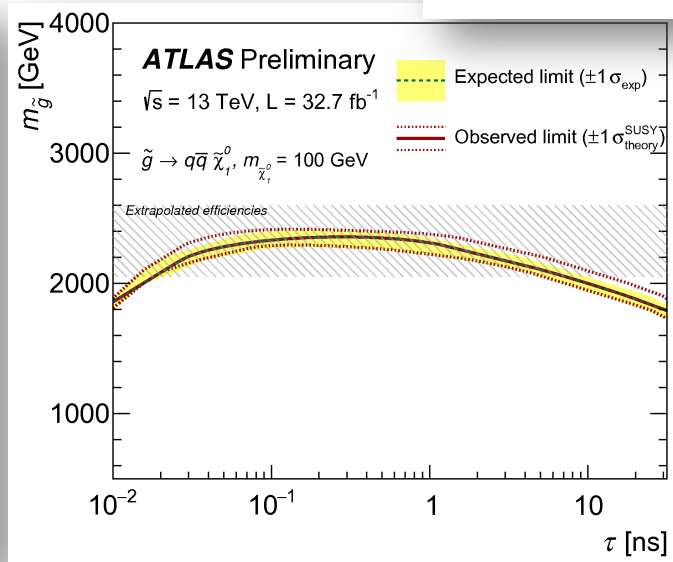
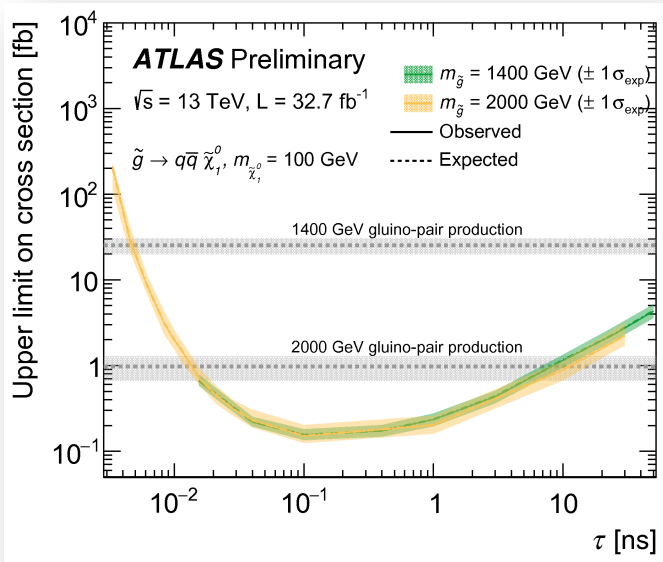
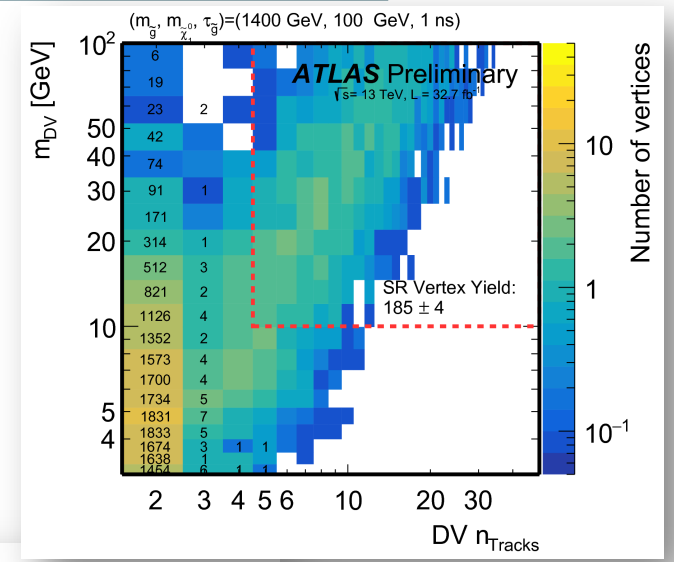
- **Large-radius tracking:** re-running standard track and vertex reconstruction improves signal efficiency at large radii
- **Backgrounds:** instrumental and estimated from data
 - high track multiplicity hadronic interactions
 - DV in regions with high material density vetoed
 - merged DV extrapolated from low- n_{trk} region
- Background estimate validated in signal-depleted regions

ATLAS-CONF-2017-026



Displaced vertices (2/2)

- SR defined as a DV with **mass > 10 GeV** and **high track multiplicity (> 5 tracks)**
- **No event is observed in the SR, compatible with a bkg. expectation of 0.2 ± 0.2 events**



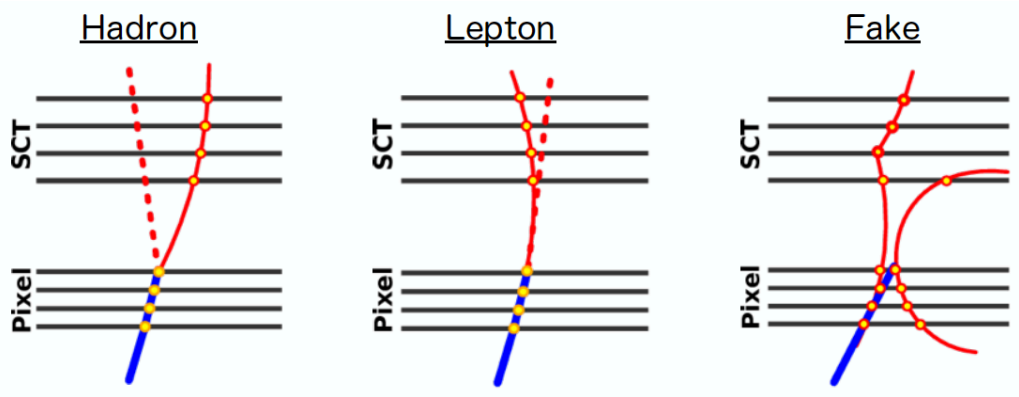
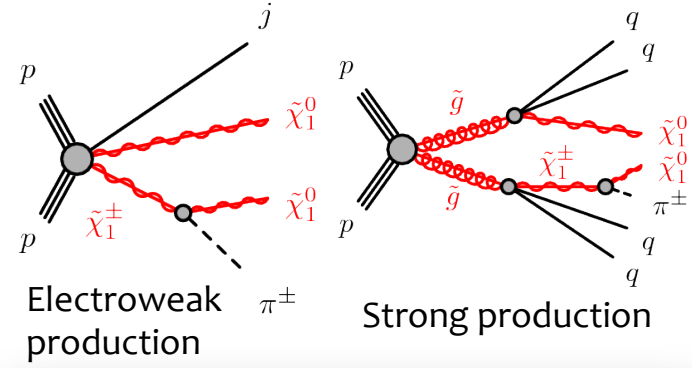
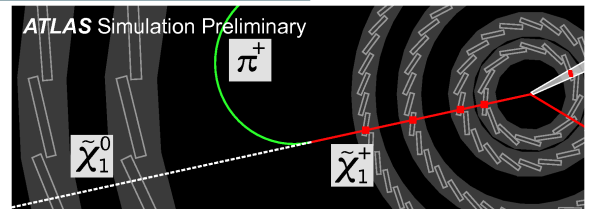
32.7 fb⁻¹ @ 13 TeV

ATLAS-CONF-2017-026

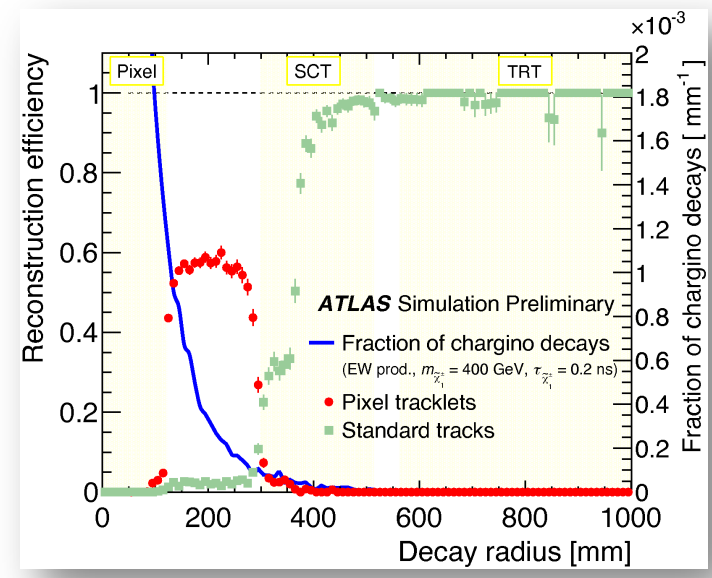
- Limits are set on gluino R-hadrons as a function of masses and lifetime
- For a lifetime of **1 ns**, gluino masses up to **2.2 TeV** are excluded

Disappearing track (1/2)

- Decays to invisible products in the Inner Detector
 - **chargino and neutralino nearly degenerate**, the soft pions in the decay are not reconstructed
 - for **wino LSP** generic prediction of ~ 160 MeV splittings, or lifetimes of ~ 0.2 ns $\gg 6$ cm
- **Pixel tracklets (\equiv pixel-only tracks)**: 10 \times increase in acceptance over standard tracks for low lifetimes
- Backgrounds estimated by a simultaneous fit to the **tracklet p_T** distribution



Background configurations

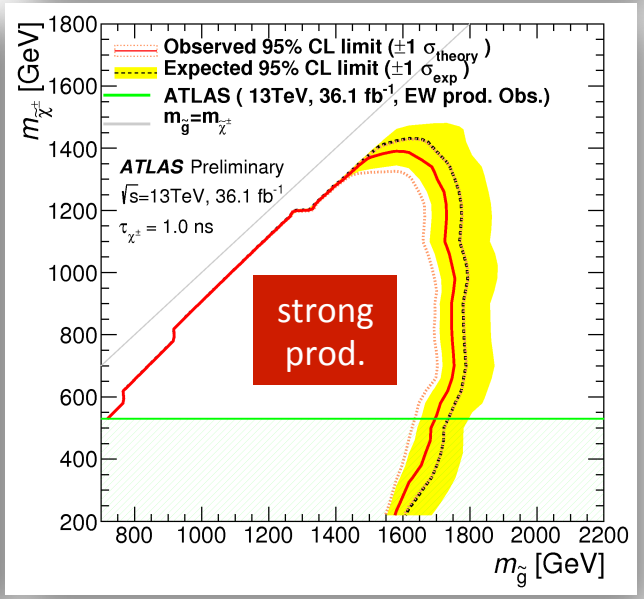
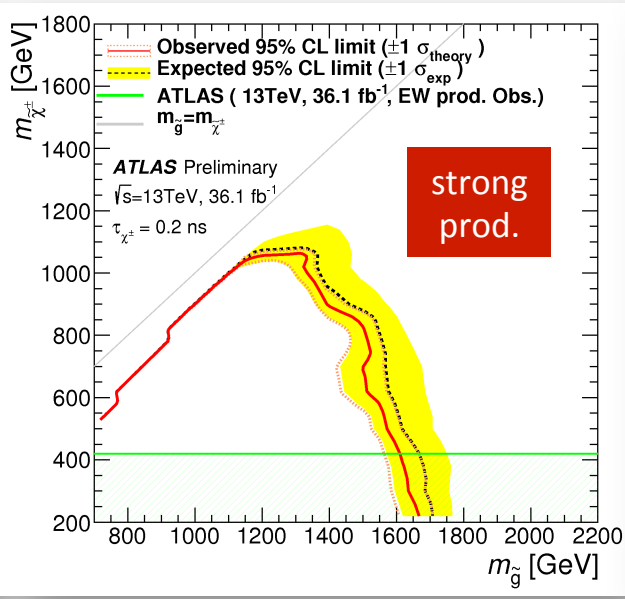
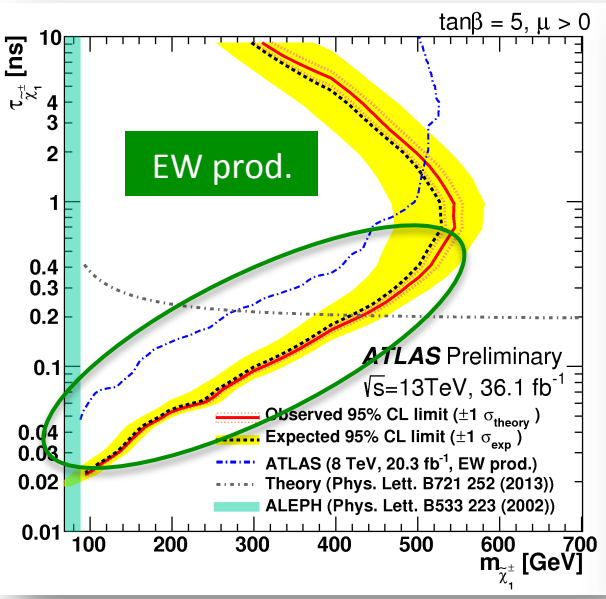
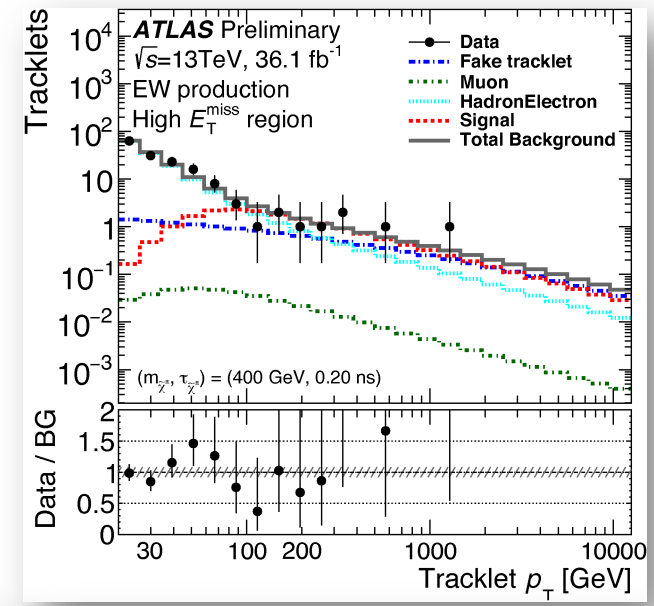


36.1 fb⁻¹ @ 13 TeV

Disappearing track (2/2)

- No significant excess is observed
- EWK production limits significantly improved at low lifetimes** ($c\tau \lesssim 12$ cm)
 - thanks to new **insertable pixel B-layer (IBL)** installed during long shutdown ($r \sim 3$ cm)
- Strong production: reaching **1.4 (1.1) TeV** in chargino mass for lifetimes of **1.0 (0.2) ns**

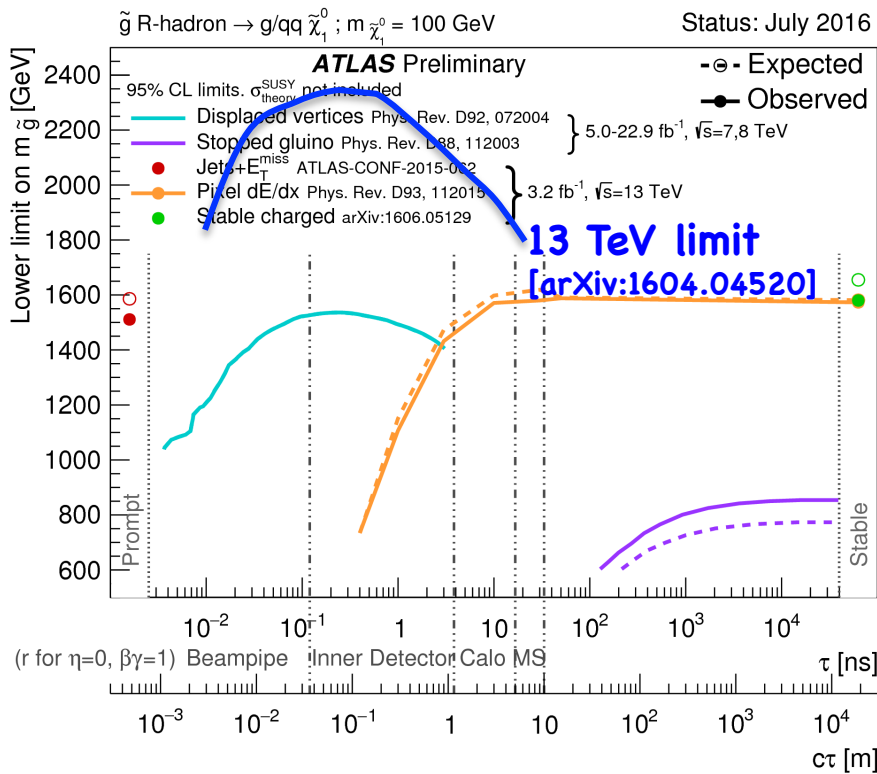
36.1 fb⁻¹ @ 13 TeV



Long-lived particles in SUSY - summary

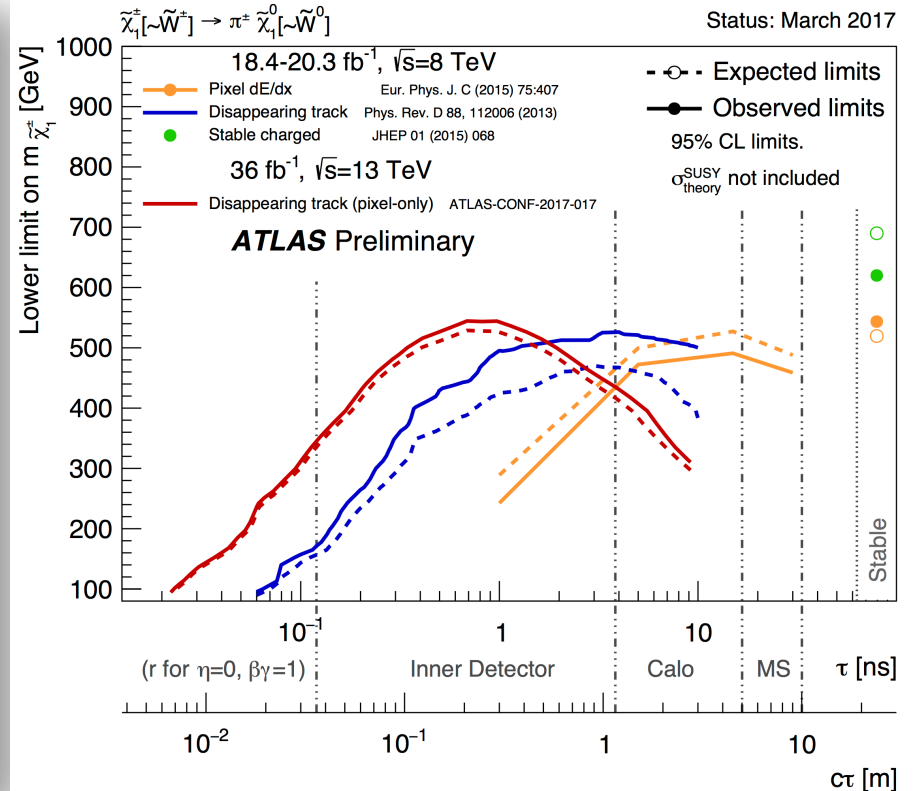
8-TeV results on R-hadrons

Split SUSY with metastable $\tilde{g} \rightarrow g/q\bar{q} \tilde{\chi}_1^0$



Summary 8-TeV & 13 TeV on disappearing track

Long lived chargino, $\tilde{\chi}_1^\pm \rightarrow \pi^\pm \tilde{\chi}_1^0$



Summary

- Standard Model limitations imperatively call for Physics beyond it, extending and complementing it
- ATLAS has searched for physics BSM at TeV scale in a variety of signatures inspired by a multitude of theoretical scenarios
- **No significant deviation from SM expectations observed so far**
- **LHC Run 2 new data may reveal hints of New Physics**
 - ATLAS is well-prepared to make the most of them
 - analysis continuously improved with new trigger and/or reconstruction techniques



Continuously updated public results:

<https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ExoticsPublicResults>

... for 2017 run results

Thank you for
your attention!

