

Searches for new physics at ATLAS

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on behalf of the ATLAS Collaboration

Introduction

- ATLAS has been collecting data since 2010, now nearing end of Run 2
- Searches for new physics have been a primary motivator for LHC physics program
- We haven't found anything yet
- Should we despair? ...

(Spoiler: no!)

Problems!

Dark matter

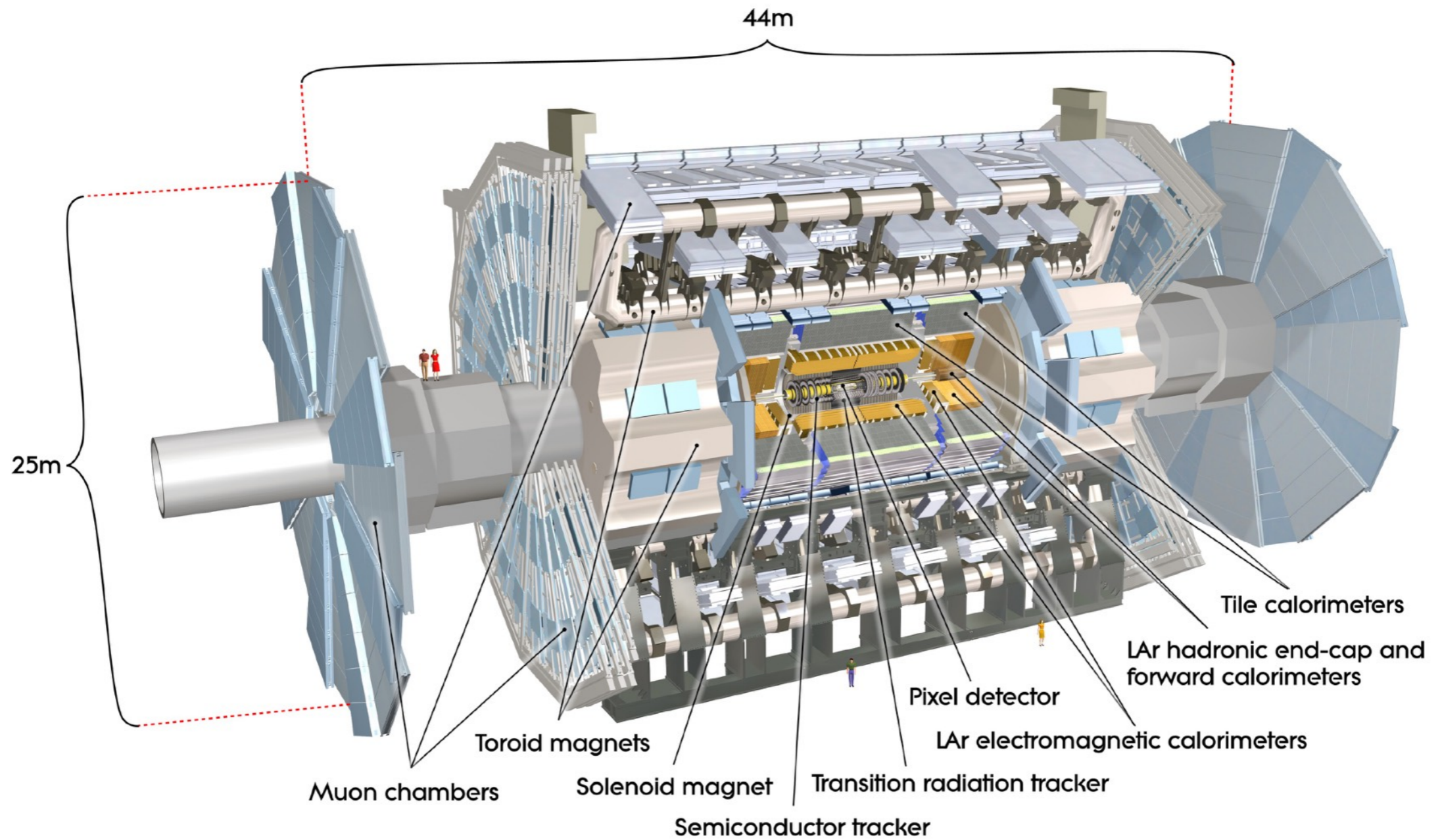
Hierarchy problem

Gauge unification

Higgs fine-tuning

....

Obligatory ATLAS experiment slide



Using simplified models, summaries, and scans
to identify research directions

How should we interpret search results so far?

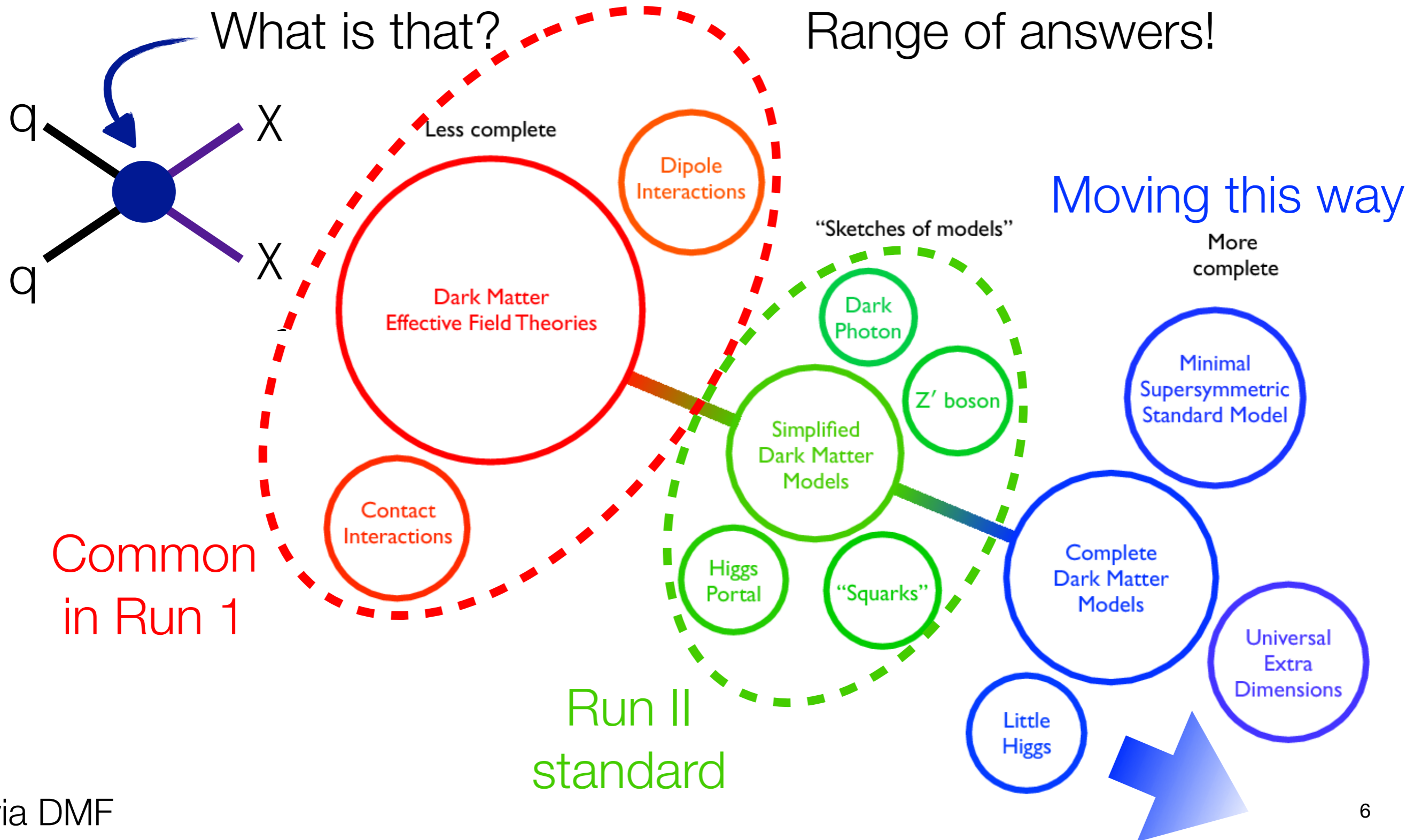
Most important statement in any search:
did we find **evidence of new physics**?

- If no, set limits! With limits, analyses prioritise making generalised statements which are as easy as possible to reinterpret in different frameworks
- Simplified models are just spherical cows but give us a framework to understand how our results relate to one another
- Summaries in context of various models help us find holes and plan next steps for search program

All models, and therefore all limits, should be taken with a
grain of salt!

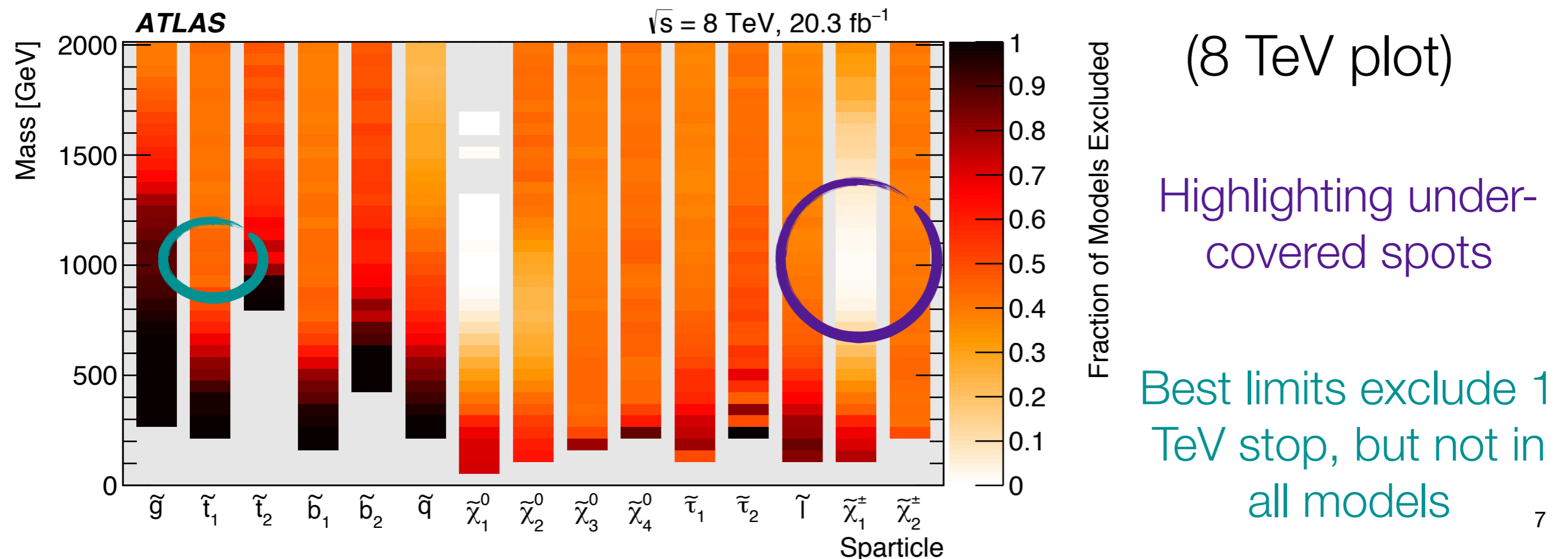
But they are important to let us **contextualise** our zeros.

Example: simplified dark matter models at ATLAS



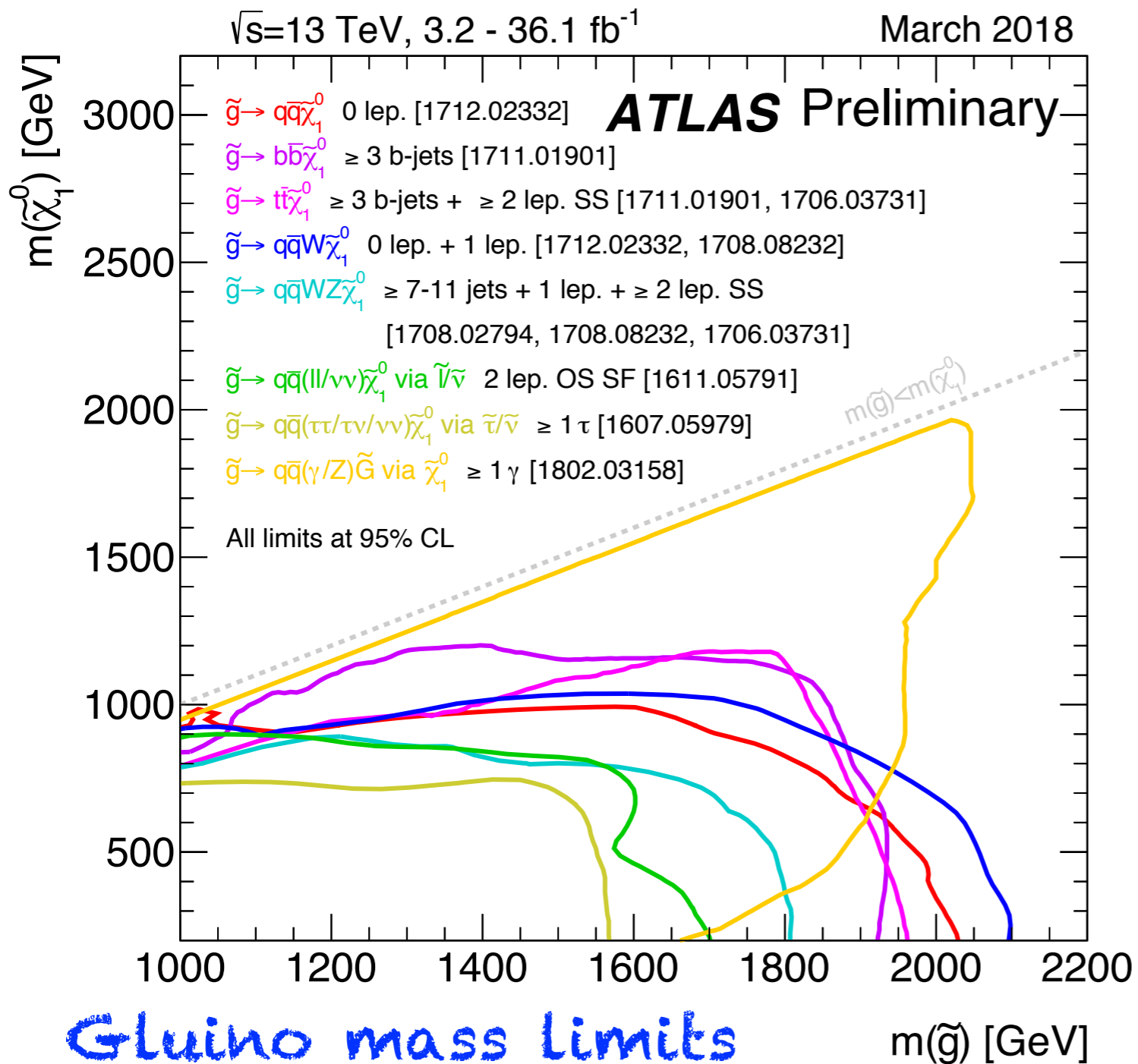
Example: PMSSM scan

- Use simplified “phenomenological” MSSM as a model generator
 - Throw toy universes with different parameters and check exclusion with analyses
 - Results reported as fraction of models excluded
- Advantages: help us find holes! Disadvantages: difficult to make meaningful statements given sparse sampling of the parameter space

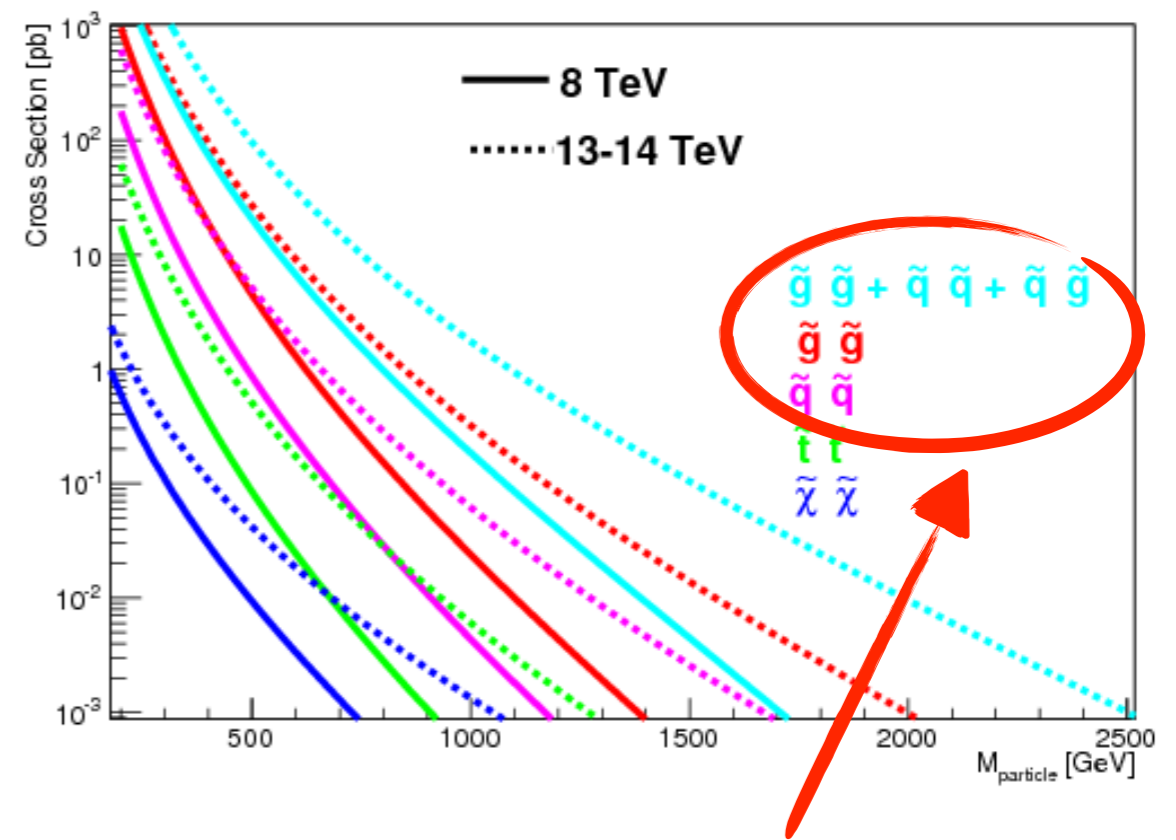


Current results in SUSY

SUSY strong production

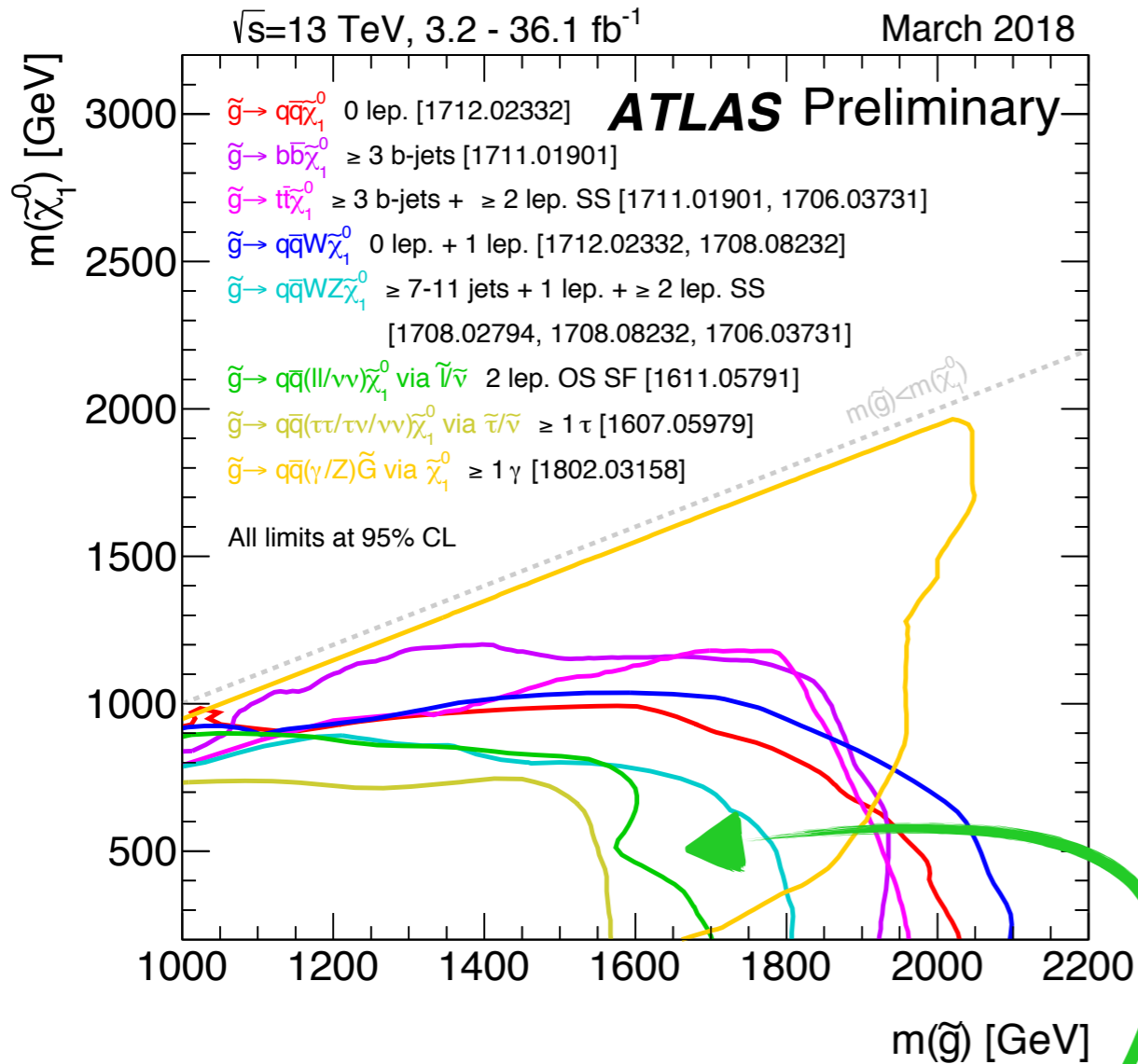
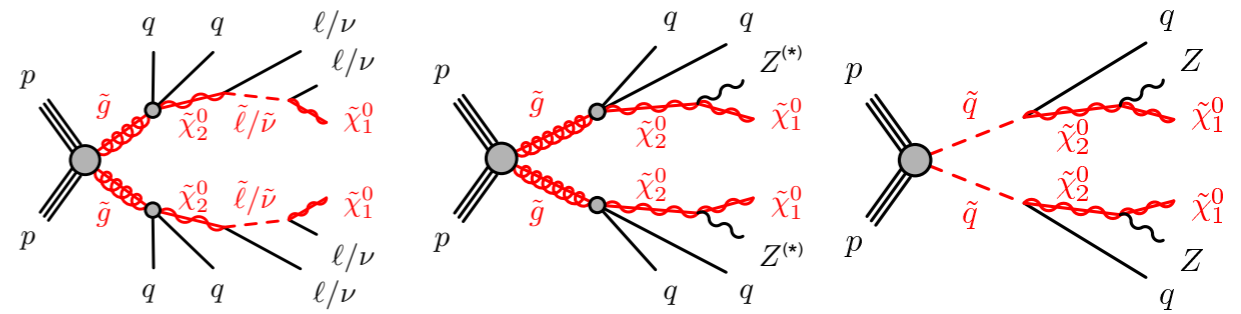


Glueino mass limits
up to ~2 TeV!



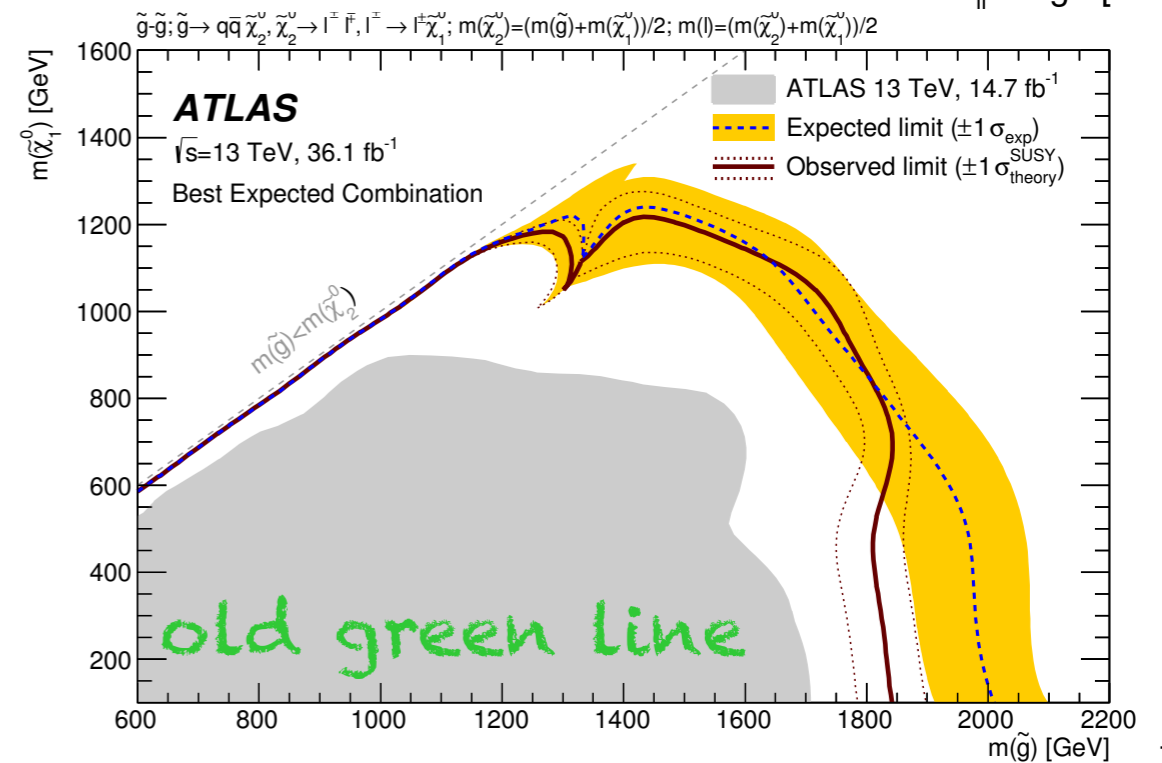
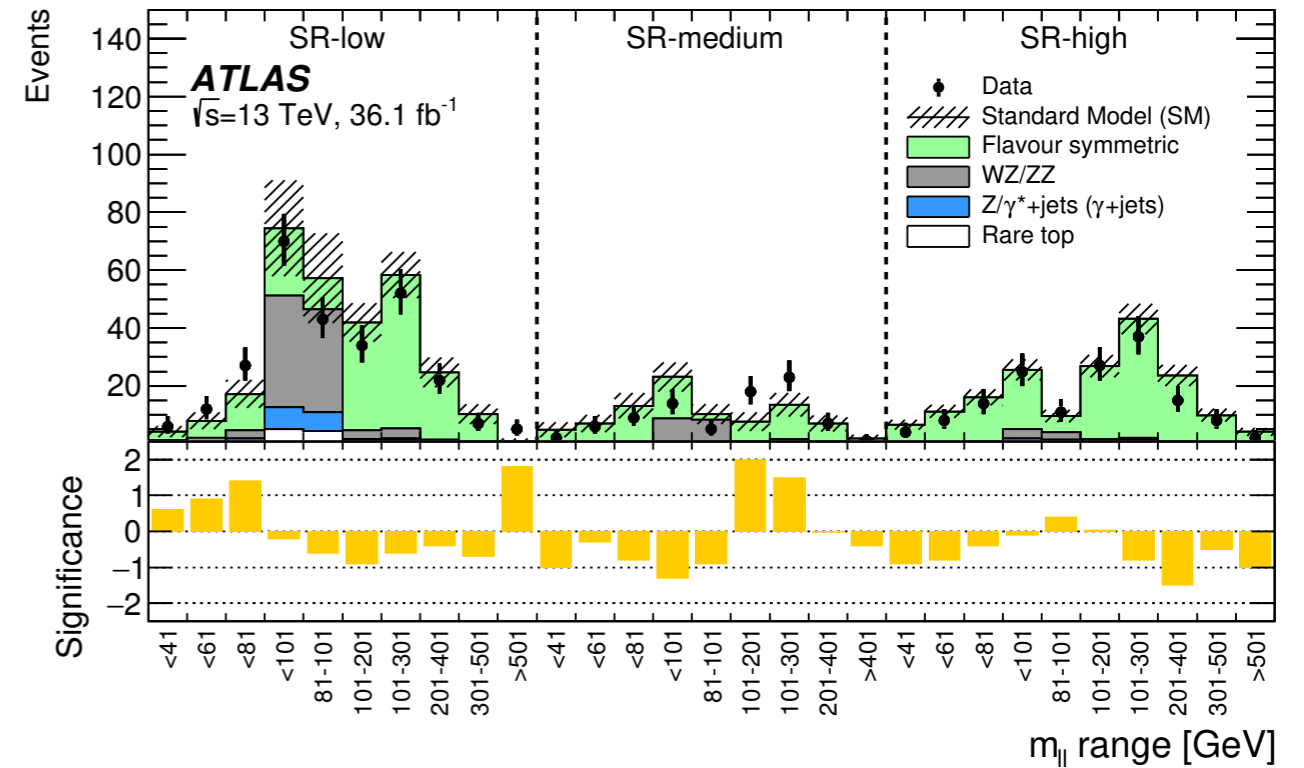
- High production σ with boost from 13 TeV \rightarrow strong motivation for early run II searches!
- Squark & gluino production gives final states with lots of hadronic activity + MET
- Strong limits with 36/fb!

Recent highlights: SUSY strong production



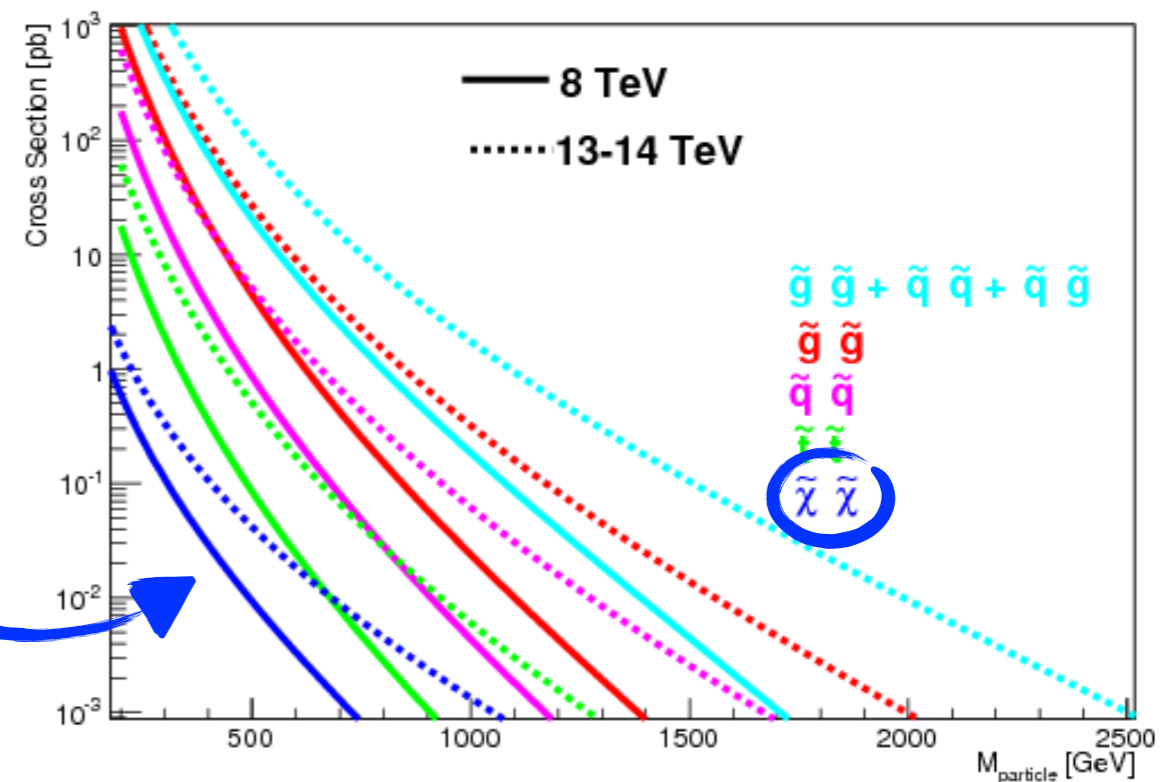
Highlight: OS-dilepton
update!

[arXiv:1805.11381](https://arxiv.org/abs/1805.11381)

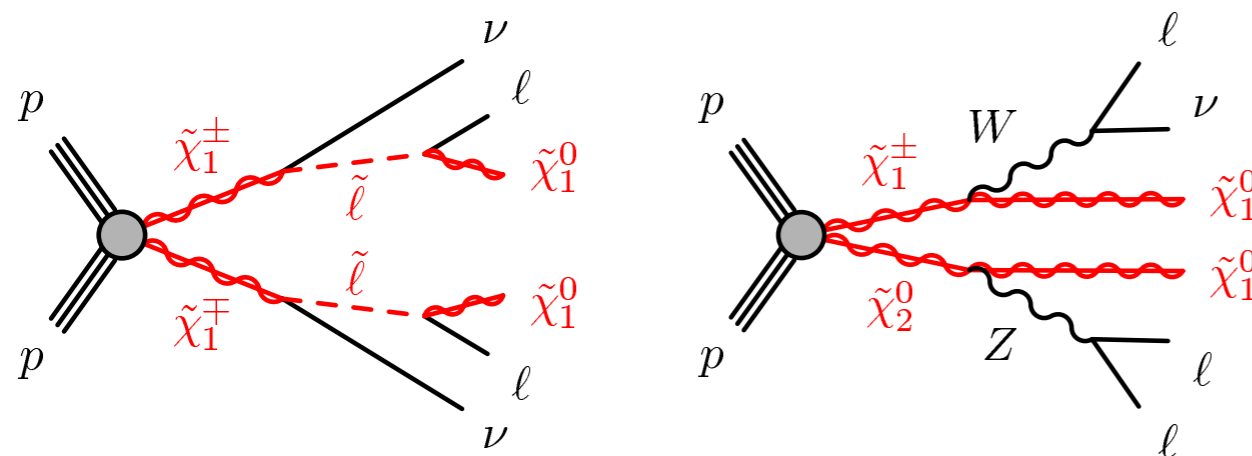


Recent highlights: EW SUSY

- Production σ for EW smaller; benefited less from CME jump
- Signature: leptons/gauge bosons+MET. Clean; main bkg from diboson, ttbar

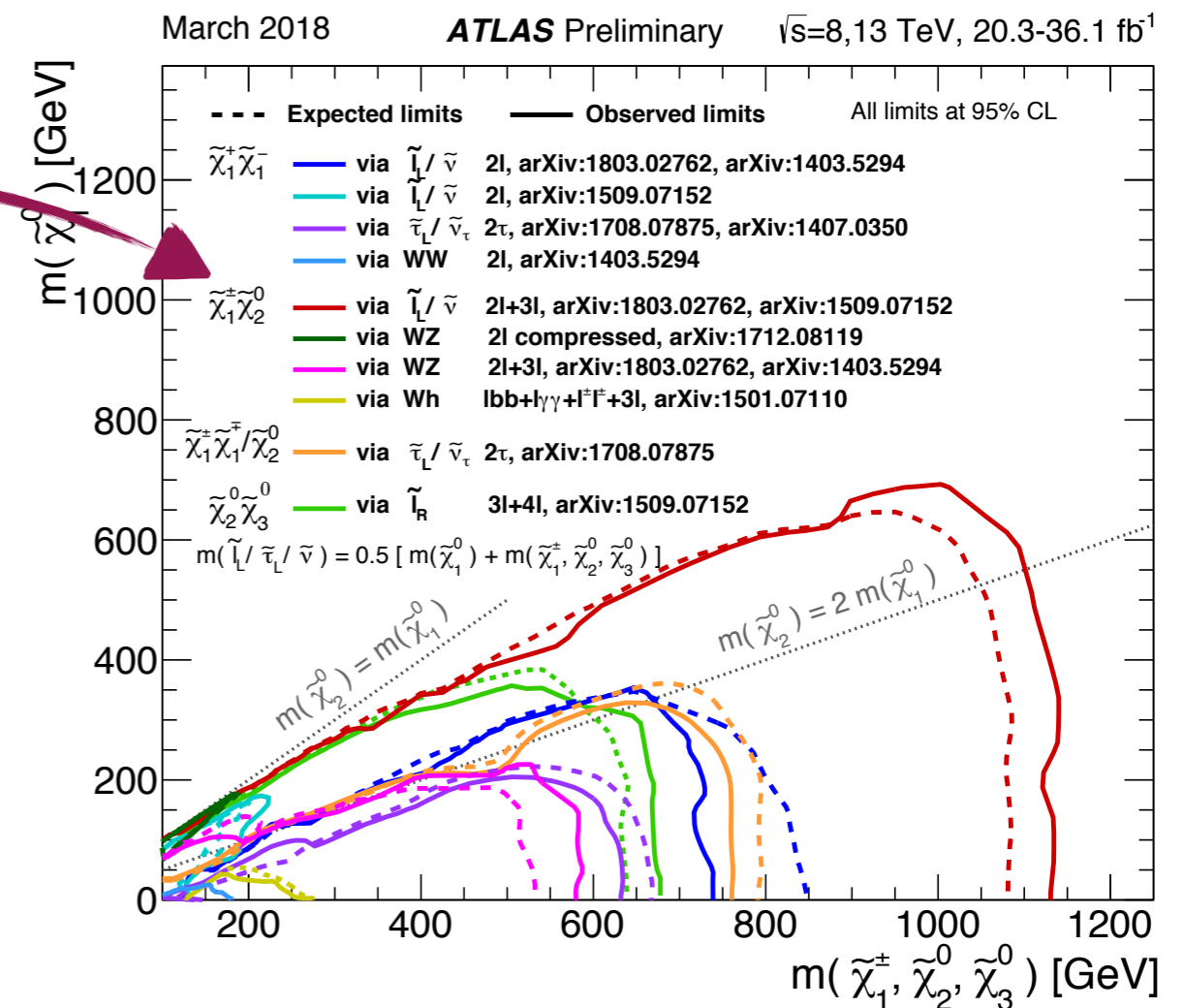


Highlight: 2/3L



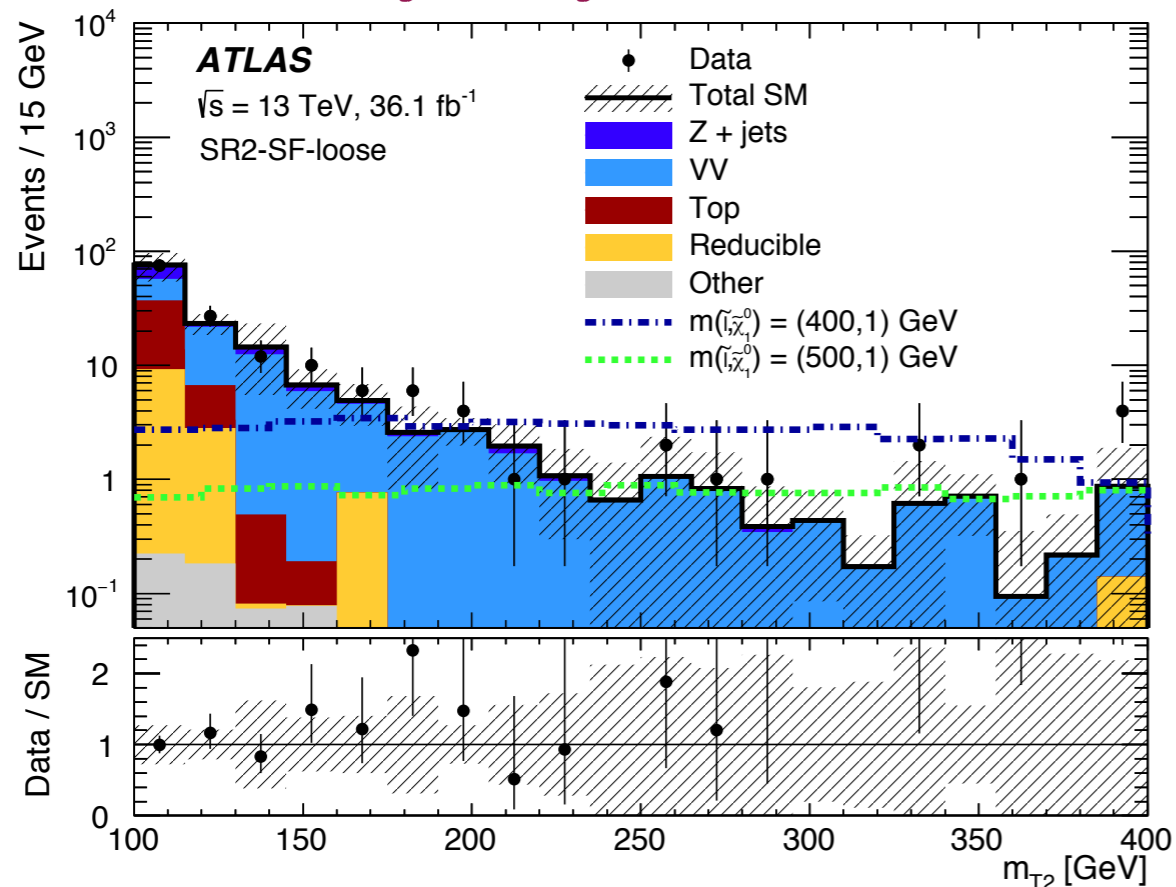
[arXiv:1803.02762](https://arxiv.org/abs/1803.02762)

+ [arXiv:1806.02293](https://arxiv.org/abs/1806.02293) (New!)



Recent highlights: EW SUSY

Highlight: 2/3L

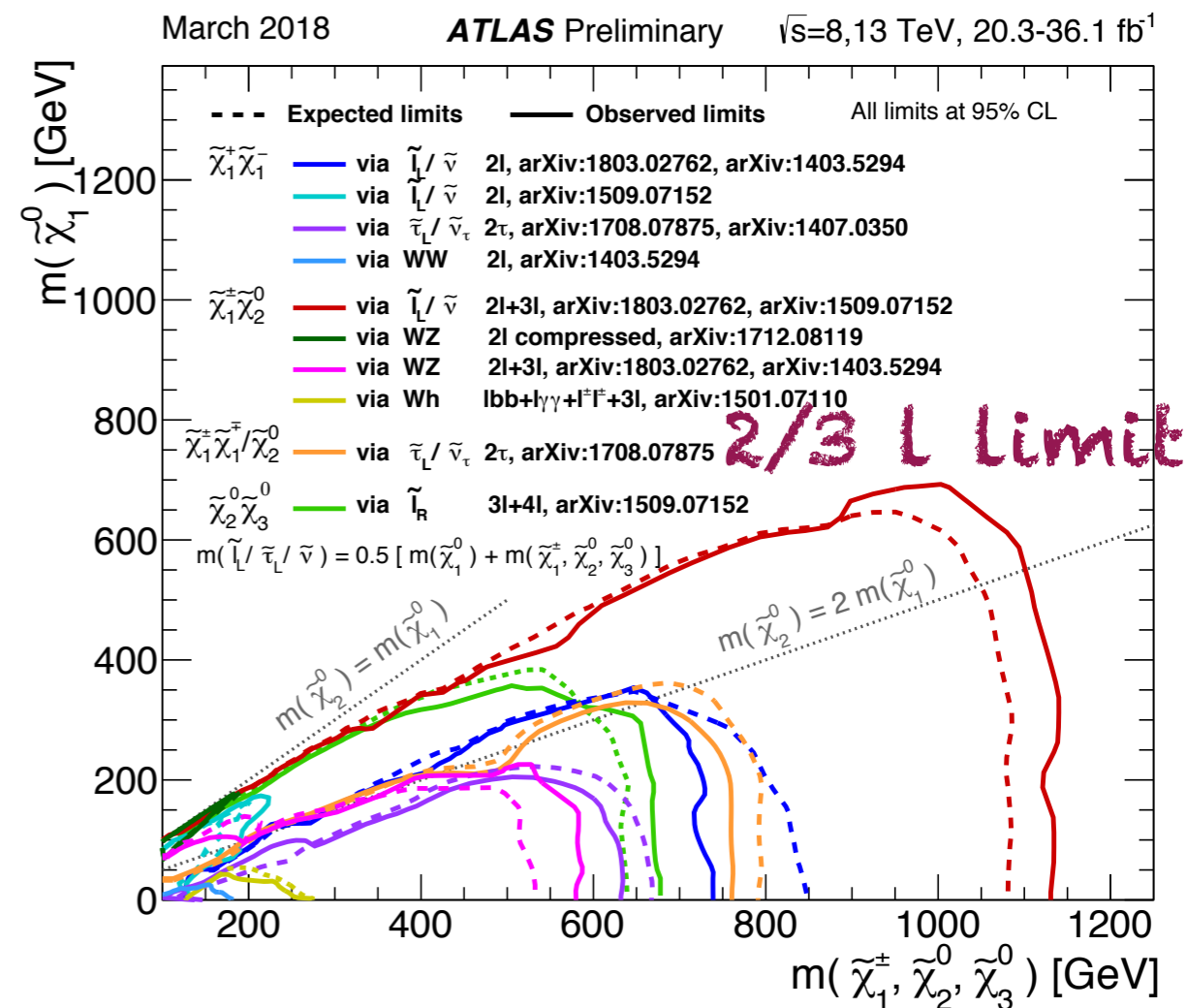
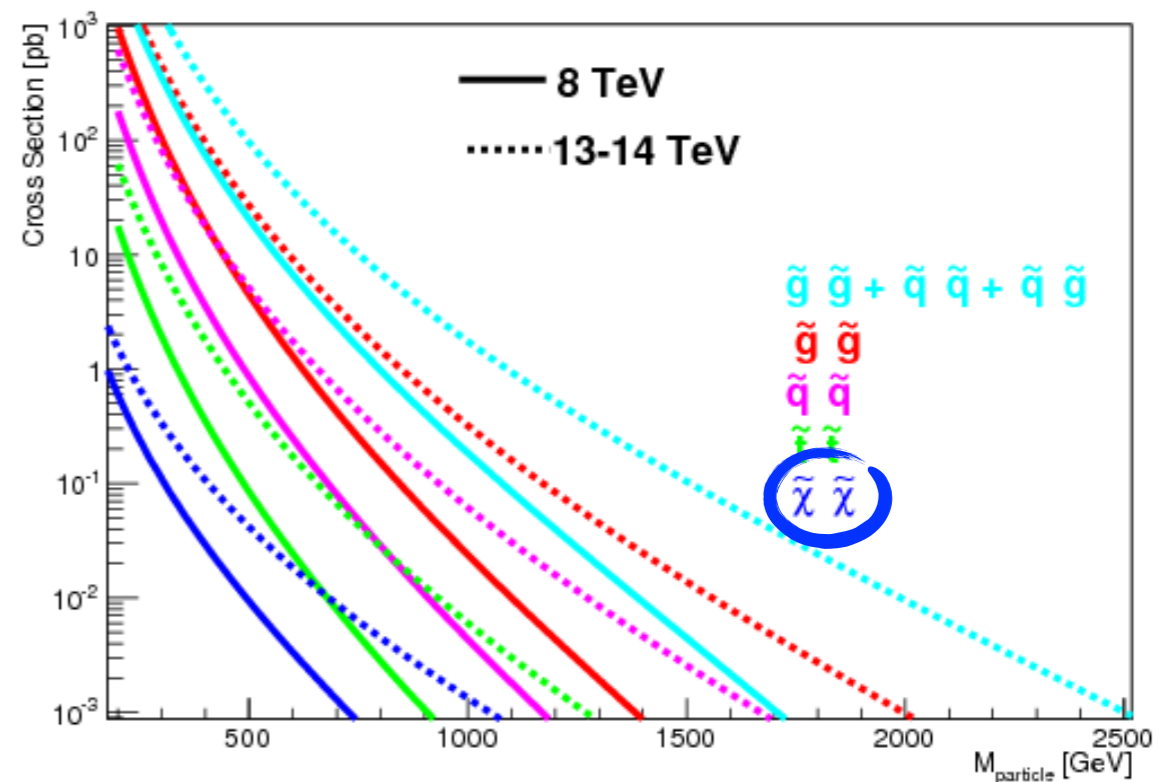


$$m_{T2} = \min_{\mathbf{q}_T} \left[\max \left(m_T(\mathbf{p}_T^{\ell 1}, \mathbf{q}_T), m_T(\mathbf{p}_T^{\ell 2}, \mathbf{p}_T^{\text{miss}} - \mathbf{q}_T) \right) \right]$$

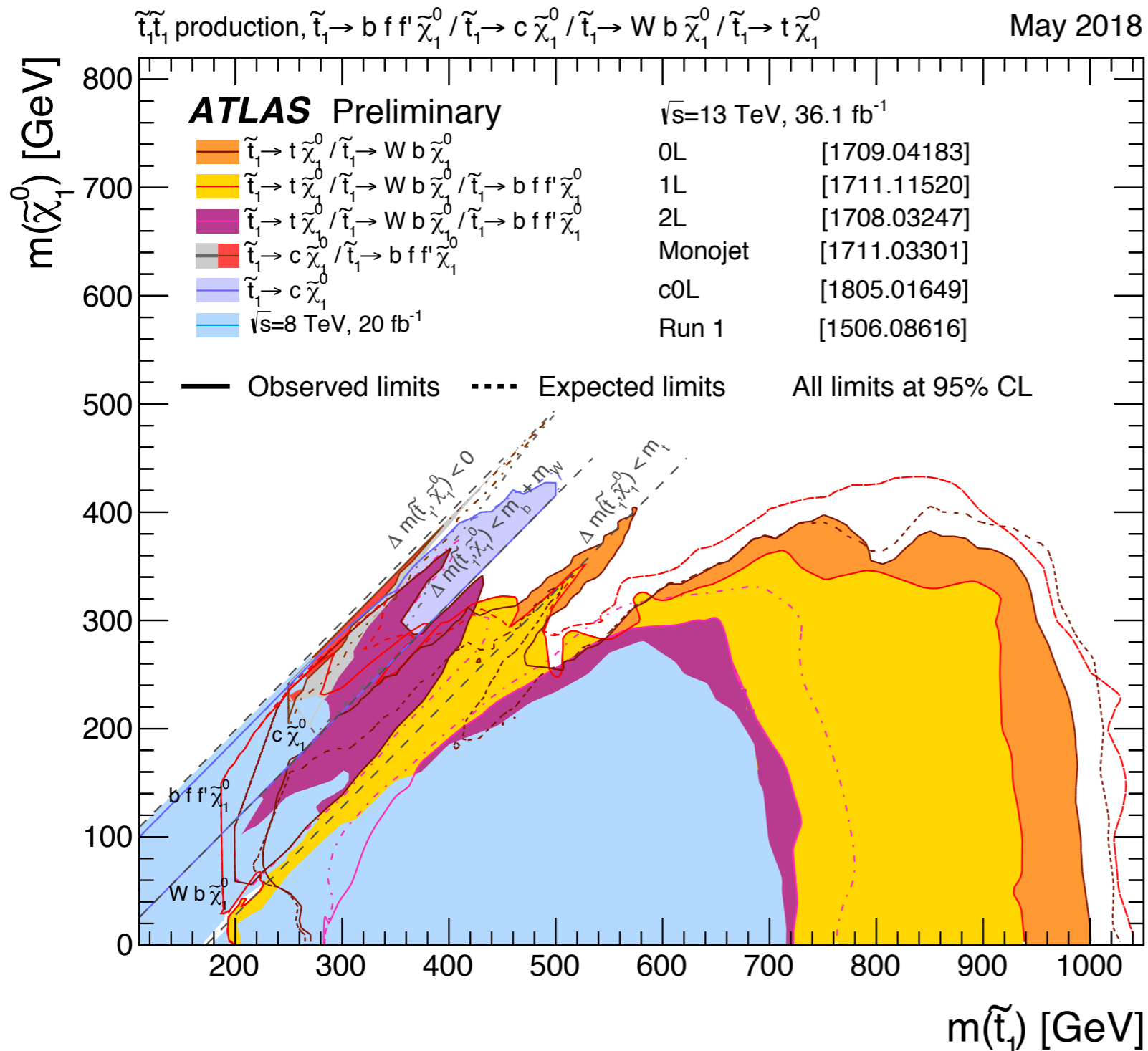
Use E_T^{miss} , m_{T2} , etc to gain info
 where lots of unmeasured particles

[arXiv:1803.02762](https://arxiv.org/abs/1803.02762)

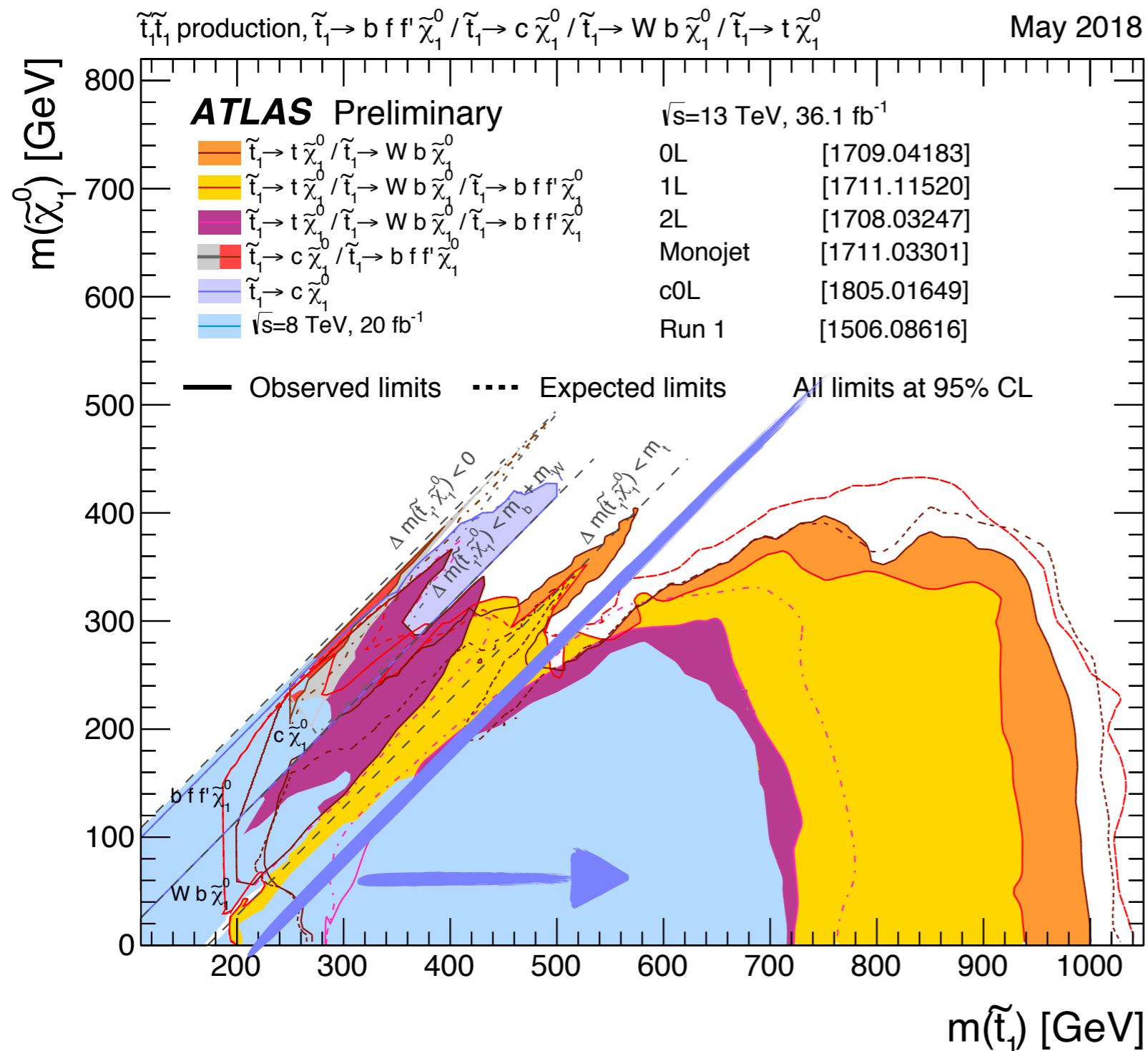
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Compressed spectra in SUSY

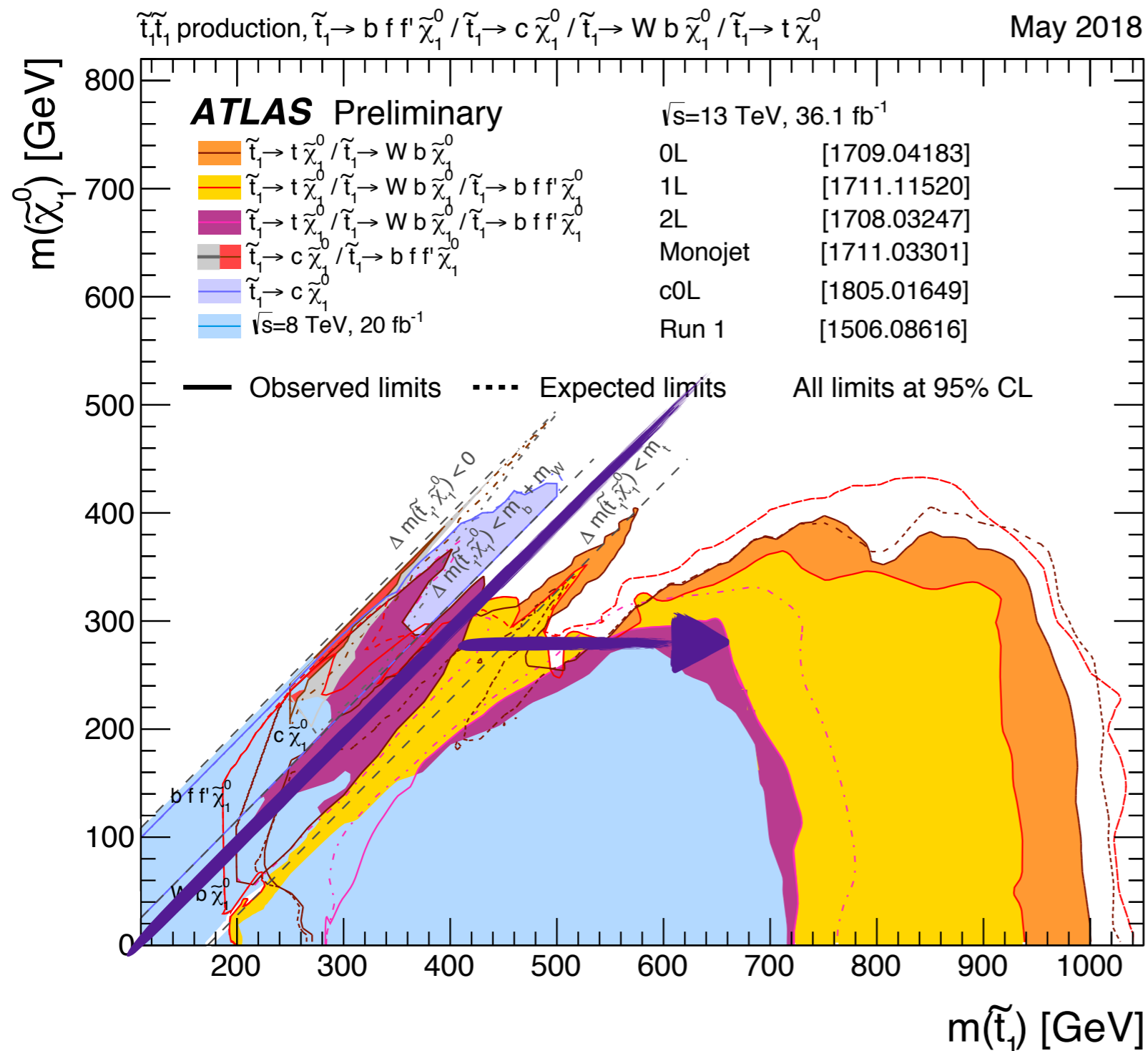


Compressed spectra in SUSY



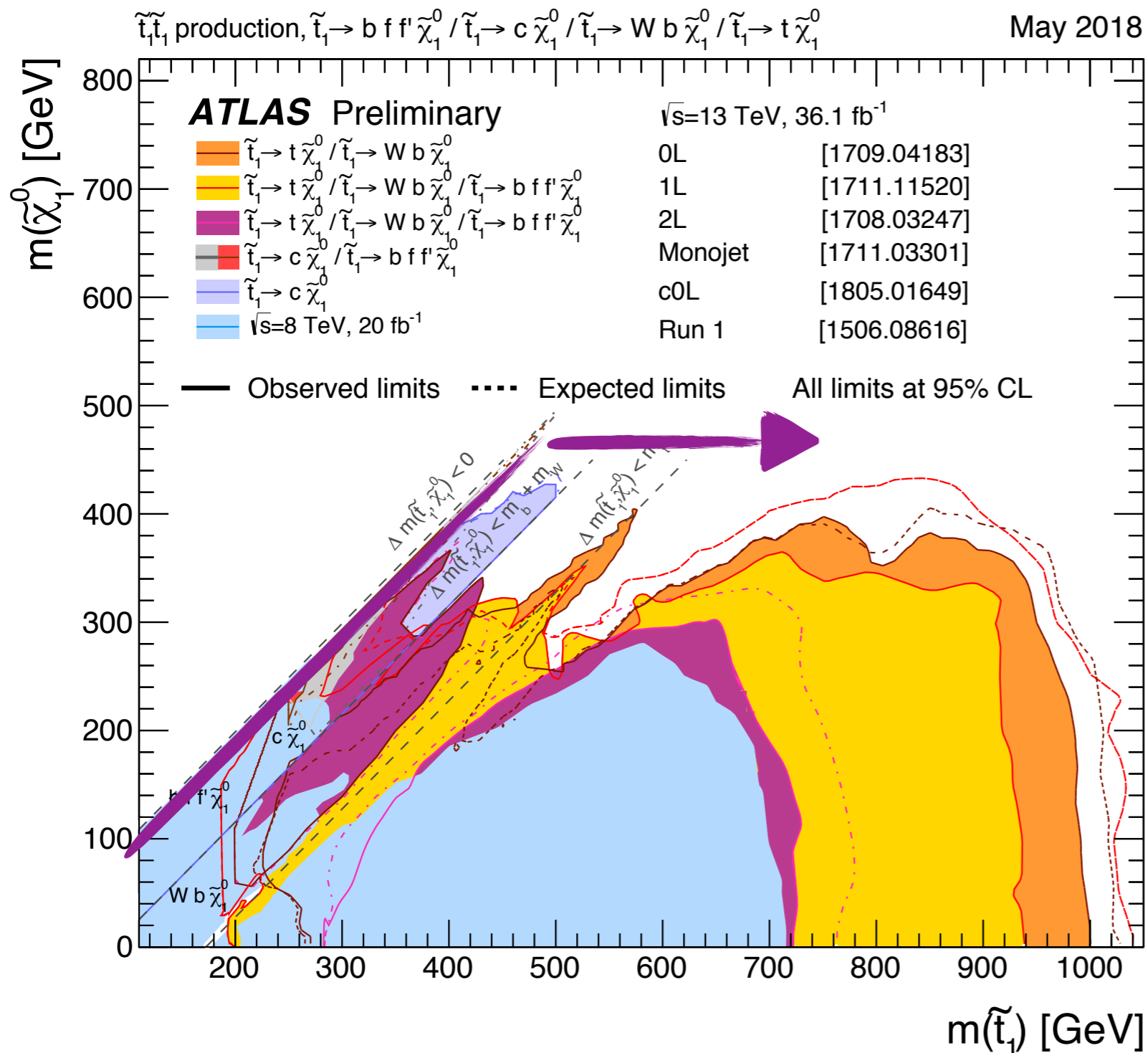
LSP a lot lighter than stop: nice easy signatures, maybe even boosted

Compressed spectra in SUSY



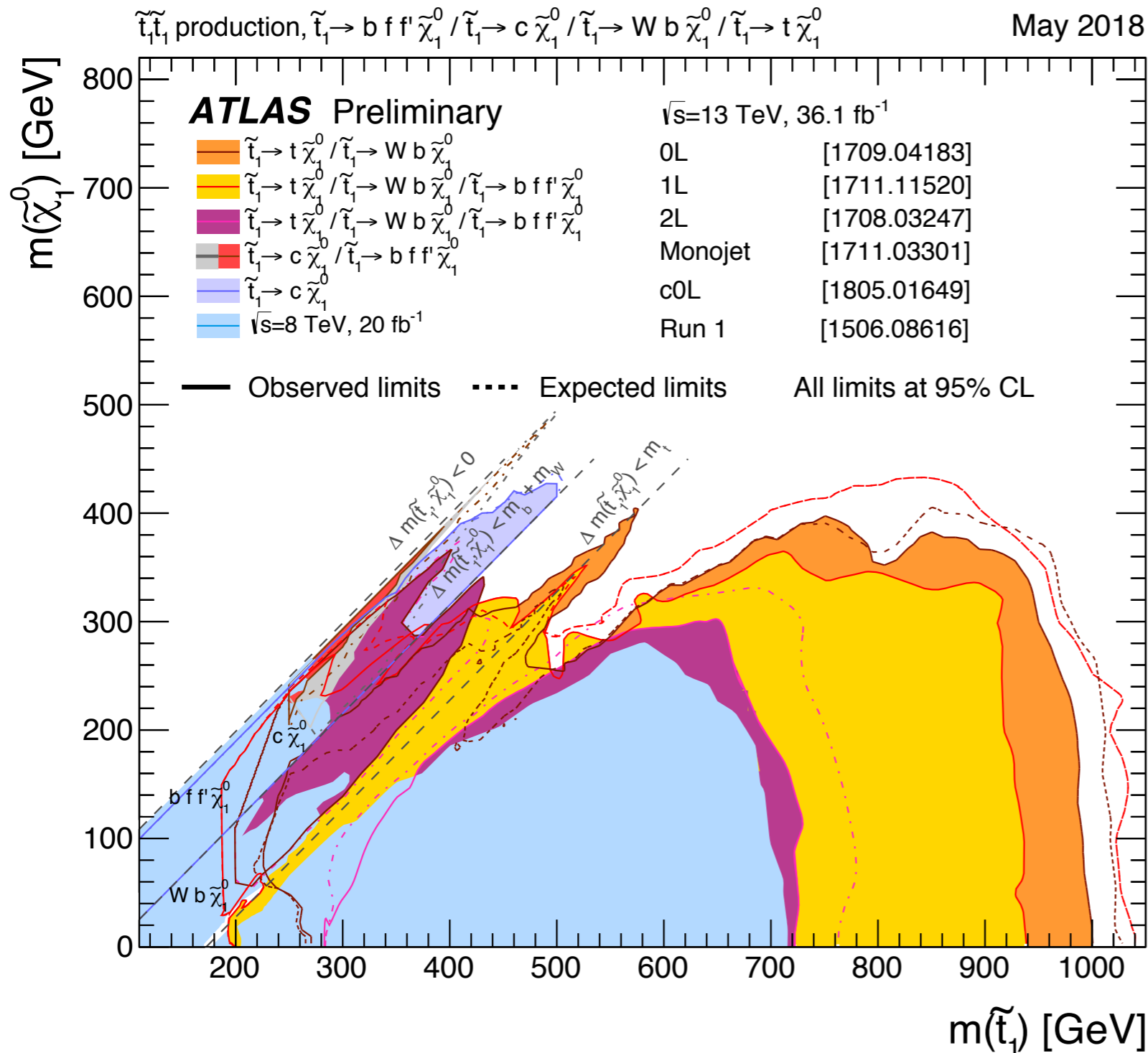
Mass splitting smaller than top mass: decays suppressed

Compressed spectra in SUSY

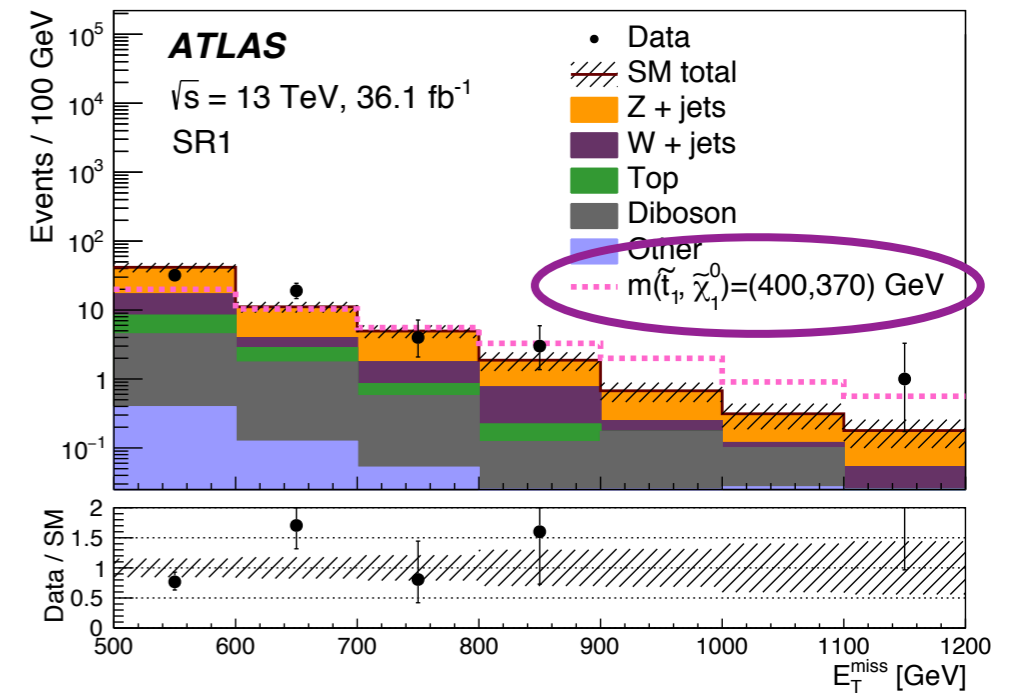
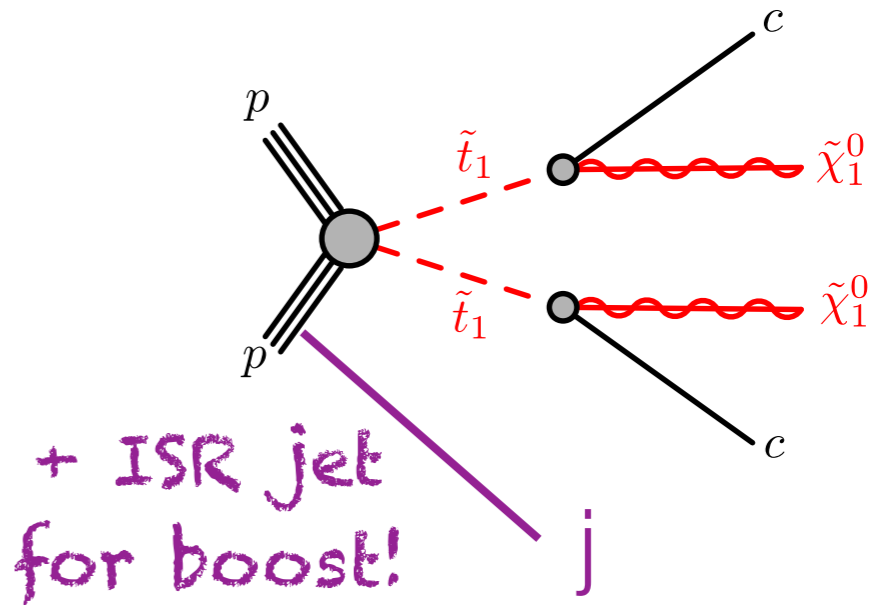


Mass splitting really small: “compressed”.
 SM particles so soft they are hard to detect

Compressed spectra in SUSY

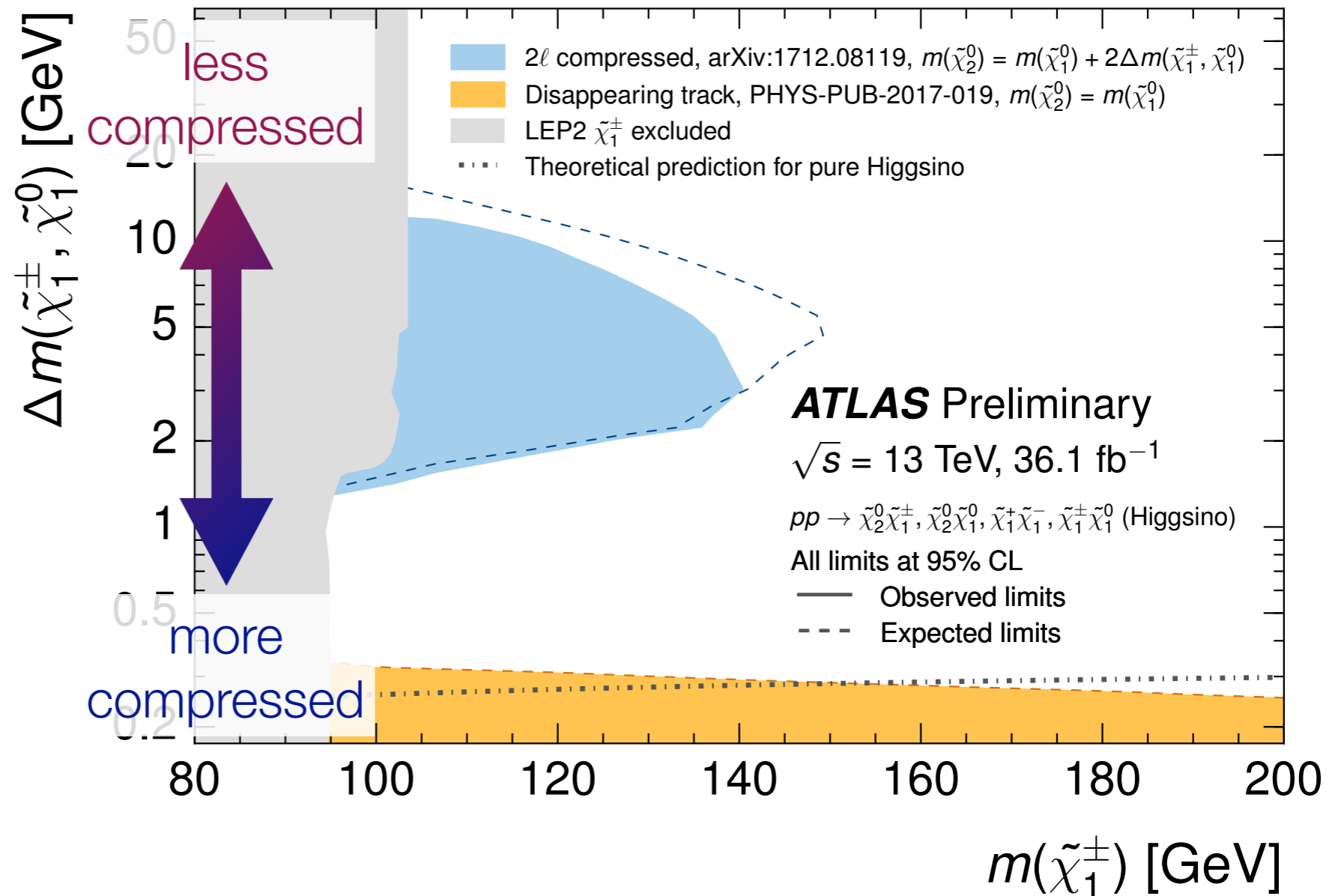


[arXiv:1708.08232](https://arxiv.org/abs/1708.08232)



A challenging corner: Higgsinos

Dedicated search for **compressed EW scenarios** (arxiv: [1712.08119](https://arxiv.org/abs/1712.08119)) handles mid-range

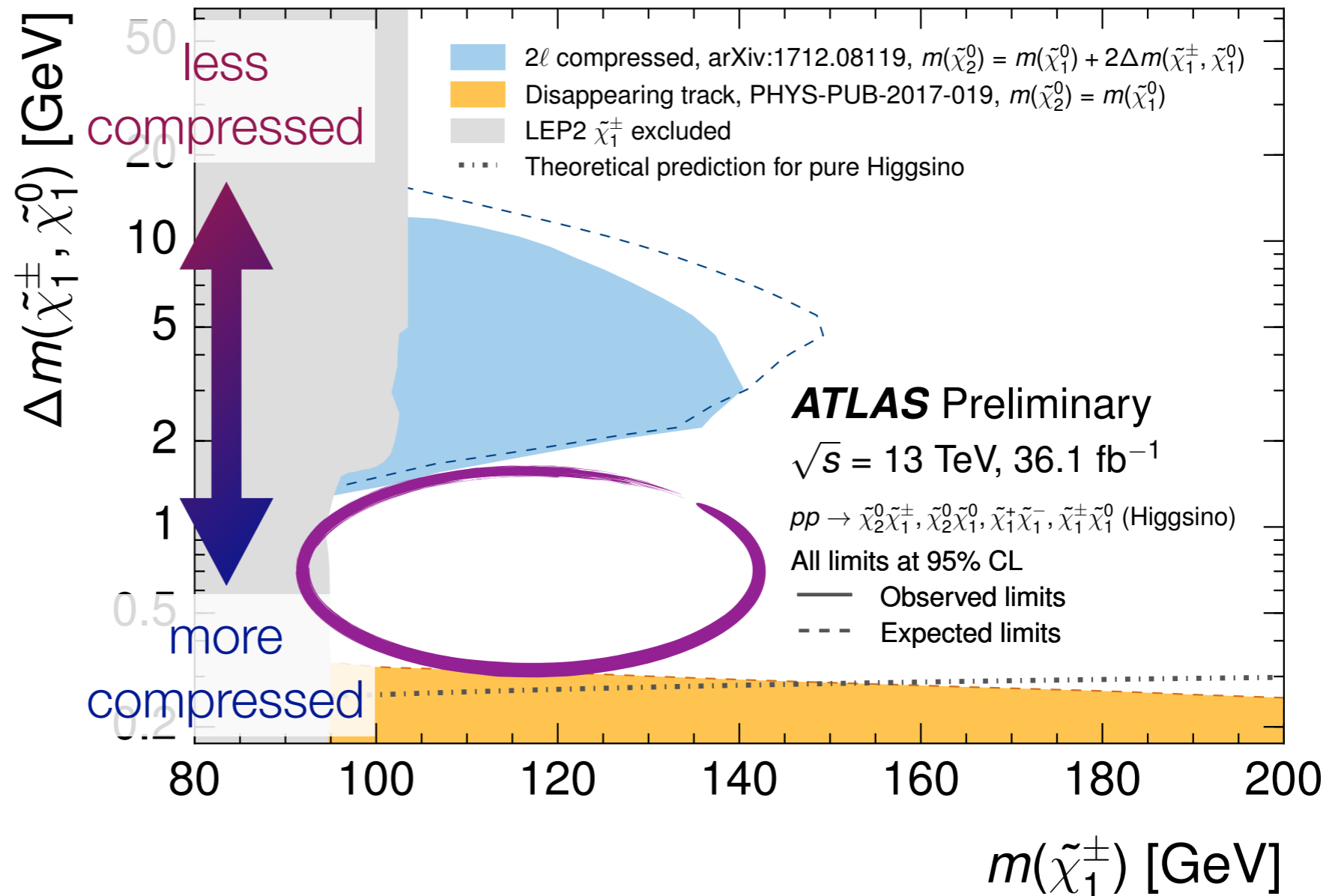


When sufficiently compressed, decays suppressed and Higgsino becomes long-lived: search via **disappearing tracks** ([arxiv:1712.02118](https://arxiv.org/abs/1712.02118))

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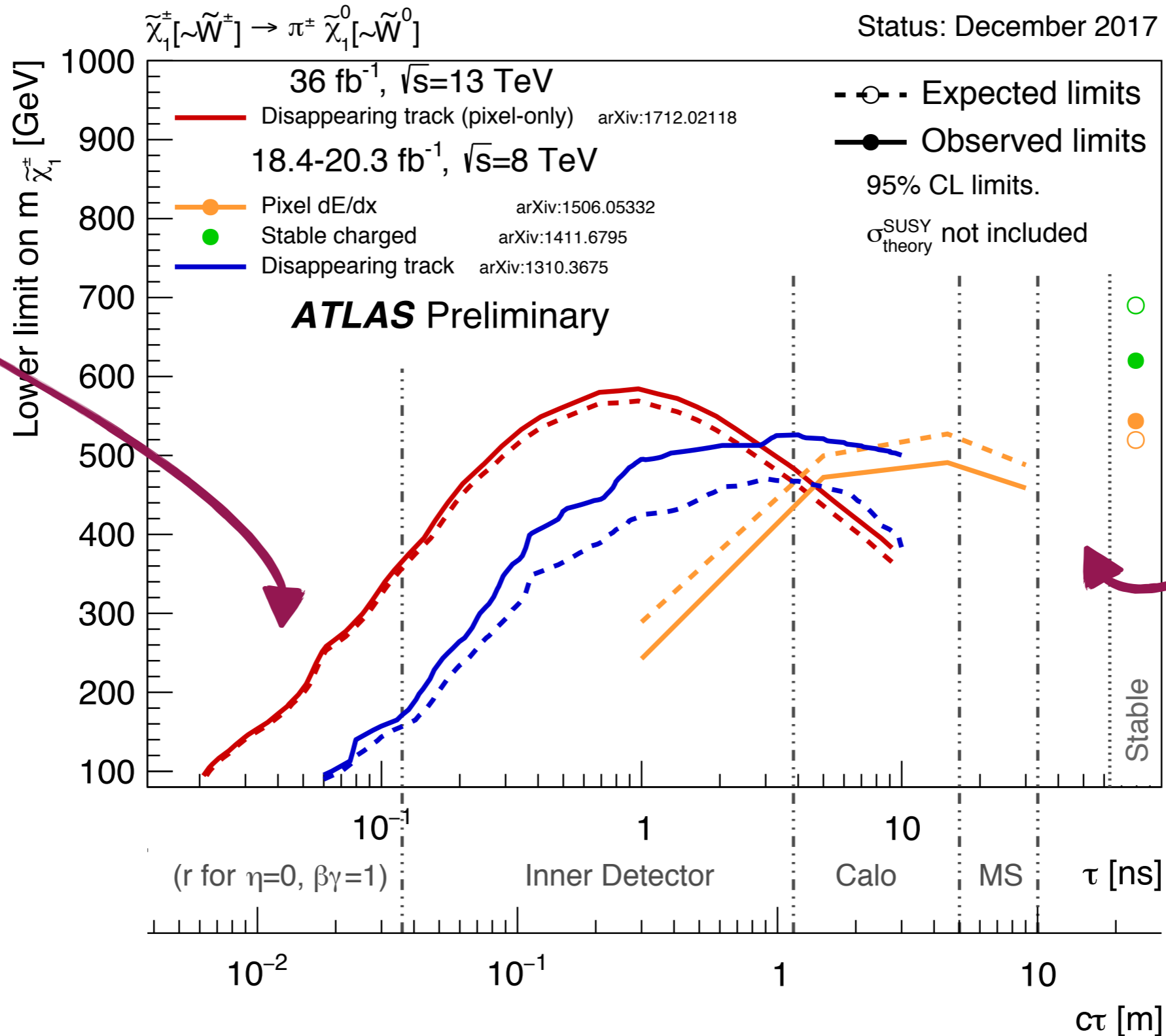
Not currently accessed!



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RPC meets RPV: Long-lived charginos

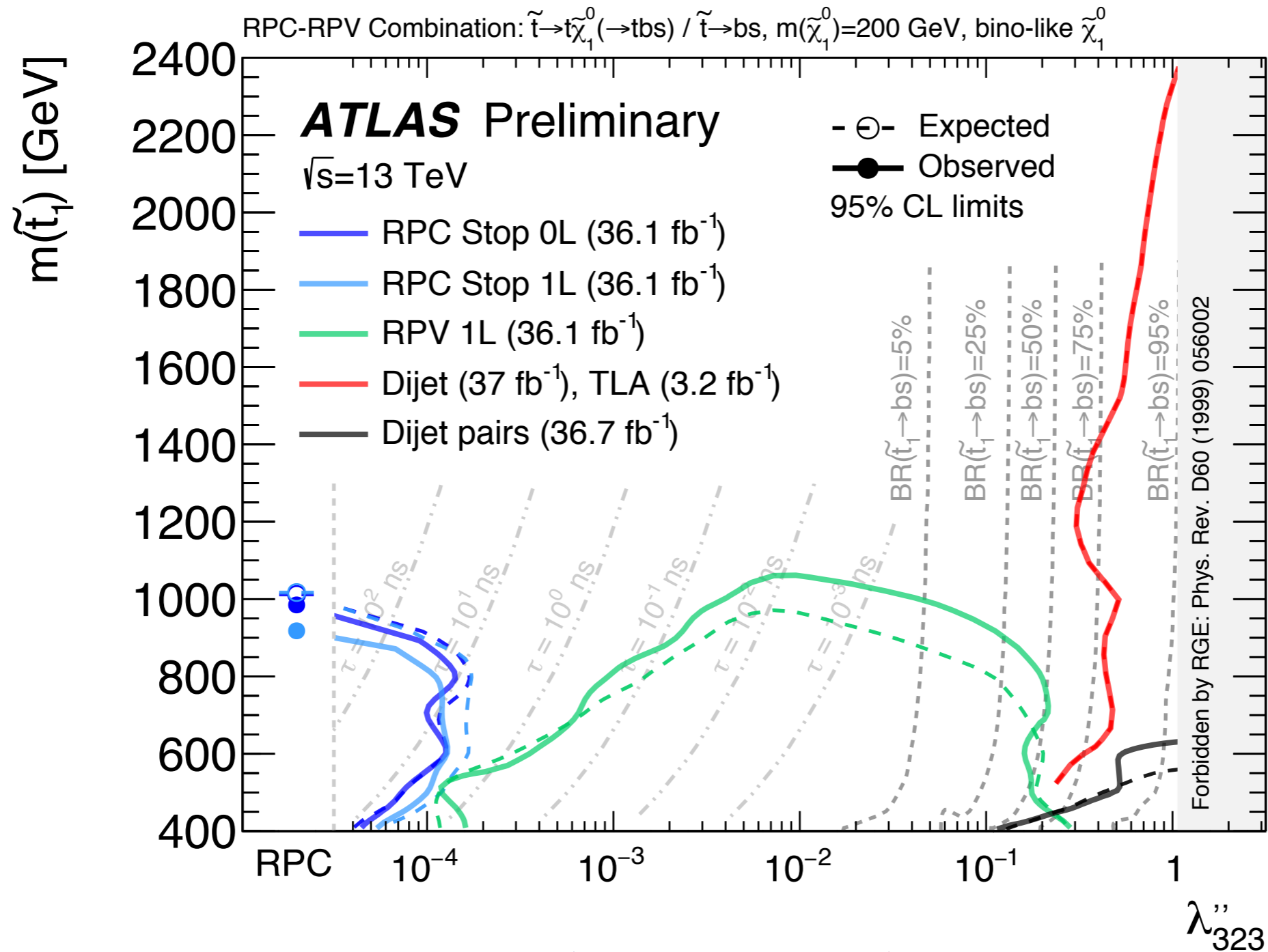
Short lifetimes are more difficult



Decay lengths outside the detector = stable for us

ATLAS-CONF-2018-003

RPC meets RPV: Stops



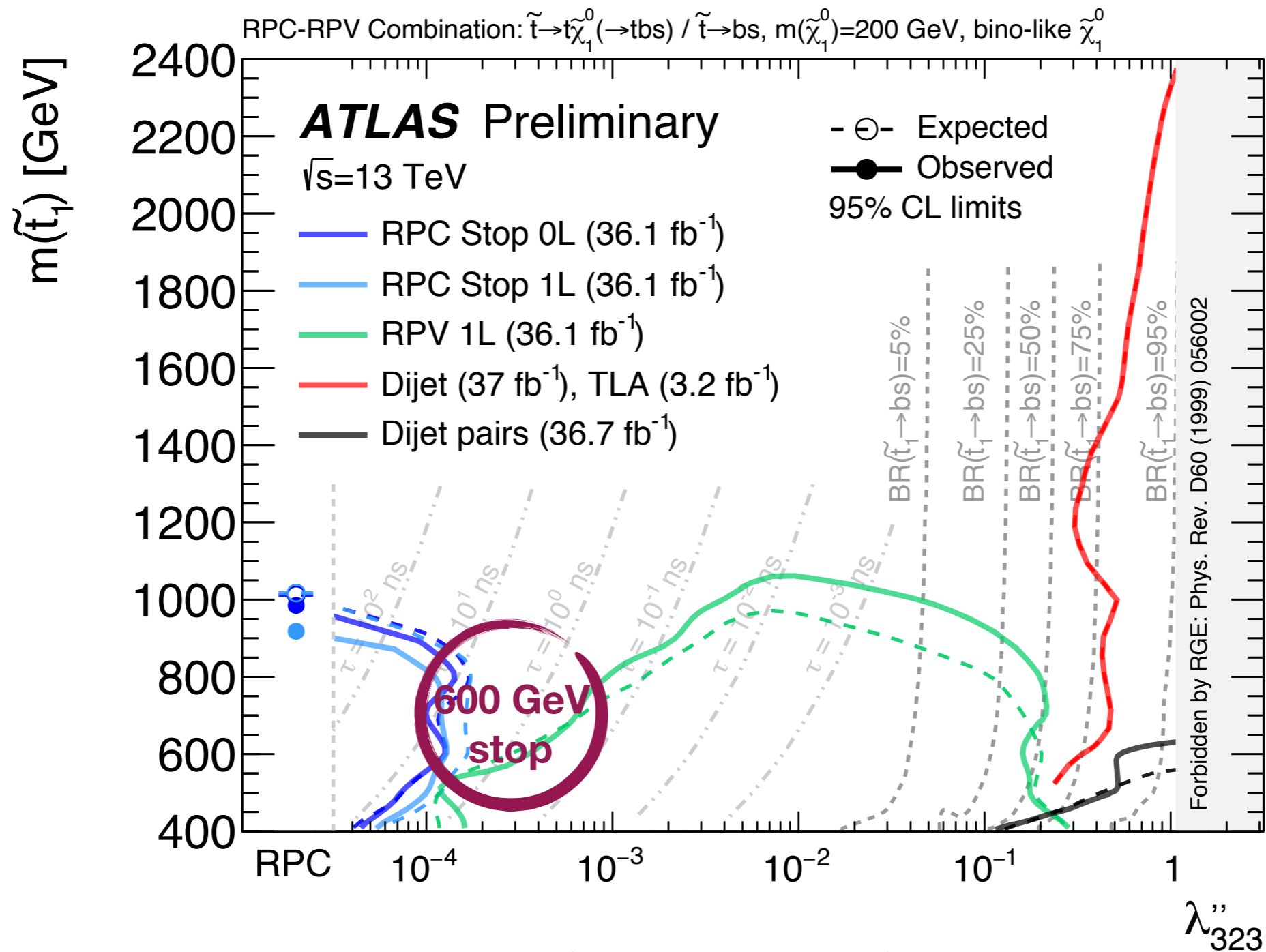
ATLAS-CONF-2018-003

More RPC-like



More RPV-like

RPC meets RPV: Stops



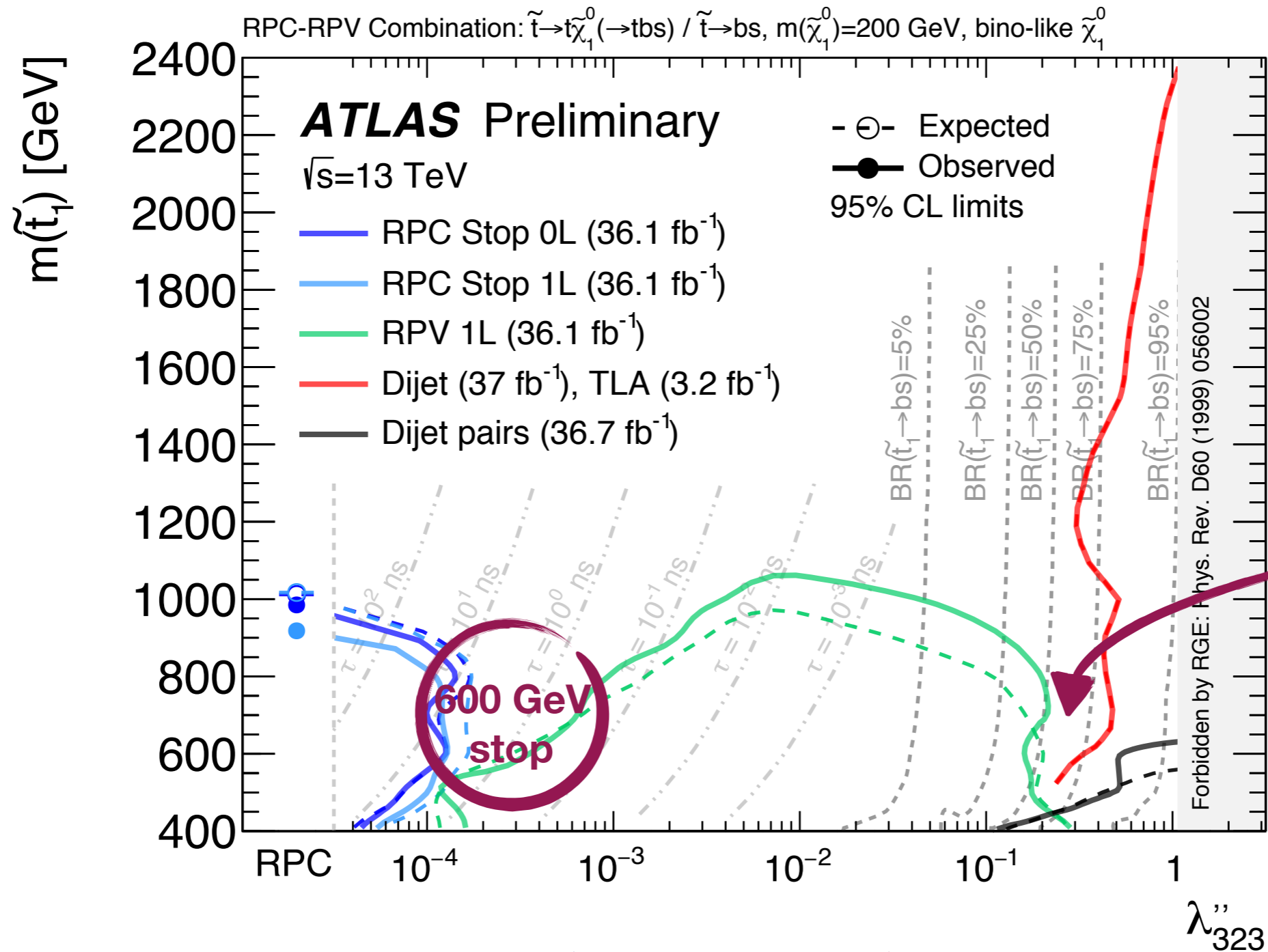
ATLAS-CONF-2018-003

More RPC-like



More RPV-like

RPC meets RPV: Stops



or here!

ATLAS-CONF-2018-003

More RPC-like



More RPV-like

ATLAS SUSY Searches* - 95% CL Lower Limits

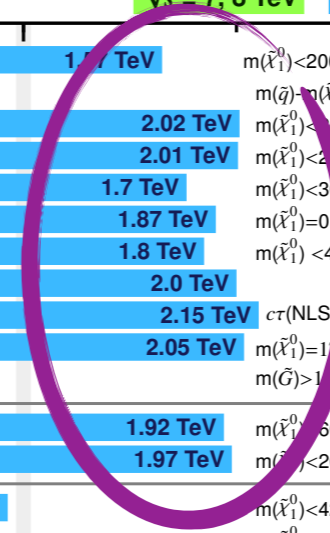
December 2017

ATLAS Preliminary

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

Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L} dt [\text{fb}^{-1}]$	Mass limit	$\sqrt{s} = 7, 8$ TeV	$\sqrt{s} = 13$ TeV	Reference	
Inclusive Searches	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{q}	1.7 TeV	$m(\tilde{\chi}_1^0) < 200$ GeV, $m(1^{\text{st}} \text{ gen. } \tilde{q}) = m(2^{\text{nd}} \text{ gen. } \tilde{q})$	1712.02332
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$ (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
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{g}	2.02 TeV	$m(\tilde{\chi}_1^0) < 100$ GeV	1712.02332
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0 \rightarrow qqW^\pm\tilde{\chi}_1^\pm$	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
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	0	2 jets	Yes	11.7	\tilde{g}	1.7 TeV	$m(\tilde{\chi}_1^0) < 300$ GeV,	1611.05791
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	0	4 jets	Yes	11.7	\tilde{g}	1.87 TeV	$m(\tilde{\chi}_1^0) = 0$ GeV	1706.03731
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qqWZ\tilde{\chi}_1^0$	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	$c\tau(\text{NLSP}) < 0.1$ mm	1607.05979
	GGM (bino NLSP)	2 γ	-	Yes	36.1	\tilde{g}	2.15 TeV	$c\tau(\text{NLSP}) < 0.1$ mm	ATLAS-CONF-2017-080
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	36.1	\tilde{g}	2.05 TeV	$m(\tilde{\chi}_1^0) = 100$ GeV, $c\tau(\text{NLSP}) < 0.1$ mm, $\mu > 0$	ATLAS-CONF-2017-080
Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale	865 GeV	$m(\tilde{G}) > 1.5 \times 10^{-4}$ eV, $m(\tilde{g}) = m(\tilde{q}) = 1.5$ TeV	1502.01518	
3 rd gen. \tilde{g} med.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	\tilde{g}	1.92 TeV	$m(\tilde{\chi}_1^0) = 600$ GeV	1711.01901
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	36.1	\tilde{g}	1.97 TeV	$m(\tilde{\chi}_1^0) < 200$ GeV	1711.01901
3 rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$	0	2 b	Yes	36.1	\tilde{b}_1	950 GeV	$m(\tilde{\chi}_1^0) < 420$ GeV	1708.09266
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow t\tilde{\chi}_1^\pm$	2 e, μ (SS)	1 b	Yes	36.1	\tilde{b}_1	275-700 GeV	$m(\tilde{\chi}_1^0) < 200$ GeV, $m(\tilde{\chi}^\pm) = m(\tilde{\chi}_1^0) + 100$ GeV	1706.03731
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{\chi}_1^\pm$	0-2 e, μ	1-2 b	Yes	4.7/13.3	\tilde{t}_1	117-170 GeV	$m(\tilde{\chi}_1^\pm) = 2m(\tilde{\chi}_1^0), m(\tilde{\chi}_1^0) = 55$ GeV	1209.2102, ATLAS-CONF-2016-077
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow Wb\tilde{\chi}_1^0$ 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	$m(\tilde{\chi}_1^0) = 1$ GeV	1506.08616, 1709.04183, 1711.11520
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$	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
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + Z$	3 e, μ (Z)	1 b	Yes	36.1	\tilde{t}_2	290-790 GeV	$m(\tilde{\chi}_1^0) = 0$ GeV	1706.03986
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2 \rightarrow \tilde{t}_1 + h$	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	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell} \rightarrow \ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	$\tilde{\ell}$	90-500 GeV	$m(\tilde{\chi}_1^0) = 0$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow \tilde{\ell}\nu(\tilde{\ell}\bar{\nu})$	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
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_2^0, \tilde{\chi}_1^\pm \rightarrow \tilde{\tau}\nu(\tilde{\tau}\bar{\nu}), \tilde{\chi}_2^0 \rightarrow \tilde{\tau}\tau(\nu\bar{\nu})$	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
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0 \rightarrow \tilde{\ell}_L\nu\tilde{\ell}_L(\tilde{\nu}\nu), \tilde{\ell}\tilde{\nu}\tilde{\ell}_L(\tilde{\nu}\nu)$	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
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0 Z\tilde{\chi}_1^0$	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
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0 h\tilde{\chi}_1^0, h \rightarrow b\tilde{b}/WW/\tau\tau/\gamma\gamma$	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
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_2^0\tilde{\chi}_3^0 \rightarrow \tilde{\ell}_R\ell$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_2^0, \tilde{\chi}_3^0$	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., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	1 $e, \mu + \gamma$	-	Yes	20.3	\tilde{W}	115-370 GeV	$c\tau < 1$ mm	1507.05493
GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	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	$m(\tilde{\chi}_1^\pm) - m(\tilde{\chi}_1^0) \sim 160$ MeV, $\tau(\tilde{\chi}_1^\pm) = 0.2$ 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	$m(\tilde{\chi}_1^\pm) - m(\tilde{\chi}_1^0) \sim 160$ MeV, $\tau(\tilde{\chi}_1^\pm) < 15$ 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, $10 \mu\text{s} < \tau(\tilde{g}) < 1000$ 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, $\tau > 10$ ns	1604.04520
	Metastable \tilde{g} R-hadron, $\tilde{g} \rightarrow qq\tilde{\chi}_1^0$	displ. vtx	-	Yes	32.8	\tilde{g}	2.37 TeV	$\tau(\tilde{g}) = 0.17$ ns, $m(\tilde{\chi}_1^0) = 100$ GeV	1710.04901
	GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$	537 GeV	$10 < \tan\beta < 50$	1411.6795
	GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$	440 GeV	$1 < \tau(\tilde{\chi}_1^0) < 3$ ns, SPS8 model	1409.5542
$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow e\tilde{\nu}/e\tilde{\nu}/\mu\tilde{\nu}$	displ. $e\tilde{\nu}/e\tilde{\nu}/\mu\tilde{\nu}$	-	-	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 $pp \rightarrow \tilde{\nu}_\tau + X, \tilde{\nu}_\tau \rightarrow e\mu/e\tau/\mu\tau$	$e\mu, e\tau, \mu\tau$	-	-	3.2	$\tilde{\nu}_\tau$	1.9 TeV	$\lambda_{311}^0 = 0.11, \lambda_{132/133/233} = 0.07$	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
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow e\tilde{\nu}, e\mu\nu, \mu\mu\nu$	4 e, μ	-	Yes	13.3	$\tilde{\chi}_1^\pm$	1.14 TeV	$m(\tilde{\chi}_1^0) > 400$ GeV, $\lambda_{12k} \neq 0$ ($k = 1, 2$)	ATLAS-CONF-2016-075
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau\nu_e, e\tau\nu_\tau$	3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^\pm$	450 GeV	$m(\tilde{\chi}_1^0) > 0.2 \times m(\tilde{\chi}_1^\pm), \lambda_{133} \neq 0$	1405.5086
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qq$	0	4-5 large- R jets	-	36.1	\tilde{g}	1.875 TeV	$m(\tilde{\chi}_1^0) = 1075$ GeV	SUSY-2016-22
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qq$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	2.1 TeV	$m(\tilde{\chi}_1^0) = 1$ TeV, $\lambda_{112} \neq 0$	1704.08493
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow bs$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	1.65 TeV	$m(\tilde{t}_1) = 1$ TeV, $\lambda_{323} \neq 0$	1704.08493
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow bs$	0	2 jets + 2 b	-	36.7	\tilde{t}_1	100-470 GeV	BR($\tilde{t}_1 \rightarrow b\ell/\mu$) > 20%	1710.07171
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\ell$	2 e, μ	2 b	-	36.1	\tilde{t}_1	0.4-1.45 TeV		1710.05544	
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	\tilde{c}	510 GeV	$m(\tilde{\chi}_1^0) < 200$ GeV	1501.01325

So don't let this scare you:



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.

Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L} dt [\text{fb}^{-1}]$	Mass limit	$\sqrt{s} = 7, 8$ TeV	$\sqrt{s} = 13$ TeV	Reference	
Inclusive Searches	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{q}	1.7 TeV	$m(\tilde{\chi}_1^0) < 200$ GeV, $m(1^{\text{st}} \text{ gen. } \tilde{q}) = m(2^{\text{nd}} \text{ gen. } \tilde{q})$	1712.02332
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$ (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
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	36.1	\tilde{g}	2.02 TeV	$m(\tilde{\chi}_1^0) < 100$ GeV	1712.02332
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0 \rightarrow qqW^\pm\tilde{\chi}_1^\pm$	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
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	0	2 jets	Yes	11.7	\tilde{g}	1.7 TeV	$m(\tilde{\chi}_1^0) < 300$ GeV,	1611.05791
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq(\ell\ell/\nu\nu)\tilde{\chi}_1^0$	0	4 jets	Yes	36.1	\tilde{g}	1.87 TeV	$m(\tilde{\chi}_1^0) = 0$ GeV	1706.03731
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qqWZ\tilde{\chi}_1^0$	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	$c\tau(\text{NLSP}) < 0.1$ mm	1607.05979
	GGM (bino NLSP)	2 γ	-	Yes	36.1	\tilde{g}	2.15 TeV	$c\tau(\text{NLSP}) < 0.1$ mm	ATLAS-CONF-2017-080
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	36.1	\tilde{g}	2.05 TeV	$m(\tilde{\chi}_1^0) = 100$ GeV, $c\tau(\text{NLSP}) < 0.1$ mm, $\mu > 0$	ATLAS-CONF-2017-080
Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale	865 GeV	$m(\tilde{G}) > 1.5 \times 10^{-4}$ eV, $m(\tilde{g}) = m(\tilde{q}) = 1.5$ TeV	1502.01518	
3 rd gen. \tilde{g} med.	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow b\tilde{b}\tilde{\chi}_1^0$	0	3 b	Yes	36.1	\tilde{g}	1.92 TeV	$m(\tilde{\chi}_1^0) = 600$ GeV	1711.01901
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0$	0-1 e, μ	3 b	Yes	36.1	\tilde{g}	1.97 TeV	$m(\tilde{\chi}_1^0) < 200$ GeV	1711.01901
3 rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$	0	2 b	Yes	36.1	\tilde{b}_1	950 GeV	$m(\tilde{\chi}_1^0) < 420$ GeV	1708.09266
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow t\tilde{\chi}_1^\pm$	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
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\tilde{\chi}_1^\pm$	0-2 e, μ	1-2 b	Yes	4.7/13.3	\tilde{t}_1	117-170 GeV	$m(\tilde{\chi}_1^\pm) = 2m(\tilde{\chi}_1^0)$, $m(\tilde{\chi}_1^0) = 55$ GeV	1209.2102, ATLAS-CONF-2016-077
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow Wb\tilde{\chi}_1^0$ 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	$m(\tilde{\chi}_1^0) = 1$ GeV	1506.08616, 1709.04183, 1711.11520
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$	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
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell} \rightarrow \ell\tilde{\chi}_1^0$	2 e, μ	0	Yes	36.1	$\tilde{\ell}$	90-500 GeV	$m(\tilde{\chi}_1^0) = 0$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow \tilde{\nu}(\nu)$	0	0	Yes	36.1	$\tilde{\chi}_1^\pm$	1.13 TeV	$m(\tilde{\chi}_1^\pm) = 0$	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow \tilde{\tau}(\tau)$, $\tilde{\chi}_2^0 \rightarrow \tilde{\tau}\tau(\nu\nu)$	0	0	Yes	36.1	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	1.13 TeV	$m(\tilde{\chi}_1^\pm) = m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0) = 0$, $m(\tilde{\ell}, \tilde{\nu}) = 0.5(m(\tilde{\chi}_1^\pm) + m(\tilde{\chi}_1^0))$	1708.07875
	$\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow \tilde{\ell}_L\nu\tilde{\ell}_L(\nu\nu)$, $\tilde{\ell}\tilde{\nu}\tilde{\ell}_L(\nu\nu)$	3 e, μ	0	Yes	36.1	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	1.13 TeV	$m(\tilde{\chi}_1^\pm) = m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0) = 0$, $\tilde{\ell}$ decoupled	ATLAS-CONF-2017-039
	$\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	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
	$\tilde{\chi}_1^+\tilde{\chi}_2^0 \rightarrow W\tilde{\chi}_1^0h\tilde{\chi}_1^0, h \rightarrow b\tilde{b}/WW/\tau\tau/\gamma\gamma$	e, μ, γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^\pm, \tilde{\chi}_2^0$	635 GeV	$m(\tilde{\chi}_1^\pm) = m(\tilde{\chi}_2^0)$, $m(\tilde{\chi}_1^0) = 0$, $\tilde{\ell}$ decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0, \tilde{\chi}_2^0 \rightarrow \tilde{\ell}R\ell$	4 e, μ	0	Yes	20.3	$\tilde{\chi}_2^0, \tilde{\chi}_3^0$	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., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	1 $e, \mu + \gamma$	-	Yes	20.3	\tilde{W}	115-370 GeV	$c\tau < 1$ mm	1507.05493
	GGM (bino NLSP) weak prod., $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$	2 γ	-	Yes	36.1	\tilde{W}	110 GeV	$c\tau < 1$ mm	ATLAS-CONF-2017-080
	Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Displ. vlx	-	Yes	36.1	$\tilde{\chi}_1^\pm$	560 GeV	$m(\tilde{\chi}_1^\pm) = 160$ MeV, $\tau(\tilde{\chi}_1^\pm) < 0.1$ ns
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	$m(\tilde{\chi}_1^\pm) - m(\tilde{\chi}_1^0) \sim 160$ MeV, $\tau(\tilde{\chi}_1^\pm) < 15$ ns	1310.6584
Stable, stopped \tilde{g} R-hadron		0	1-5 jets	Yes	27.9	\tilde{g}	850 GeV	$m(\tilde{g}) = 100$ GeV, $10 \mu\text{s} < \tau(\tilde{g}) < 1000$ s	1606.05129
Stable \tilde{g} R-hadron		trk	-	-	3	\tilde{g}	1.57 TeV	$m(\tilde{\chi}_1^0) = 100$ GeV, $\tau > 10$ ns	1604.04520
Metastable \tilde{g} R-hadron		dE/dx trk	-	-	3.2	\tilde{g}	1.57 TeV	$m(\tilde{\chi}_1^0) = 100$ GeV, $\tau > 10$ ns	1604.04520
Metastable \tilde{g} R-hadron, $\tilde{g} \rightarrow qq\tilde{\chi}_1^0$		displ. vlx	-	yes	32.8	\tilde{g}	2.37 TeV	$\tau(\tilde{g}) = 0.17$ ns, $m(\tilde{\chi}_1^0) = 100$ GeV	1710.04901
GMSB, stable $\tilde{\tau}, \tilde{\chi}_1^0 \rightarrow \tilde{\tau}(\tilde{e}, \tilde{\mu}) + \tau(e, \mu)$		1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$	537 GeV	$10 < \tan\beta < 50$	1411.6795
GMSB, $\tilde{\chi}_1^0 \rightarrow \gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$	440 GeV	$1 < \tau(\tilde{\chi}_1^0) < 3$ ns, SPS8 model	1409.5542	
$\tilde{g}\tilde{g}, \tilde{\chi}_1^0 \rightarrow ee\nu/e\mu\nu/\mu\mu\nu$	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 $pp \rightarrow \tilde{\nu}_\tau + X, \tilde{\nu}_\tau \rightarrow e\mu/e\tau/\mu\tau$	$e\mu, e\tau, \mu\tau$	-	-	3.2	$\tilde{\nu}_\tau$	1.9 TeV	$\lambda_{311}^0 = 0.11, \lambda_{132/133/233} = 0.07$	1607.08079
	Bilinear RPV CMSSM	2 e, μ (SS)	0-3 b	Yes	20.3	\tilde{q}, \tilde{g}	1.45 TeV	$m(\tilde{q}) = m(\tilde{g}), c\tau_{\text{LSP}} < 1$ mm	1404.2500
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow ee\nu, e\mu\nu, \mu\mu\nu$	4 e, μ	-	Yes	13.3	$\tilde{\chi}_1^\pm$	1.14 TeV	$m(\tilde{\chi}_1^0) > 400$ GeV, $\lambda_{12k} \neq 0$ ($k = 1, 2$)	ATLAS-CONF-2016-075
	$\tilde{\chi}_1^+\tilde{\chi}_1^-, \tilde{\chi}_1^+ \rightarrow W\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \tau\tau\nu_e, e\tau\nu_\tau$	3 $e, \mu + \tau$	-	Yes	20.3	$\tilde{\chi}_1^\pm$	450 GeV	$m(\tilde{\chi}_1^0) > 0.2 \times m(\tilde{\chi}_1^\pm), \lambda_{133} \neq 0$	1405.5086
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow qq\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qq\tilde{q}$	0	4-5 large- R jets	-	36.1	\tilde{g}	1.875 TeV	$m(\tilde{\chi}_1^0) = 1075$ GeV	SUSY-2016-22
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow qq\tilde{q}$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	2.1 TeV	$m(\tilde{\chi}_1^0) = 1$ TeV, $\lambda_{112} \neq 0$	1704.08493
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow bs$	1 e, μ	8-10 jets/0-4 b	-	36.1	\tilde{g}	1.65 TeV	$m(\tilde{t}_1) = 1$ TeV, $\lambda_{323} \neq 0$	1704.08493
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow bs$	0	2 jets + 2 b	-	36.7	\tilde{t}_1	100-470 GeV	$\text{BR}(\tilde{t}_1 \rightarrow b\ell/\mu) > 20\%$	1710.07171
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow b\ell$	2 e, μ	2 b	-	36.1	\tilde{t}_1	480-610 GeV		1710.05544	
Other	Scalar charm, $\tilde{c} \rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	\tilde{c}	510 GeV	$m(\tilde{\chi}_1^0) < 200$ GeV	1501.01325

So don't let this scare you:

These are ideal-case limits intended for reinterpretation: simple BR assumptions, straightforward parameter choices... there is still space for a <2 TeV gluino, just in more complicated scenarios!

Mass scale [TeV]

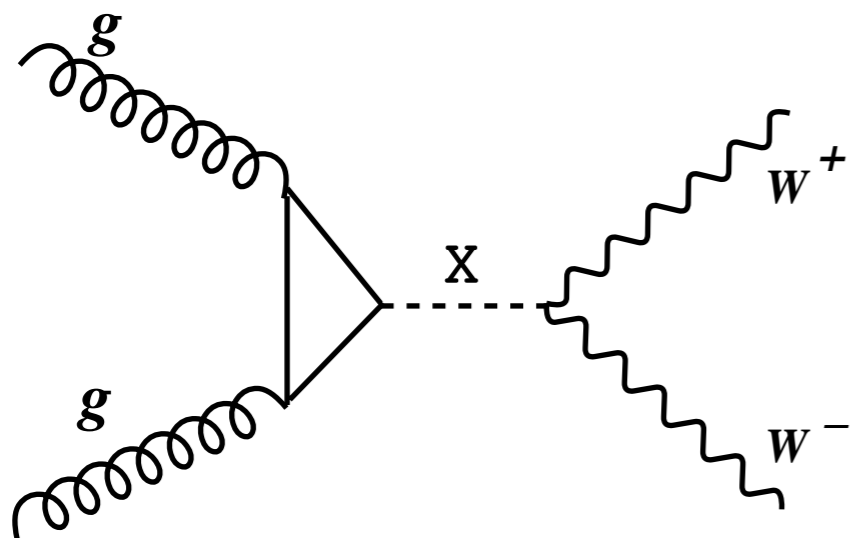
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

BSM Higgs

The BSM Higgs program

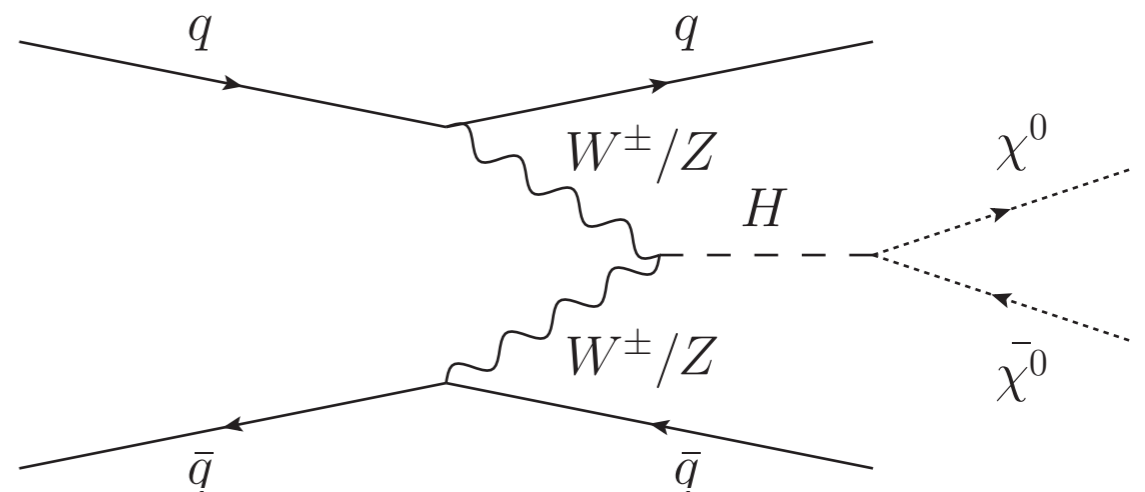
Additional Higgses

- Many models (incl. 2HDM) postulate additional Higgs bosons
- Charged higgses or heavier equivalents of SM Higgs



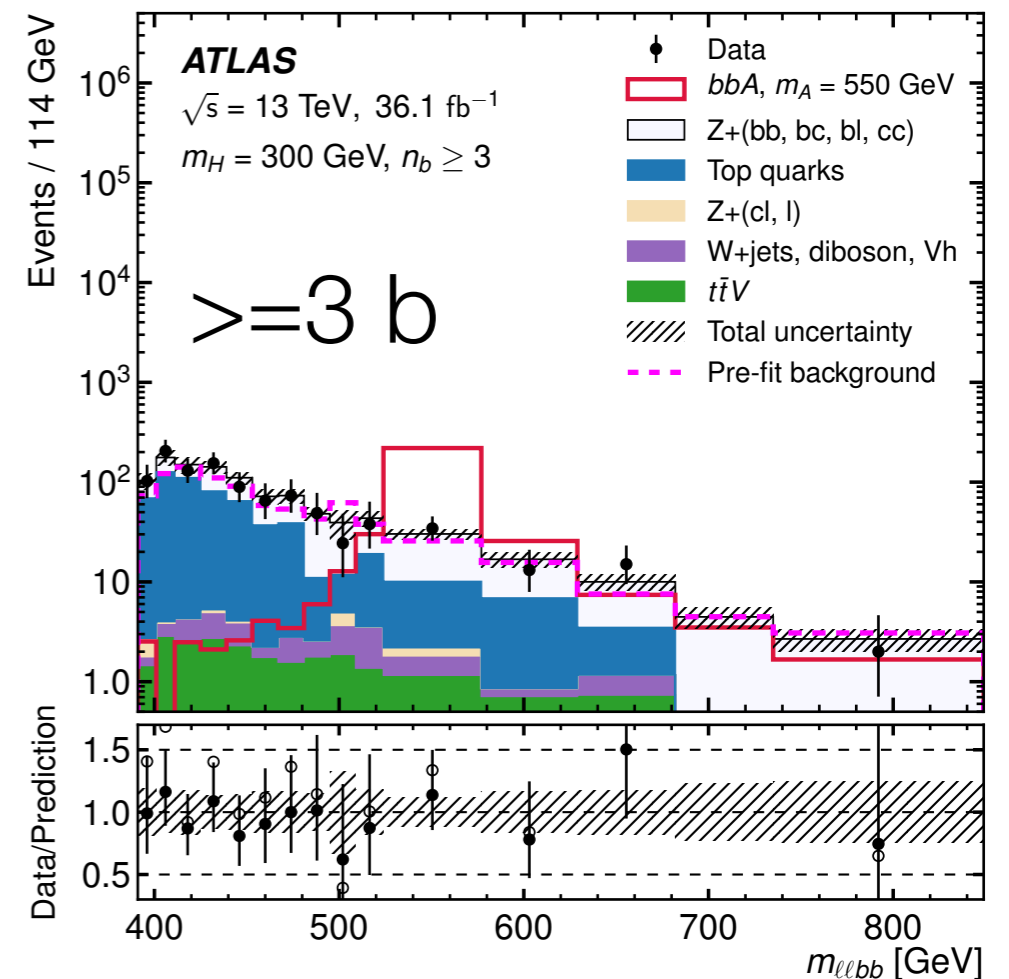
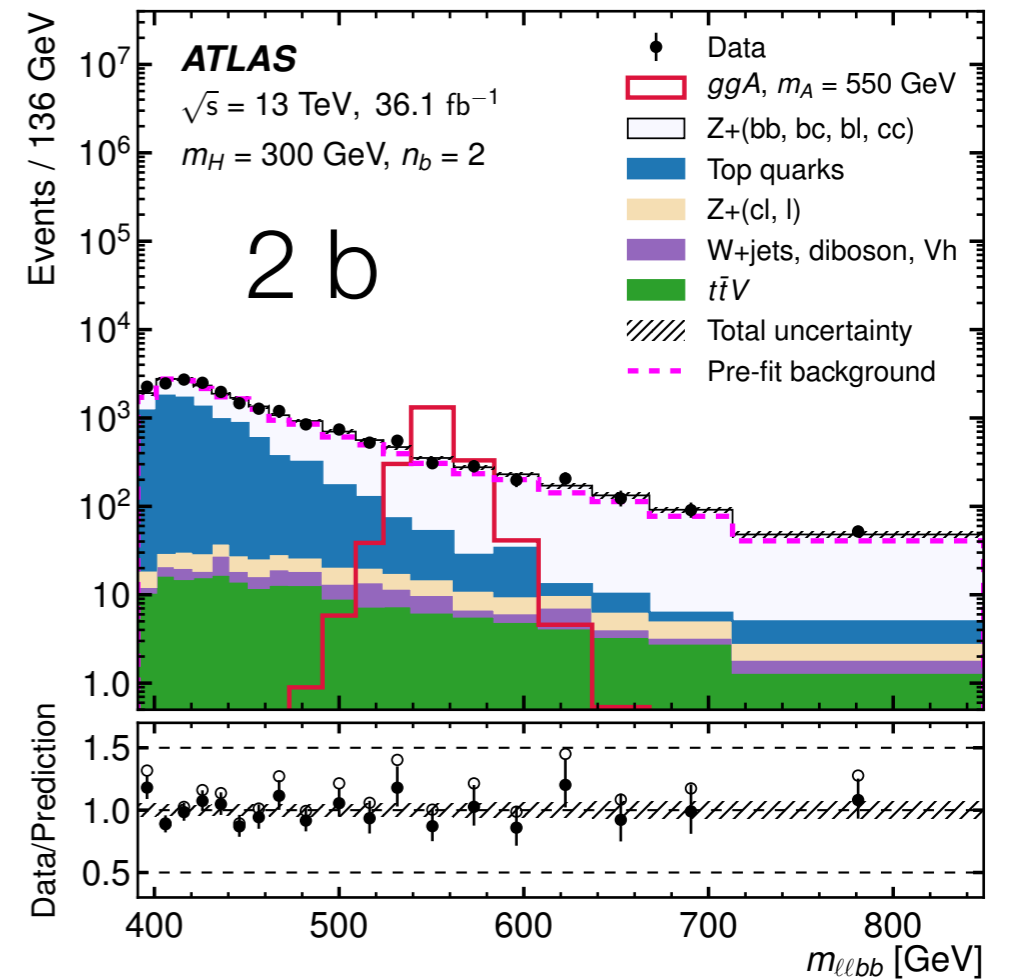
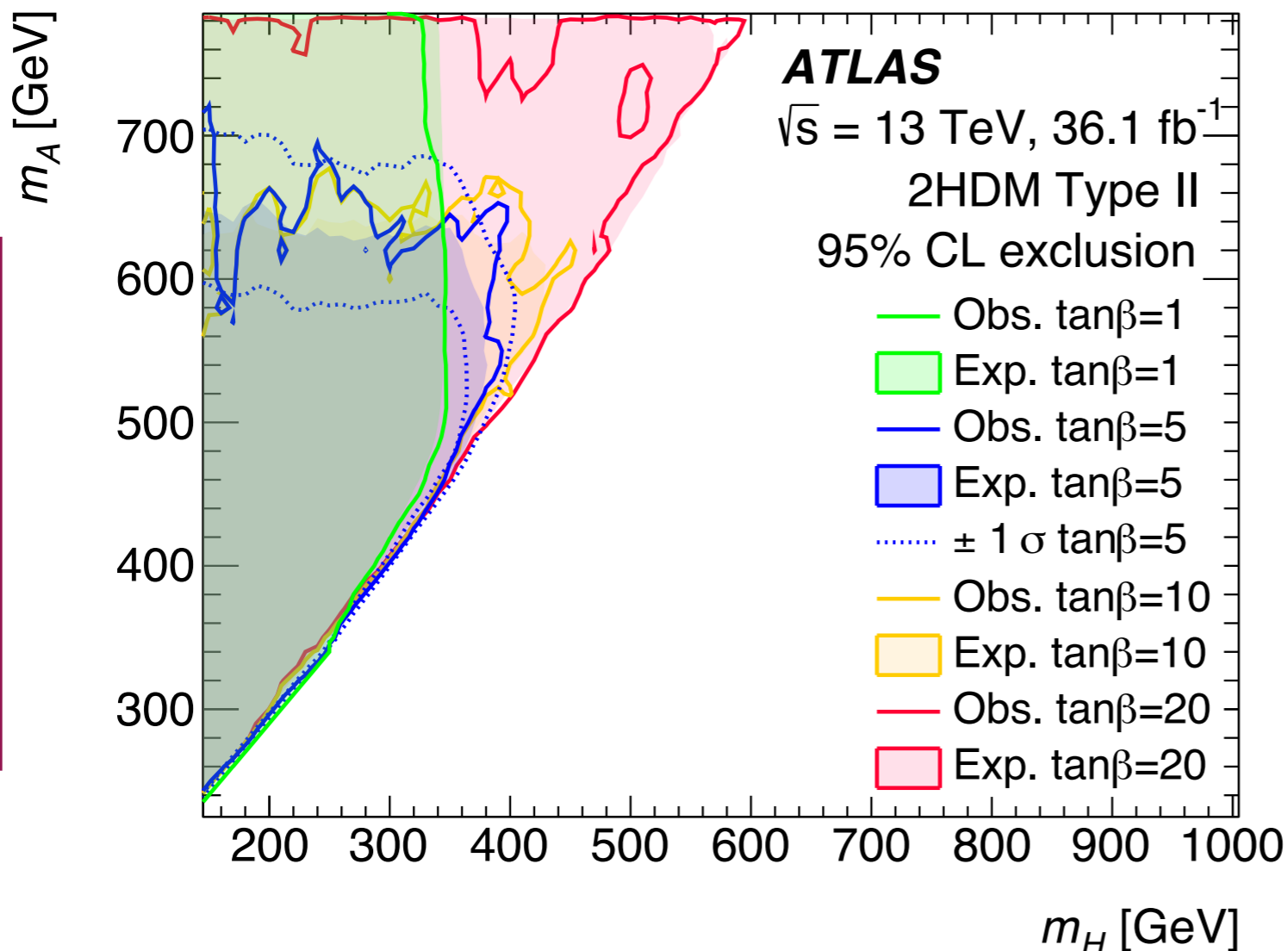
Higgs to Invisible

- Look for production of DM particles by decays of SM Higgs
- Uncertainty on SM Higgs production σ is $\sim 30\%$, so sufficient “wobble room” to allow this



Recent highlights: Heavy Higgs to ZH

- Search in $Z \rightarrow ll$, (another non-SM) $H \rightarrow bb$. Possible additional b-jets in association with A.
- Results framed in 2HDM model with various parameter choices for generality



CERN-EP-2018-030

(Other) exotics searches

Exotics search methodology

- Largely signature driven
- Each signature open to range of BSM models
- Various dedicated summary or combination efforts in Run II

Diboson

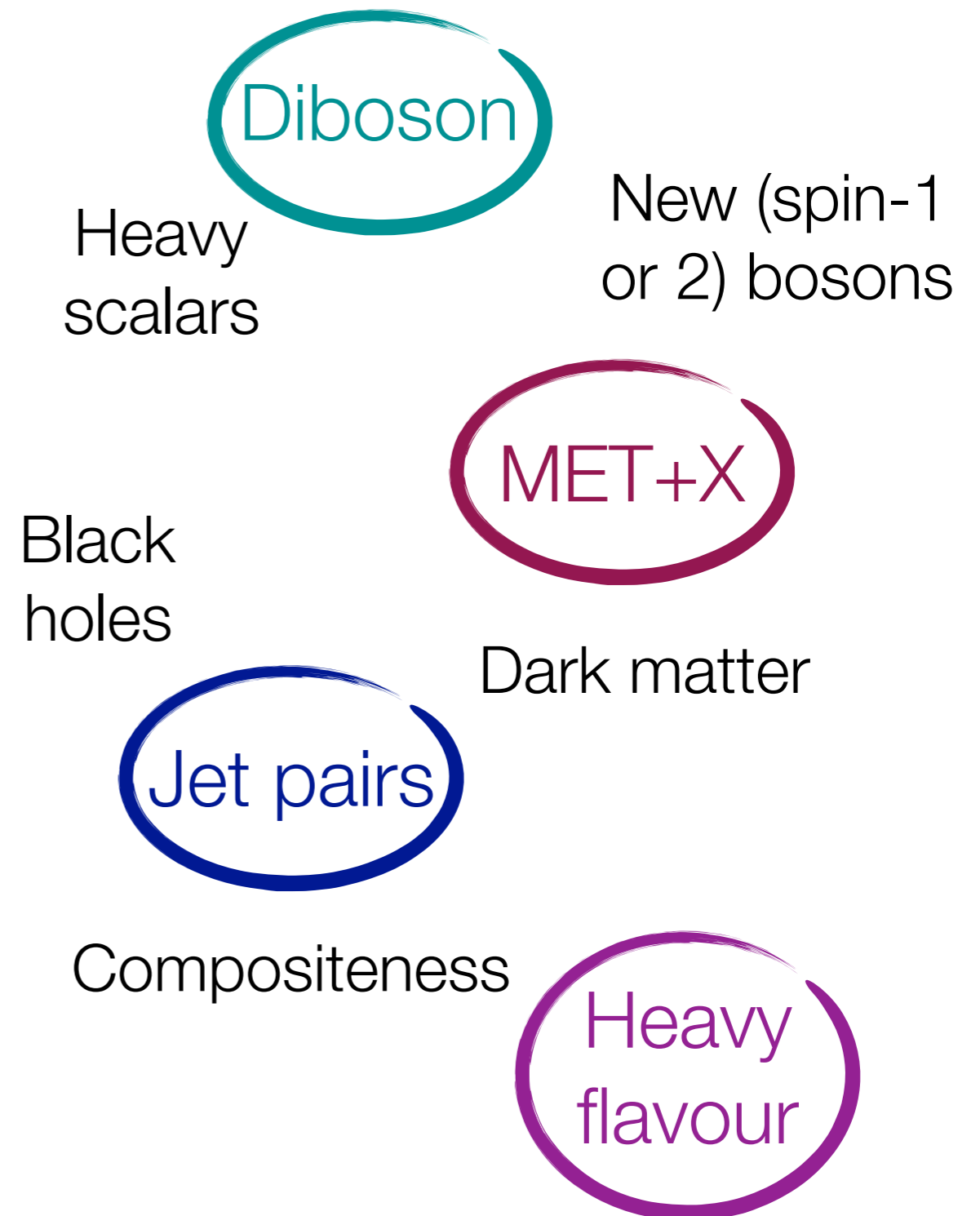
MET+X

Jet pairs

Heavy
flavour

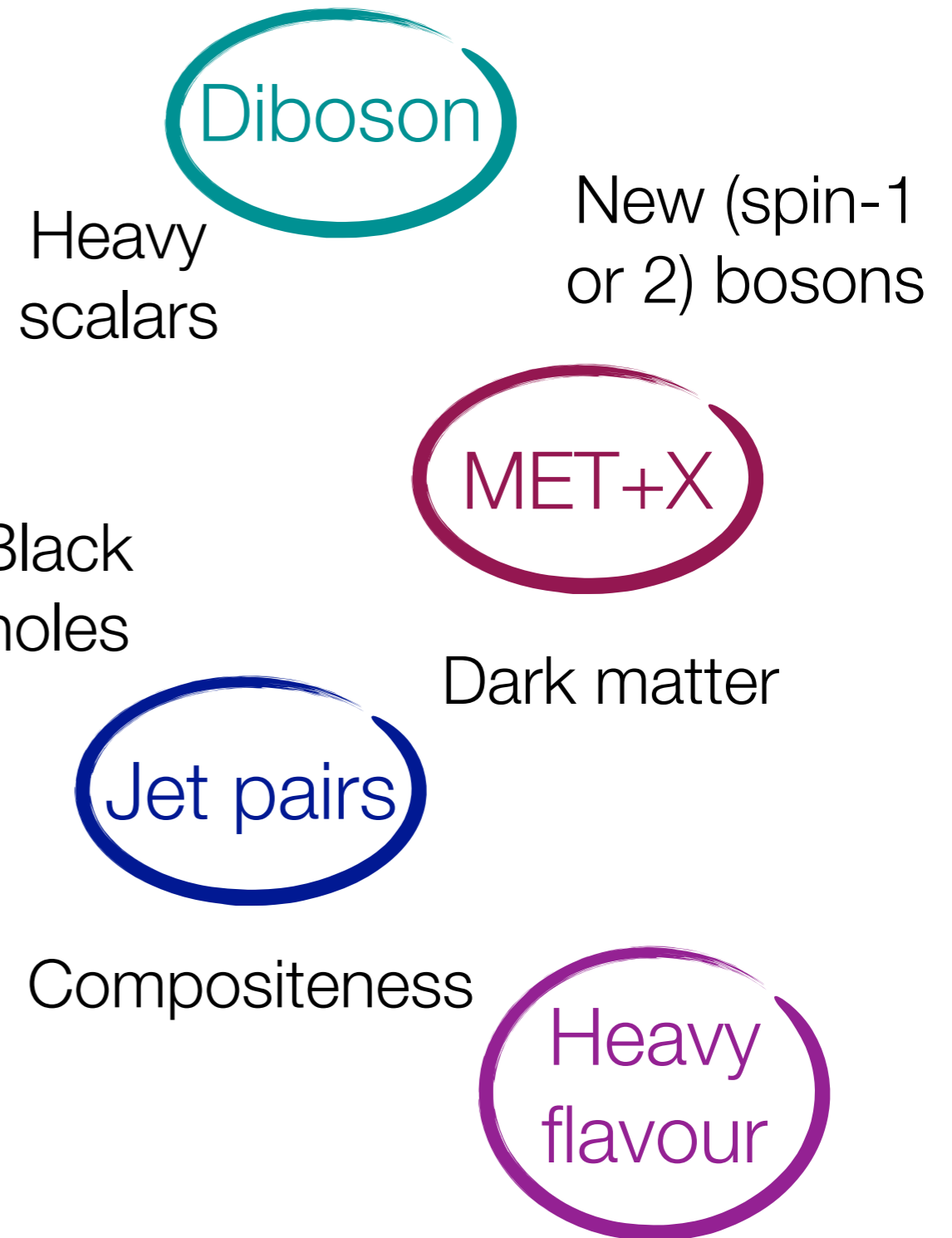
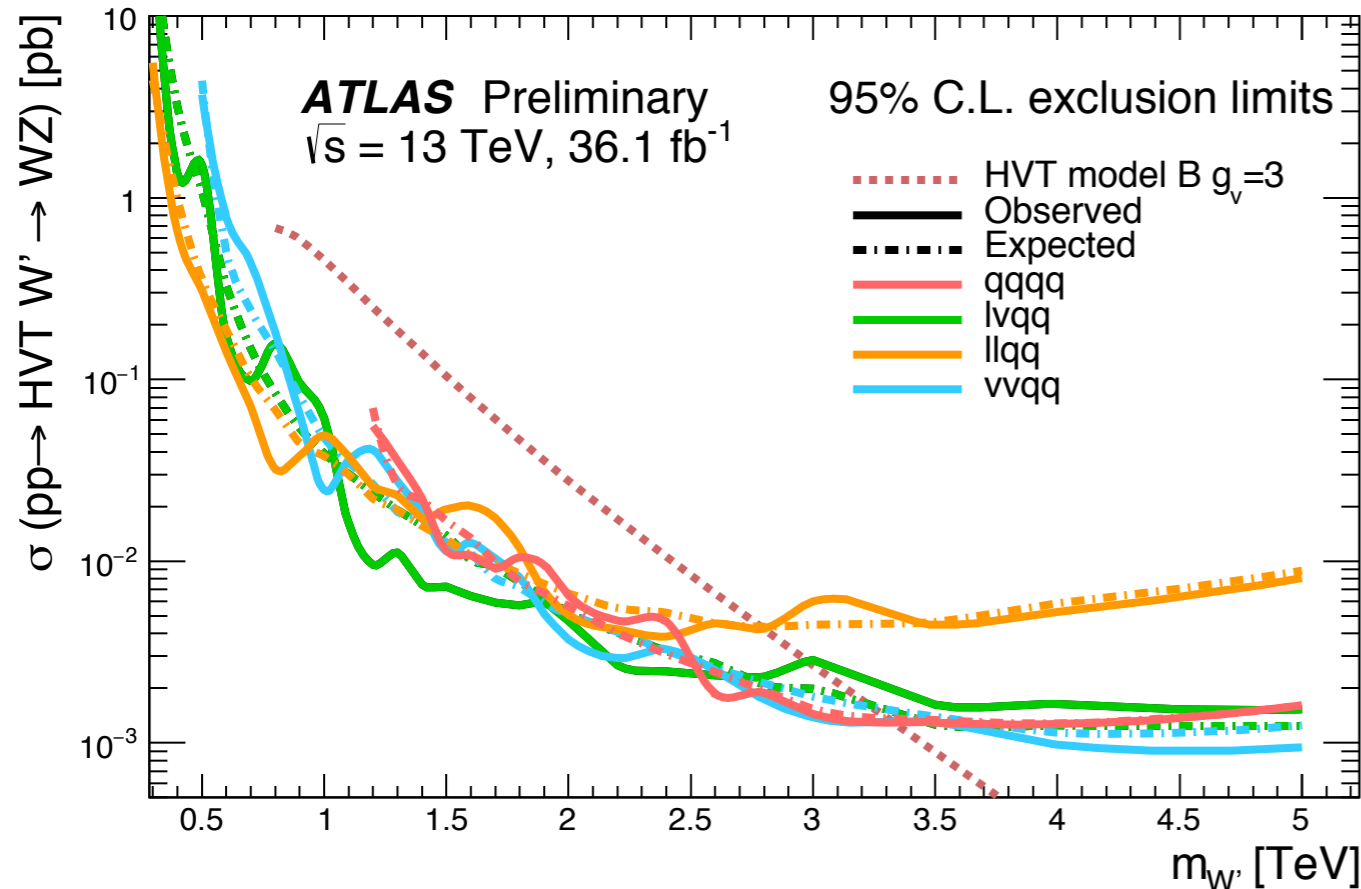
Exotics search methodology

- Largely signature driven
- Each signature open to range of BSM models
- Various dedicated summary or combination efforts in Run II



Exotics search methodology

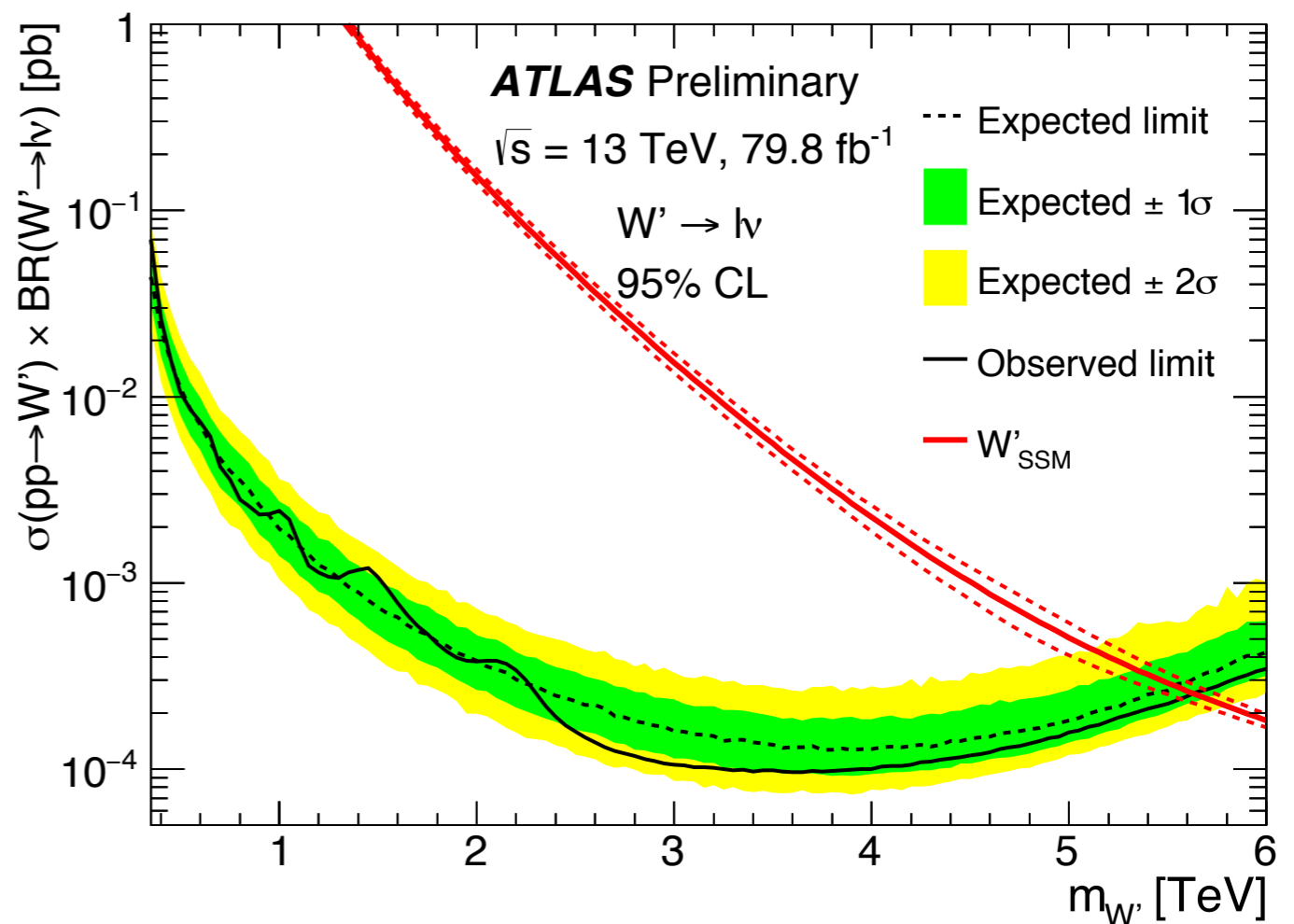
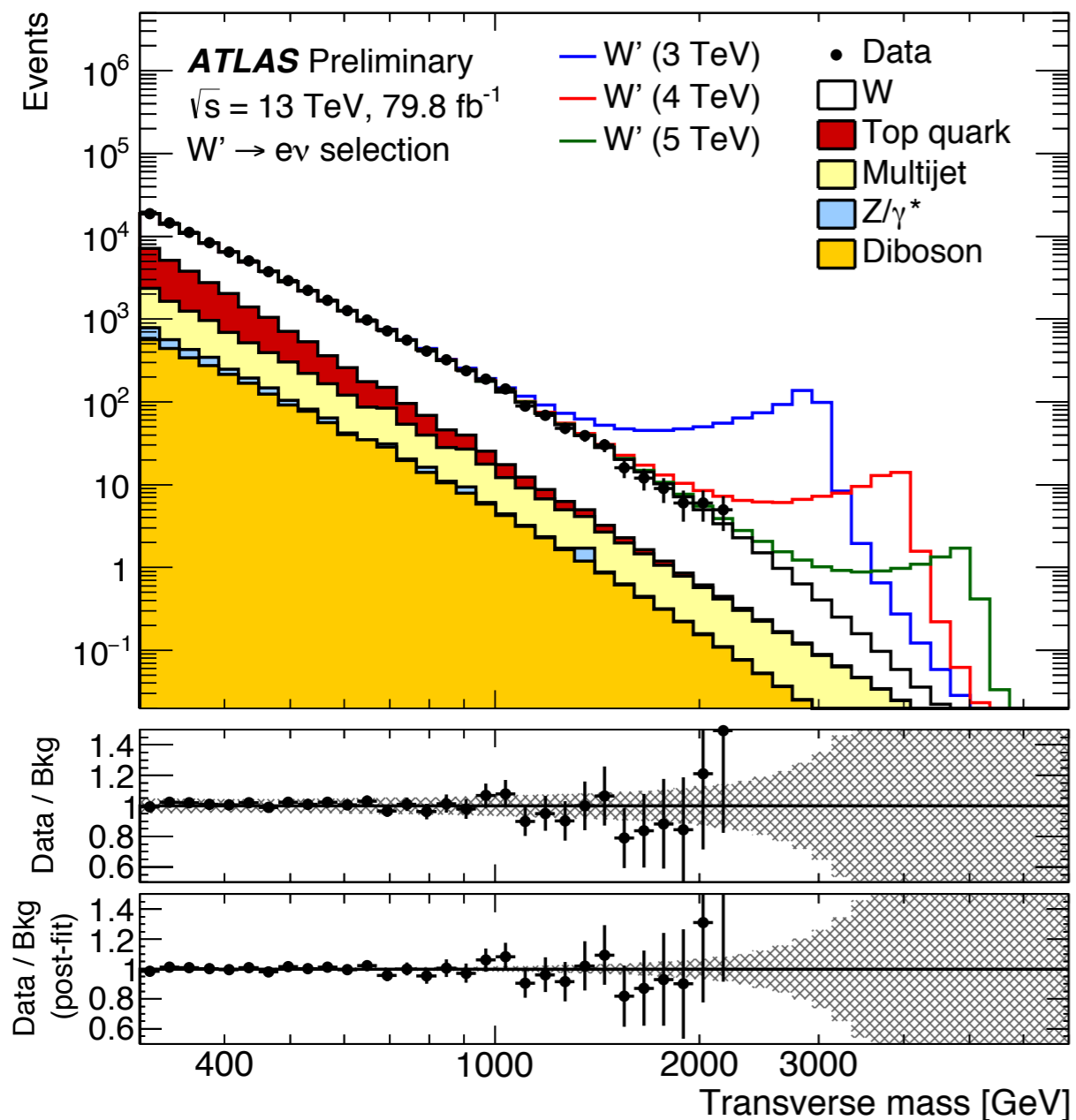
- Largely signature driven
- Each signature open to range of BSM models
- Various dedicated summary or combination efforts in Run II



Recent highlights: lepton+MET

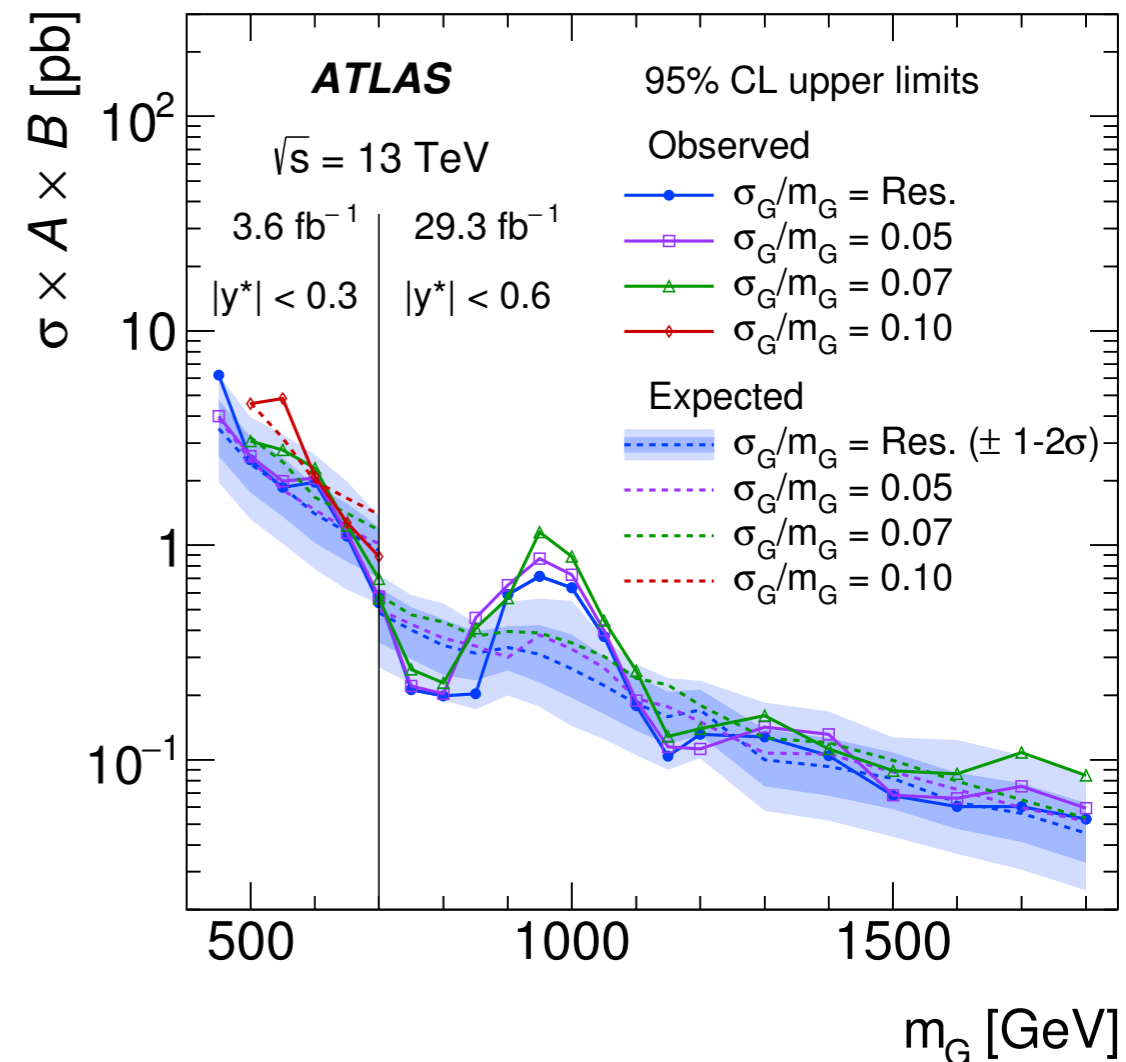
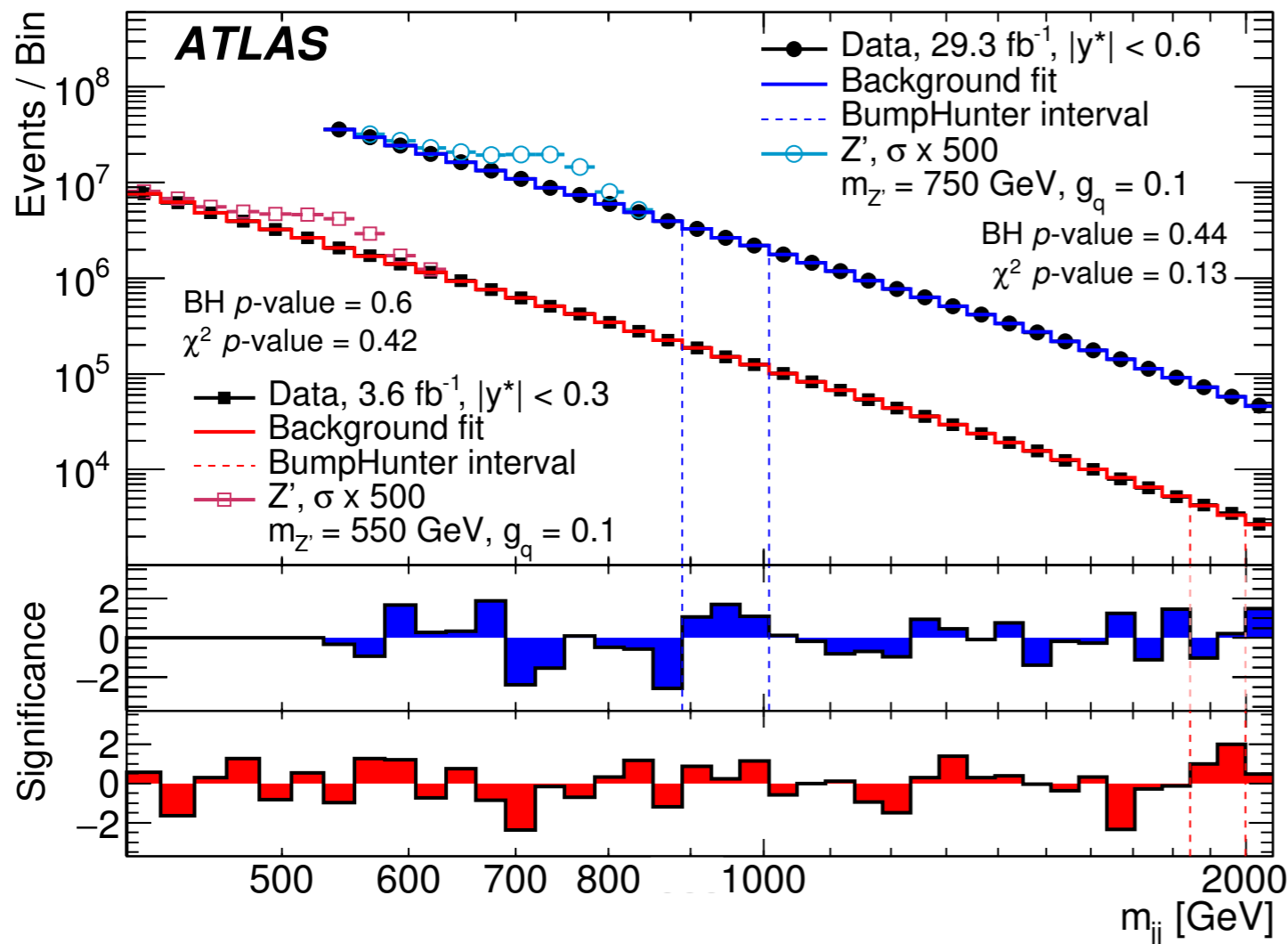
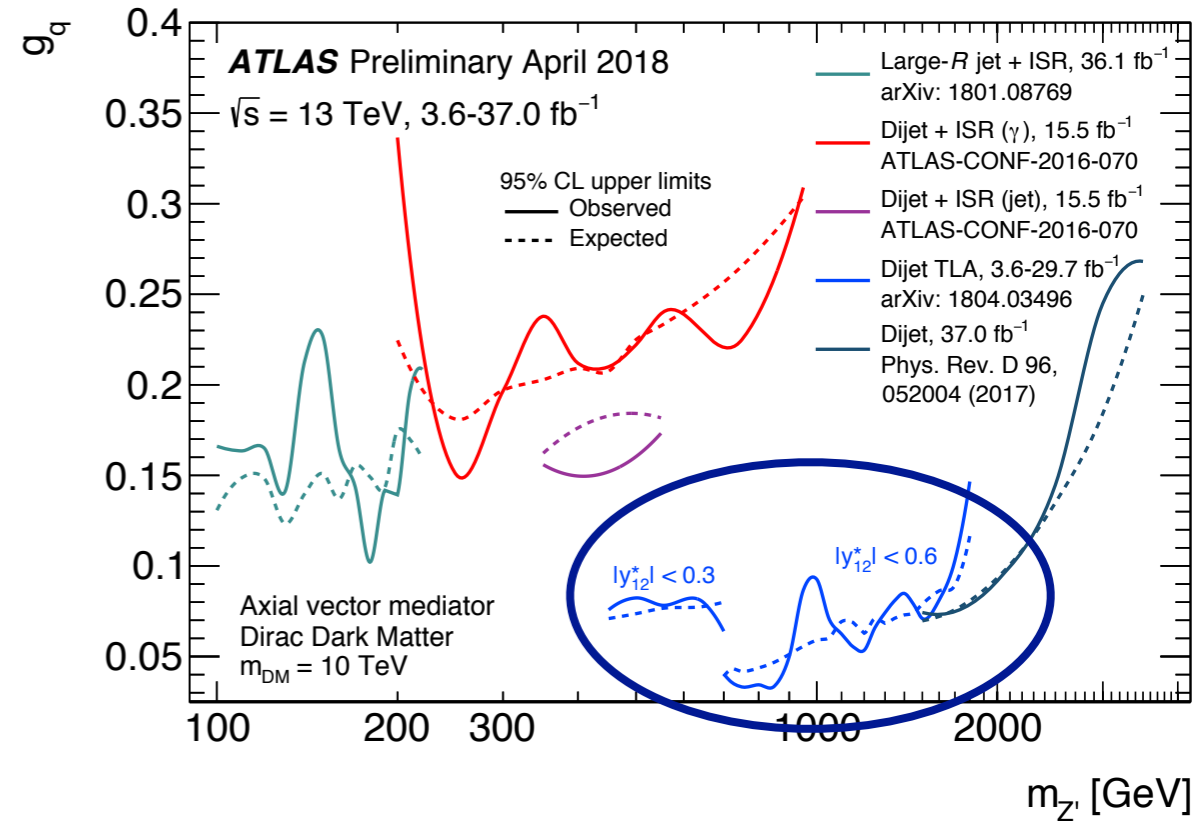
$$m_T = \sqrt{2p_T E_T^{\text{miss}} (1 - \cos \phi_{\ell\nu})}$$

- Search for heavy resonances decaying to $e/\mu + \nu$
- W' boson used as benchmark model to define limits
- One of first 80/fb “intermediate” ATLAS results

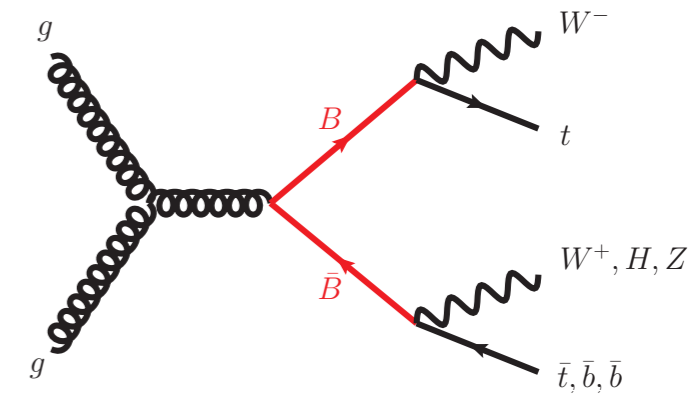


Recent highlights: TLA

- Dijet final state open to many models. Here, look for Z' mediator
- Use jets at trigger level to access low cross section, low mass signals

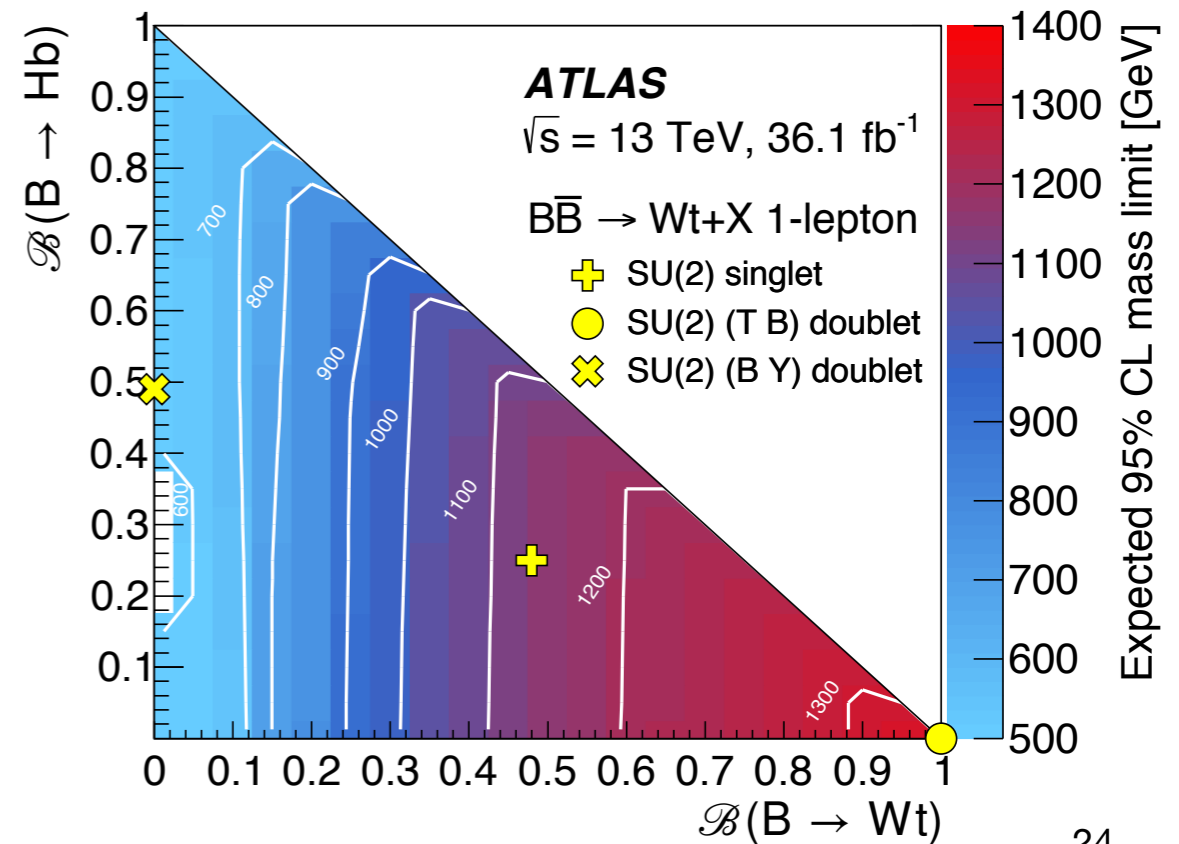
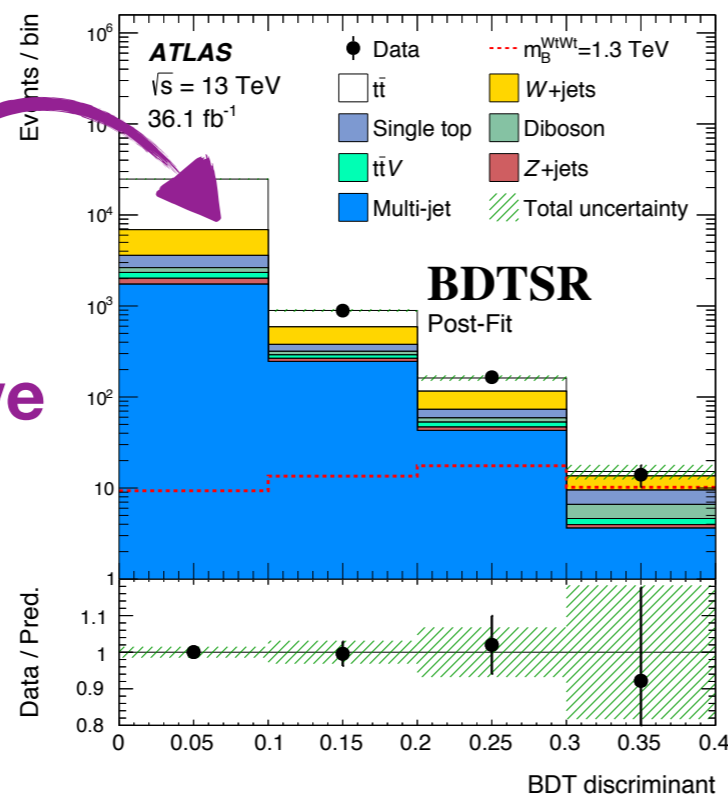
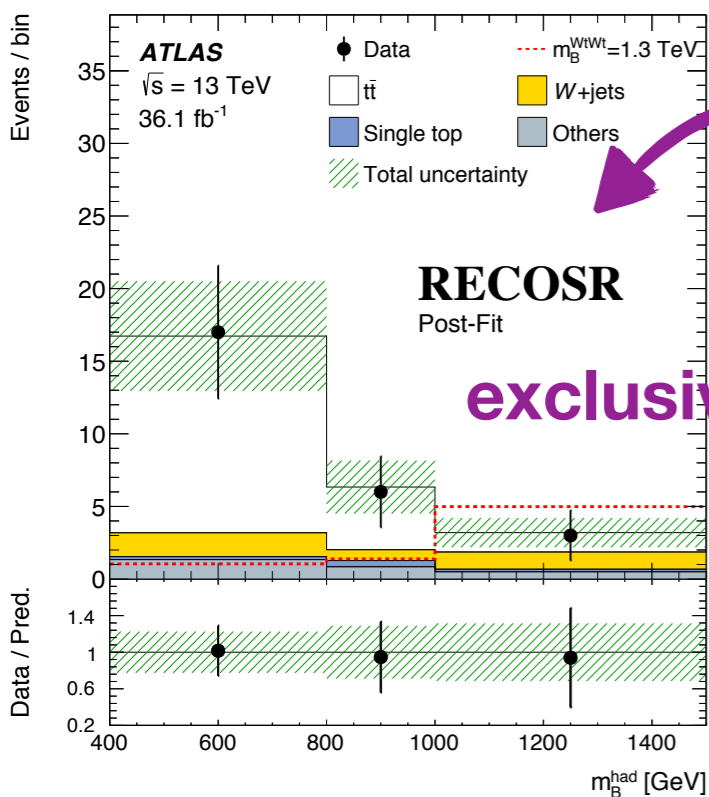
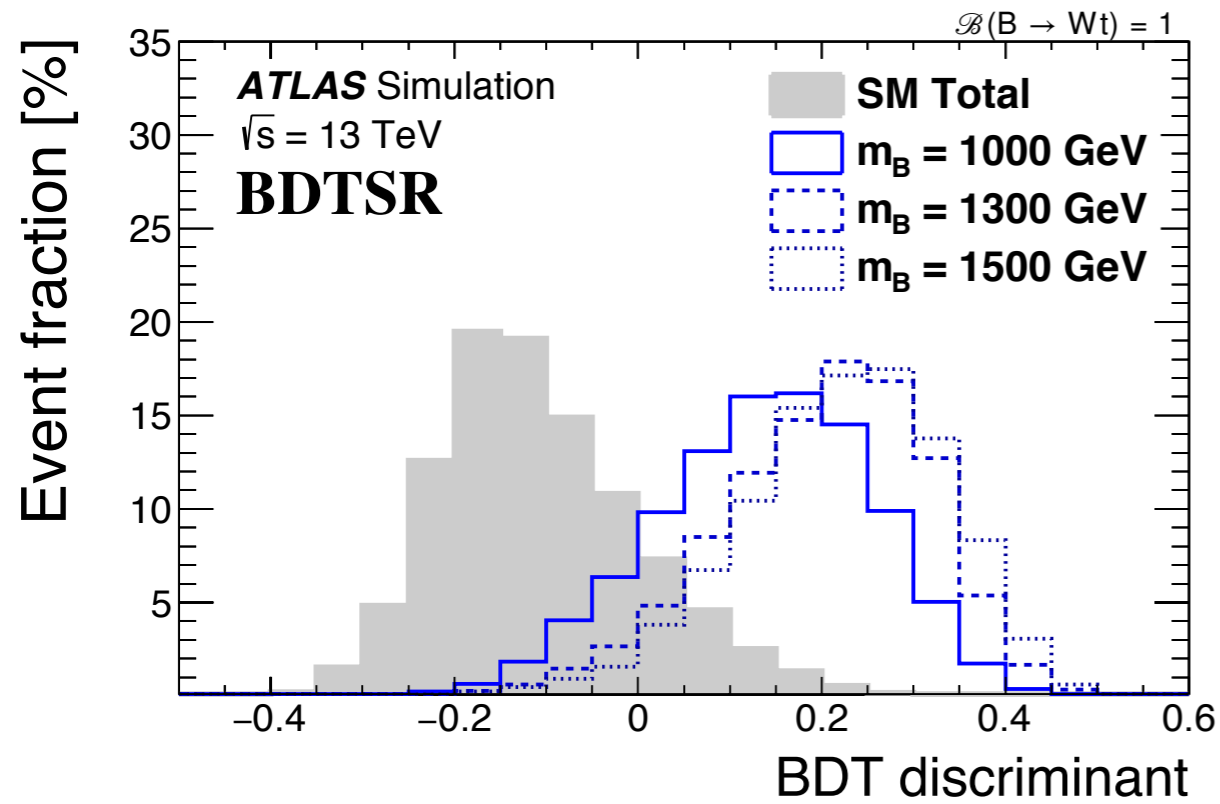


Recent highlights: vector-like quarks



arxiv:1806.01762

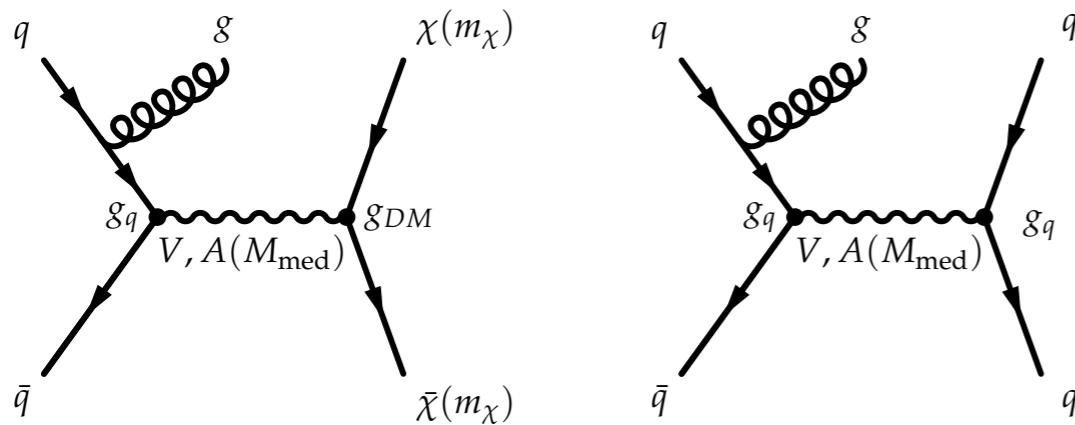
- Example of increasing usage of machine learning in ATLAS: one signal region defined via a BDT!
- Only events not in traditional SR considered in BDT selection



Exotics constraints on dark matter

Z' simplified model

- Assume vector or axial-vector mediator

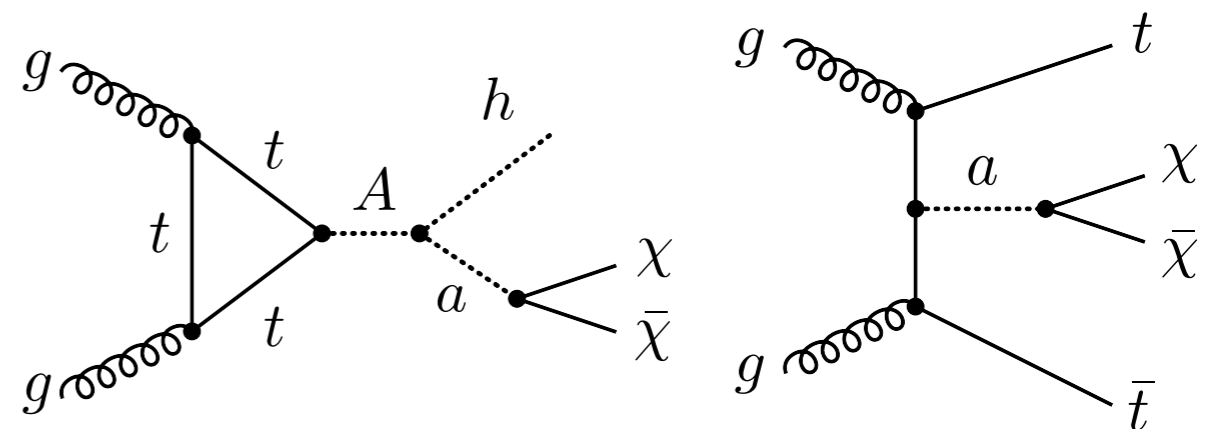


- Strong constraints from mono-X, dijet(+X), dilepton analysis families
- Public plots out now, see next page!

[arxiv:1507.00966](https://arxiv.org/abs/1507.00966)

2-Higgs doublet model

- More realistic benchmark
- Still simplified, but UV-complete

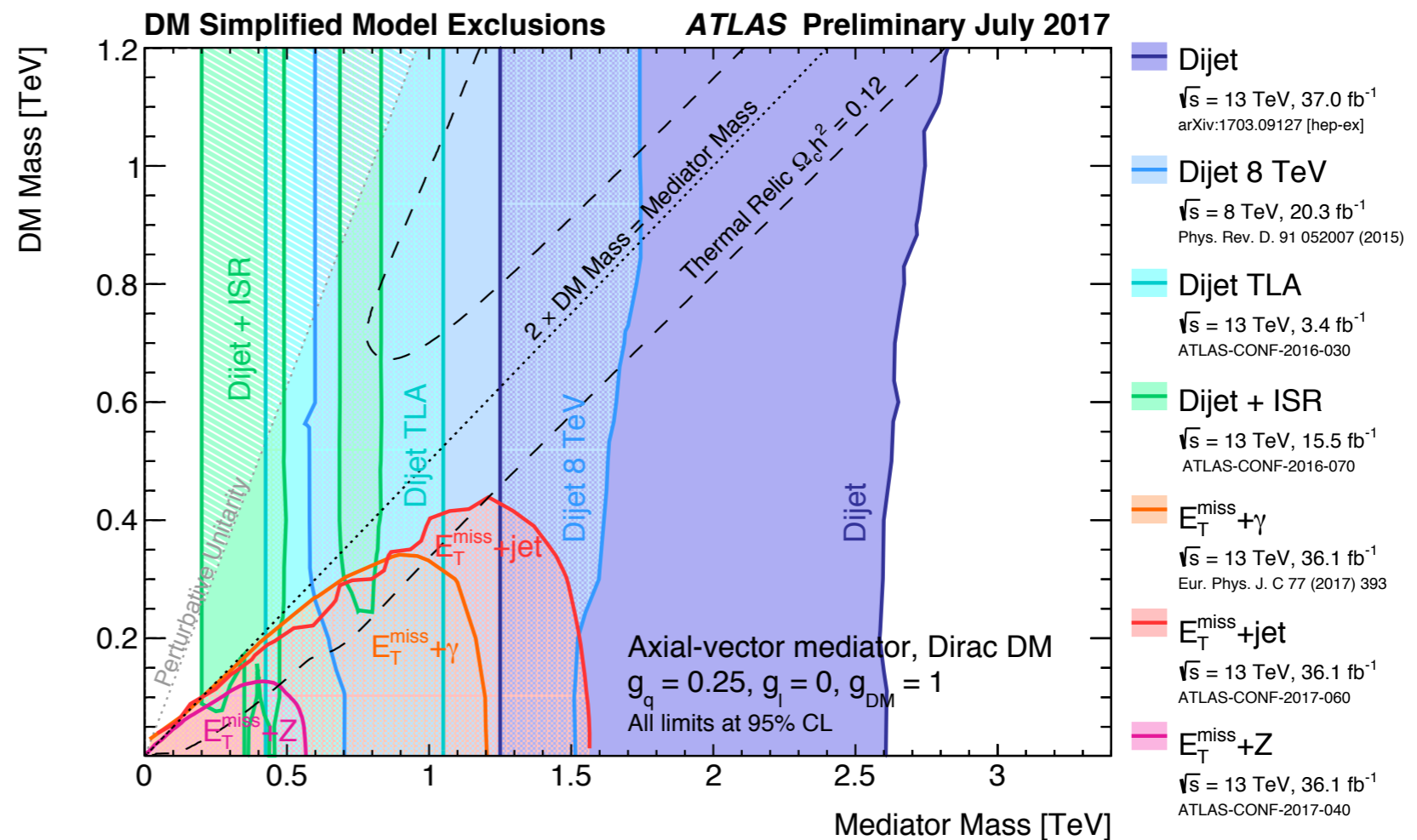
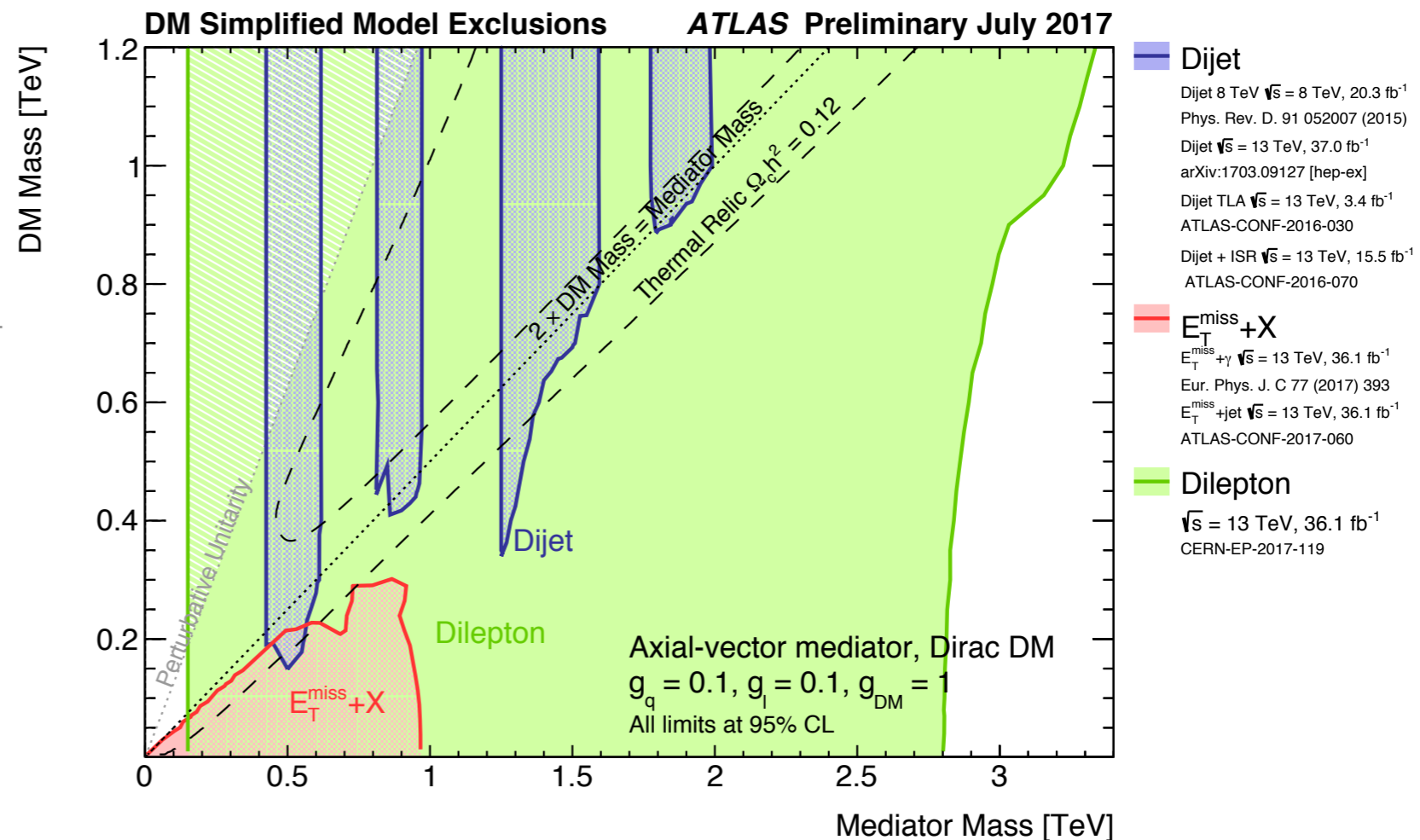


- Strong constraints from mono-X, heavy flavour analyses
- Summary in whitepaper

[arxiv:1701.07427](https://arxiv.org/abs/1701.07427)

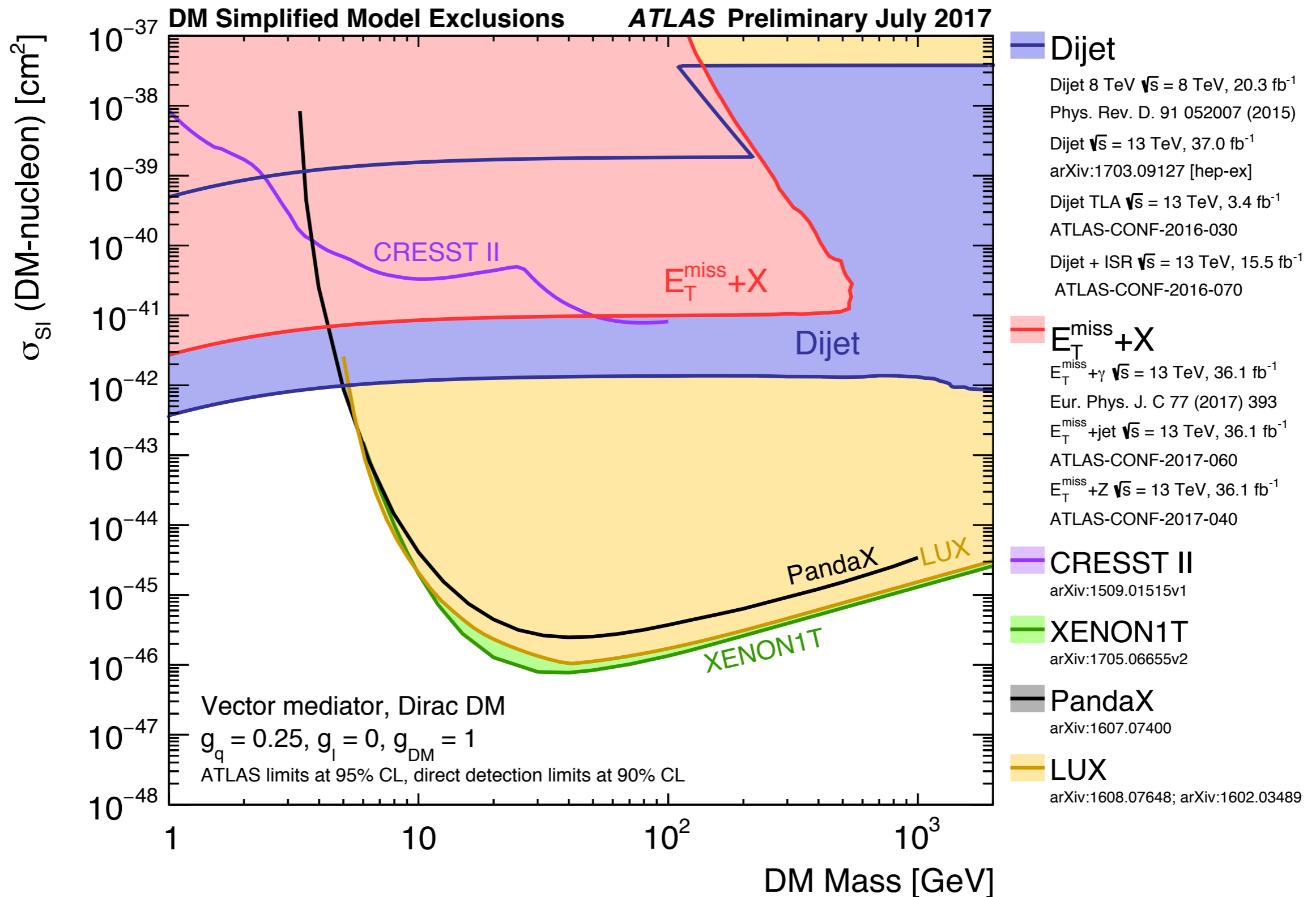
Dark matter: Z' mediator summary

- Results still depend a lot on the assumptions we make, even with just 5 free parameters!
- Plots: axial-vector mediator (vector mediator in backup)
- Top: $g_L = 0.1, g_q = 0.1$
- Bottom: $g_L = 0, g_q = 0.25$

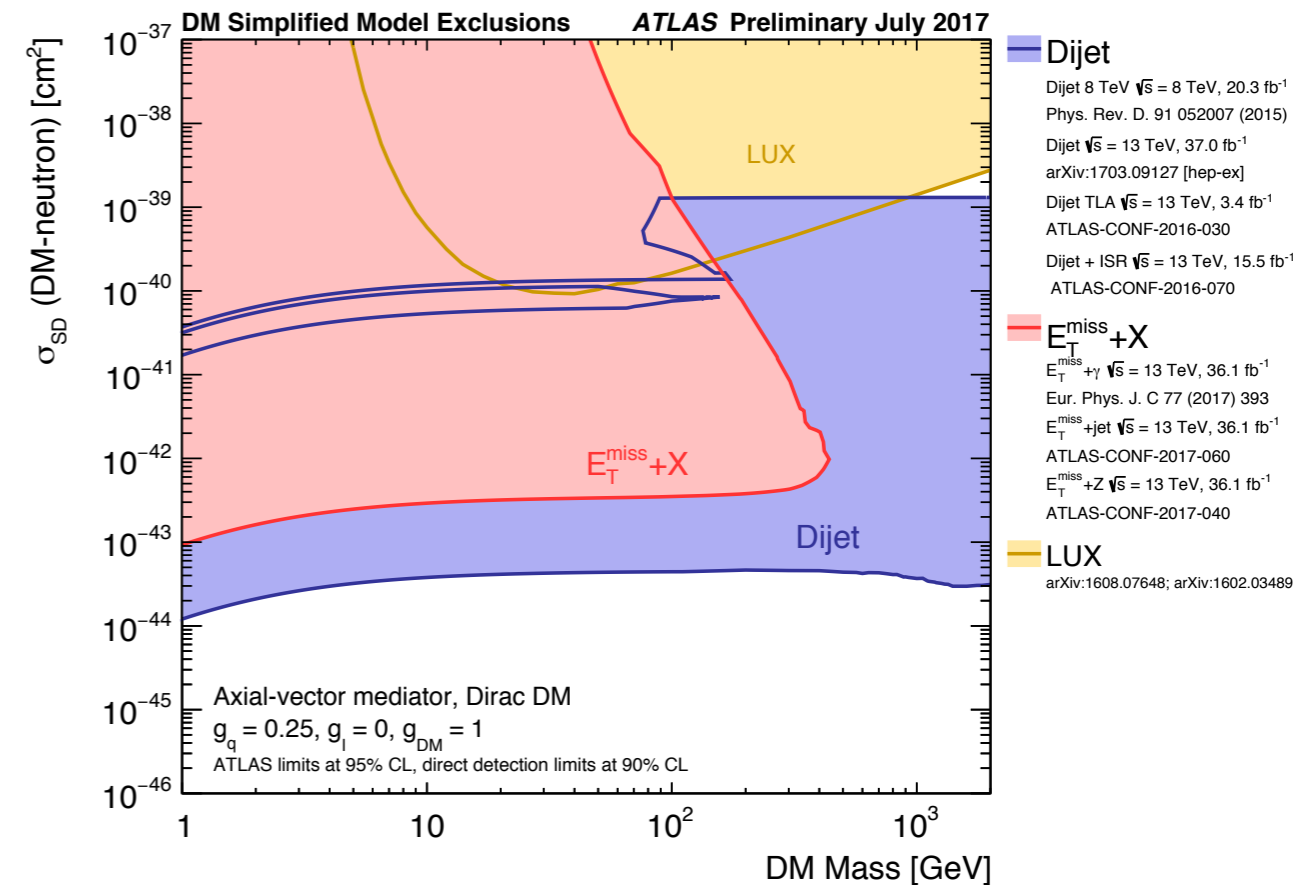
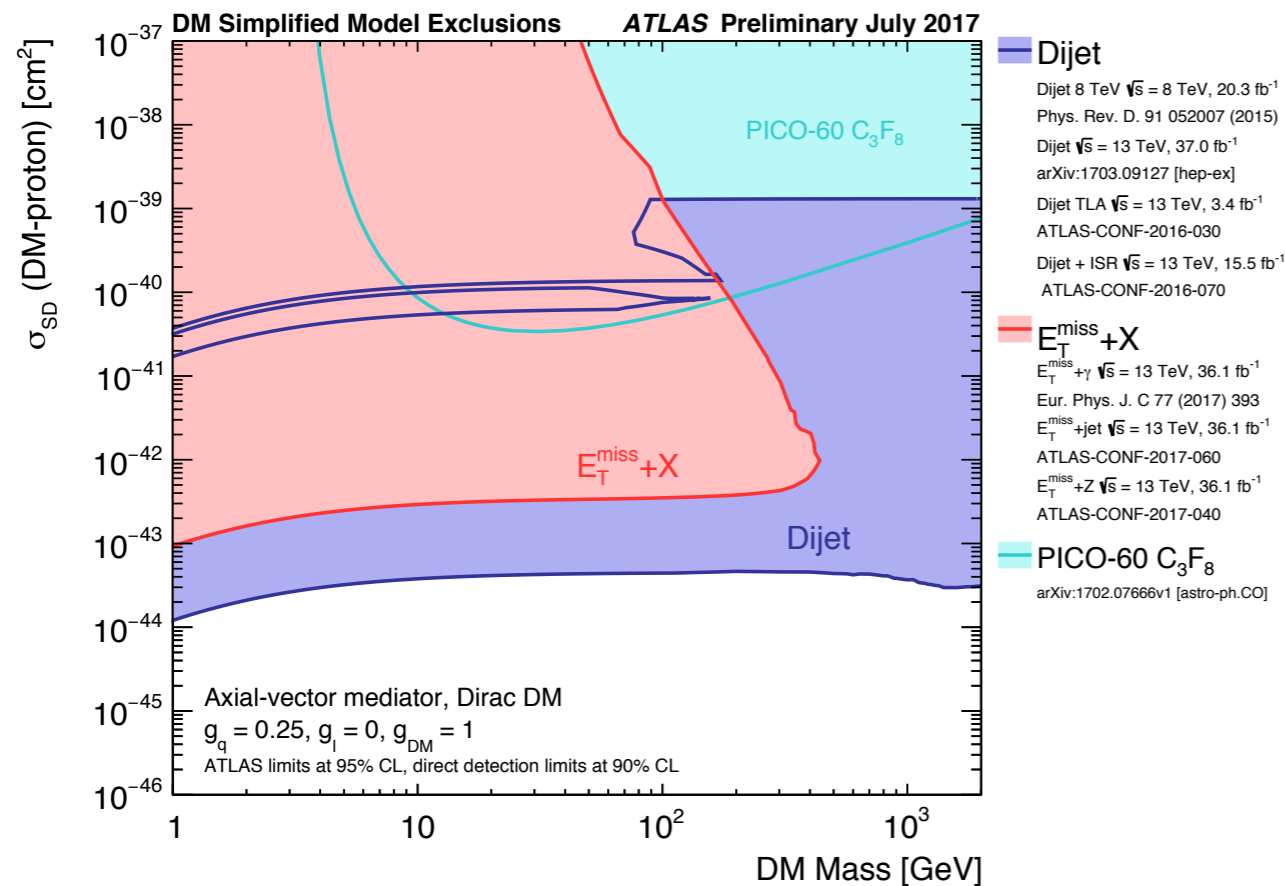


Comparing collider DM limits to the rest of the field

Spin-independent DM-nucleon σ



Comparing collider DM limits to the rest of the field



- Axial vector mediators, spin dependent limits
- Left: DM-proton cross section. Right: DM-neutron cross section.

Important to place collider results in wider context!

Now what?

Up and out



Search program in early Run II
focused on low-hanging fruit:
strongly produced signatures, simple
final states, simple detector needs



Up and out

Now working up the tree:
EW SUSY, low mass or low cross
section signals are still benefitting
from increasing luminosity

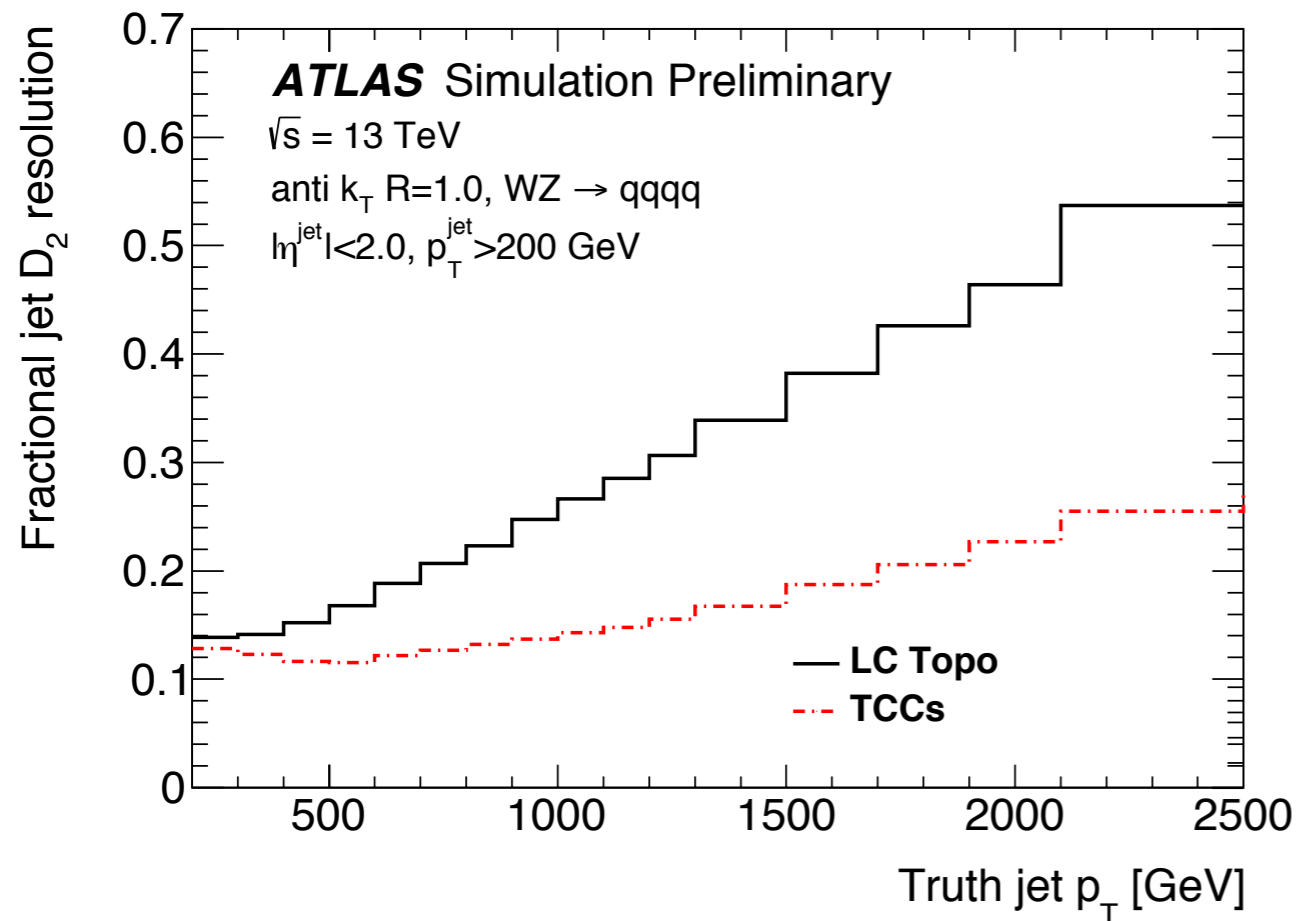


Up and out

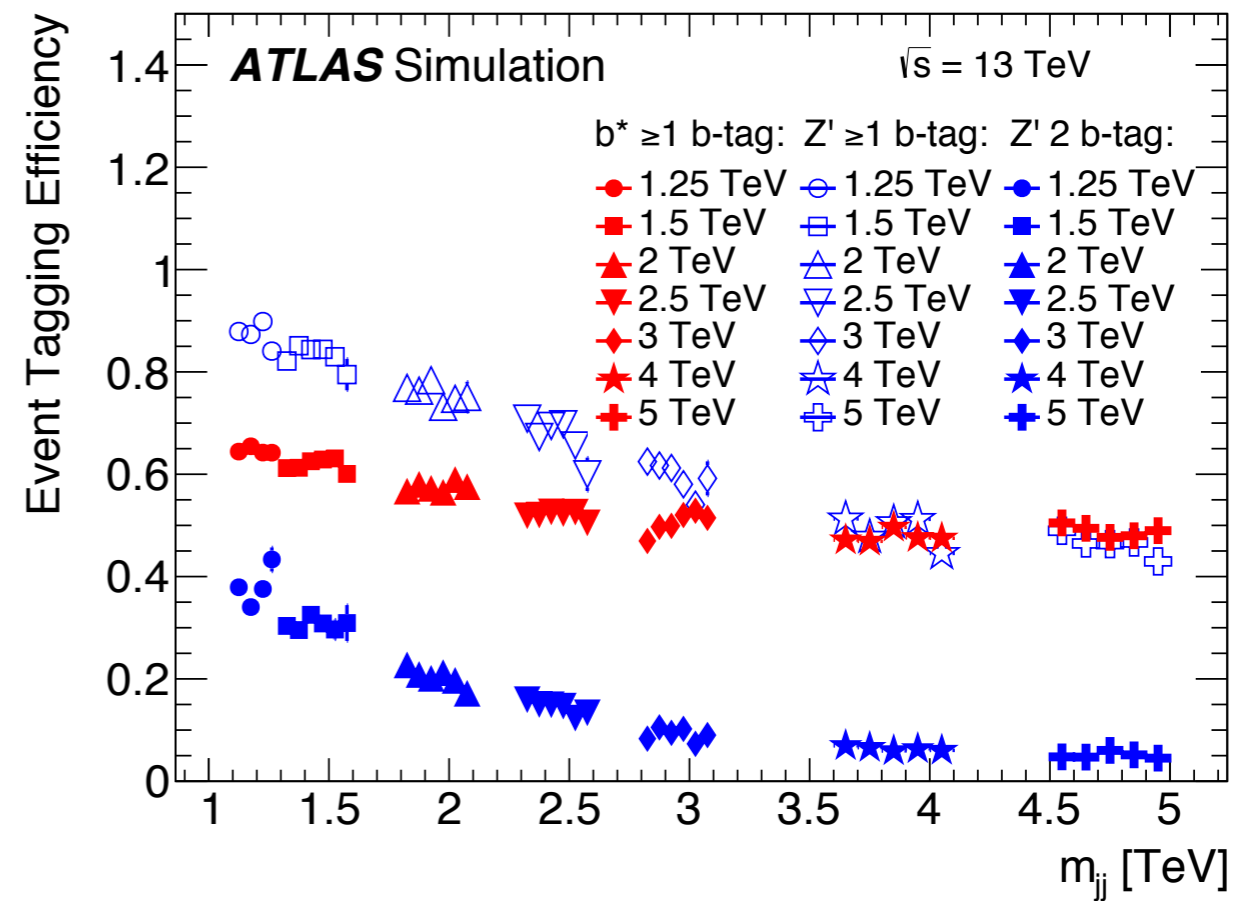
Lots left to do which is hard to see or hard to access! Really compressed states, long lived particles, signatures with interference...

Improving performance improves analyses!

- Instead of sitting and waiting for a slow accumulation of luminosity, push performance improvements and analysis reach improves.

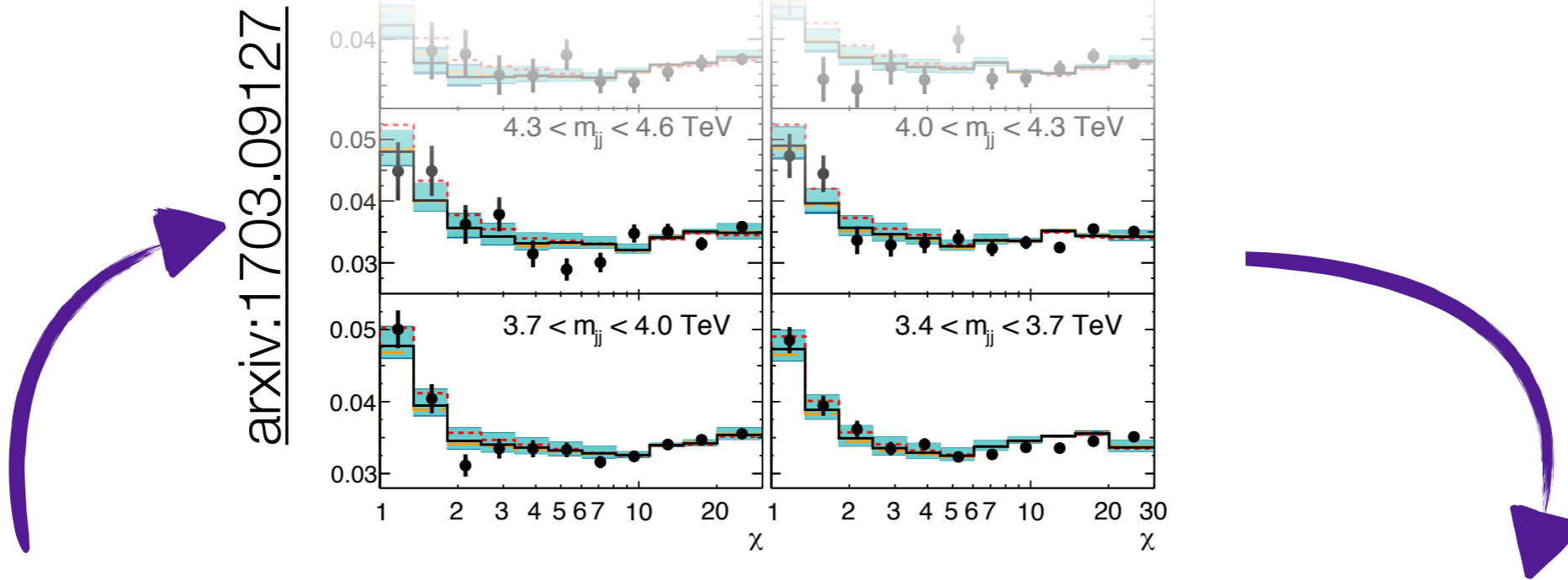


Example: new jet inputs in $VVJJ$ improve resolution!

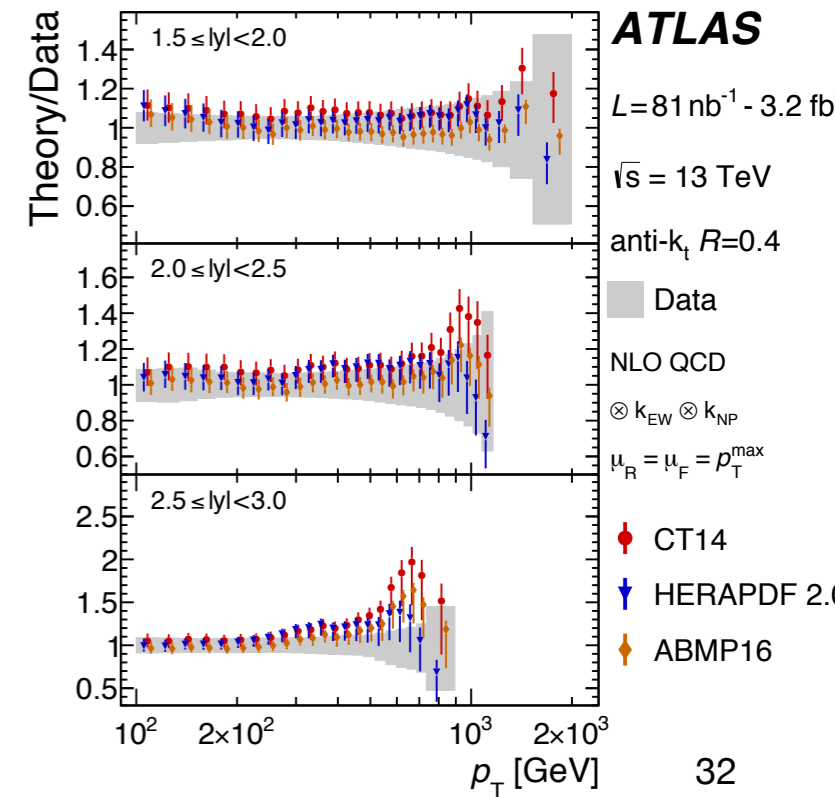
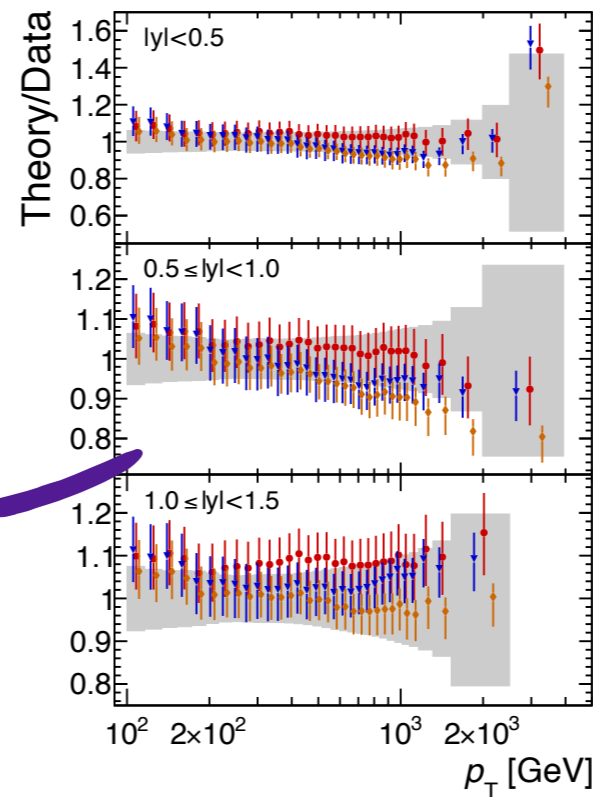
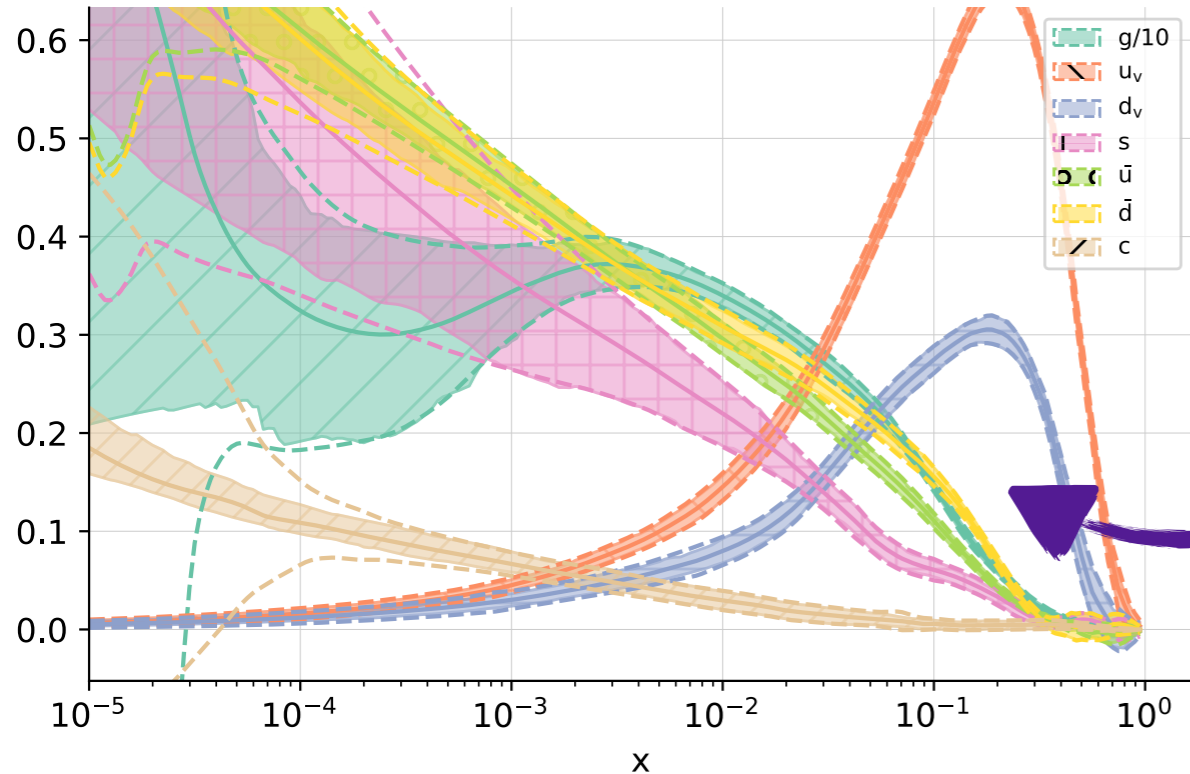


Example: improving b-tagging efficiency would benefit searches!

The search and measurement lifecycle

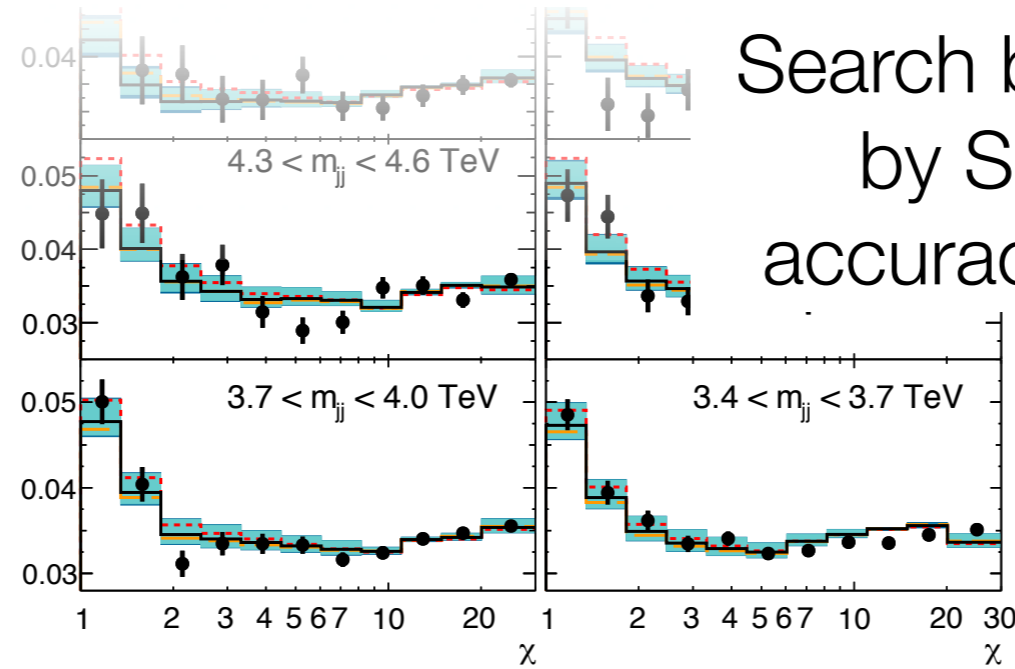


NNPDF 3.1 NNLO Q= 2.0 GeV



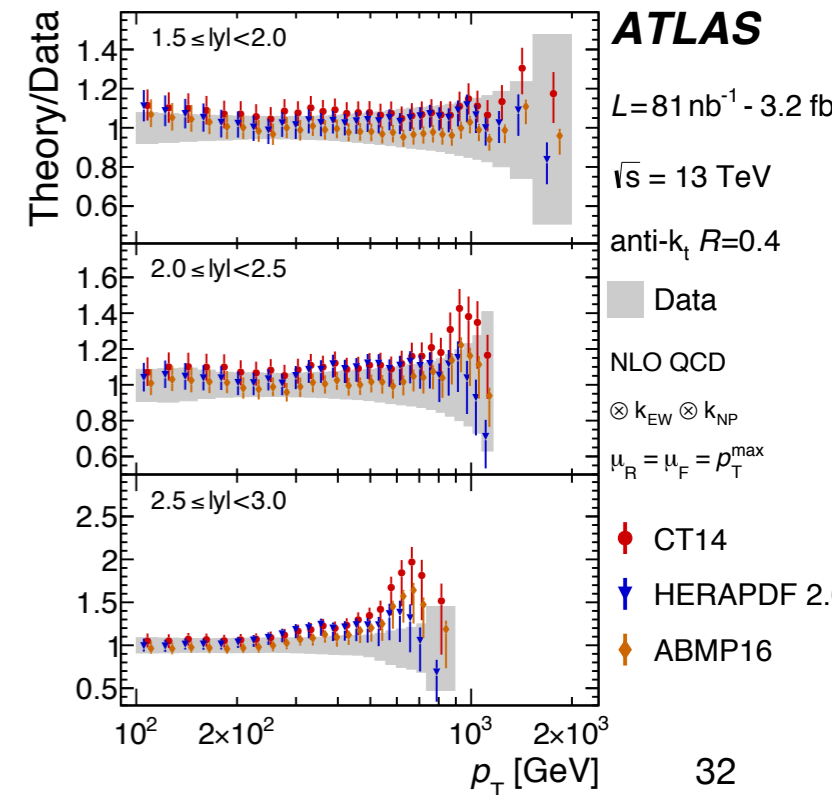
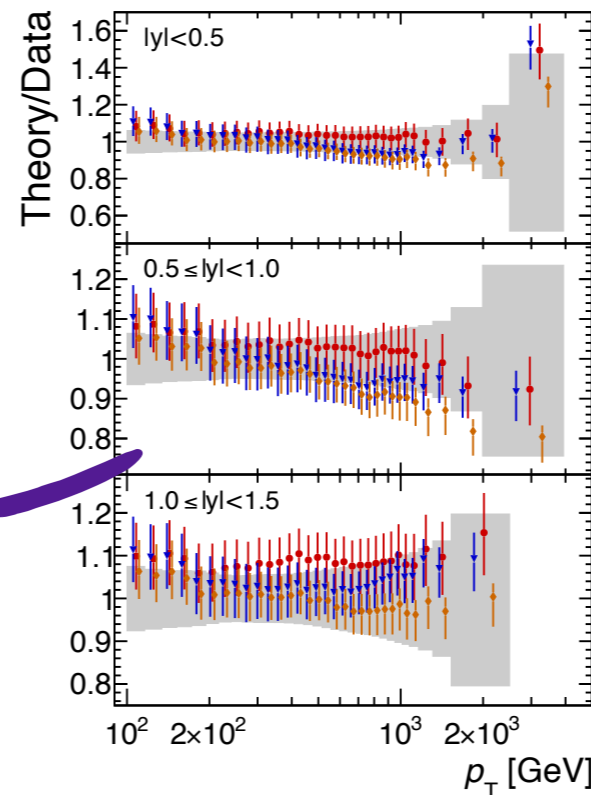
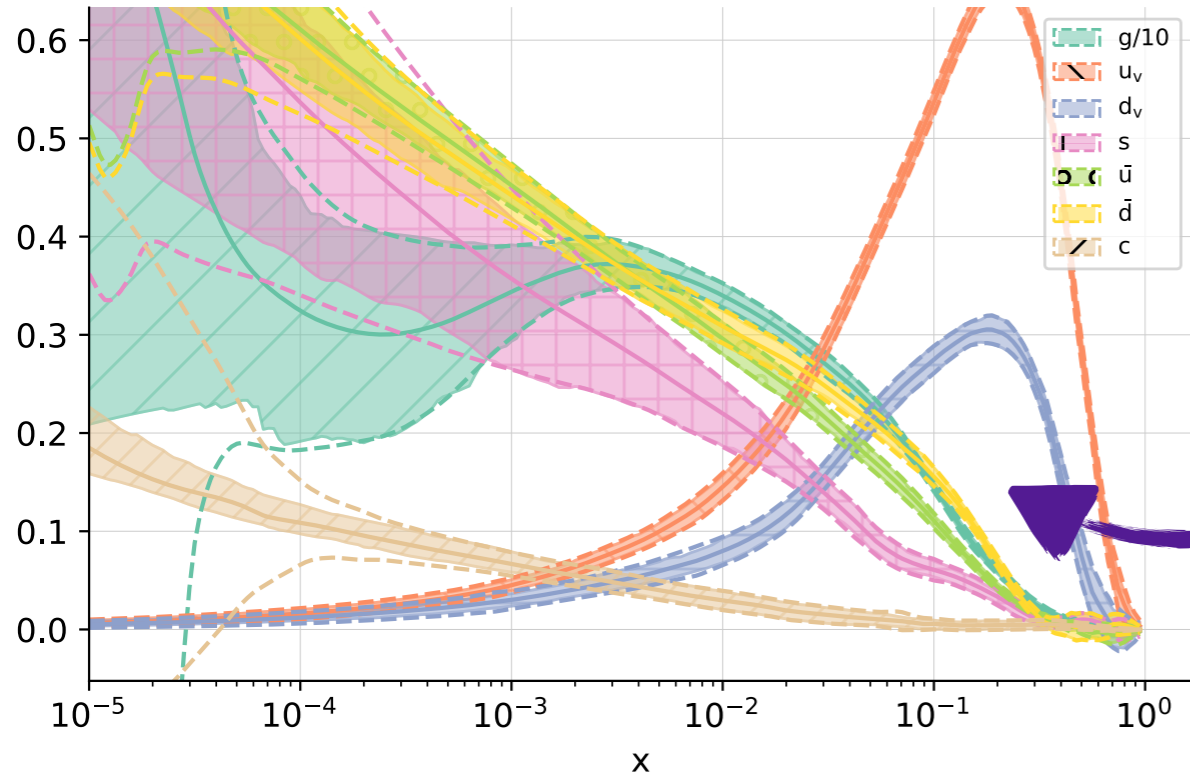
The search and measurement lifecycle

arxiv:1703.09127



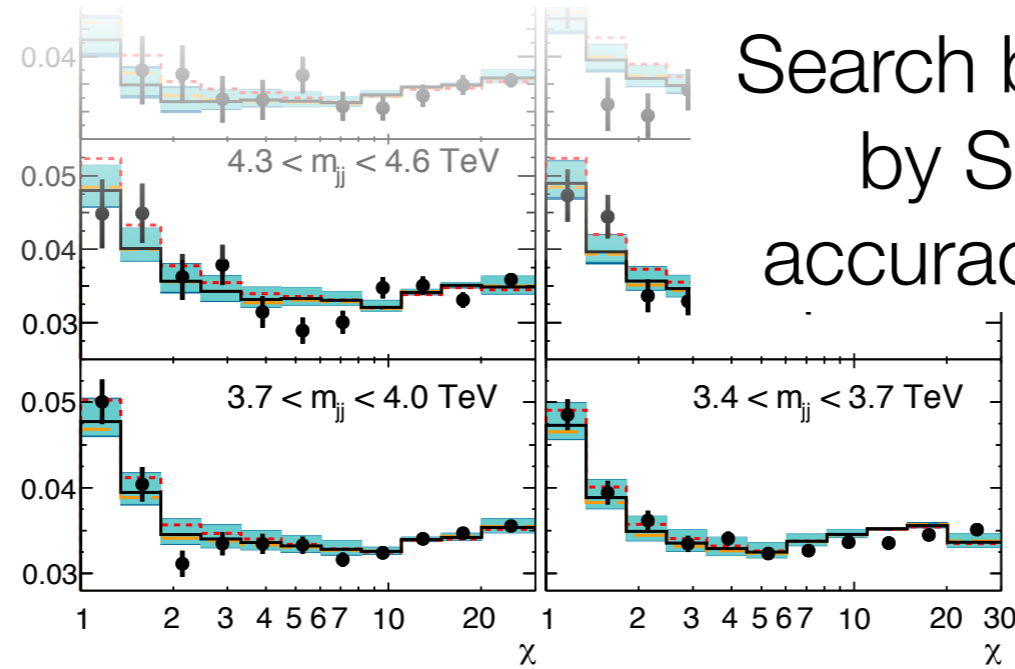
Search becomes limited by SM prediction accuracy/uncertainties

NNPDF 3.1 NNLO Q= 2.0 GeV



The search and measurement lifecycle

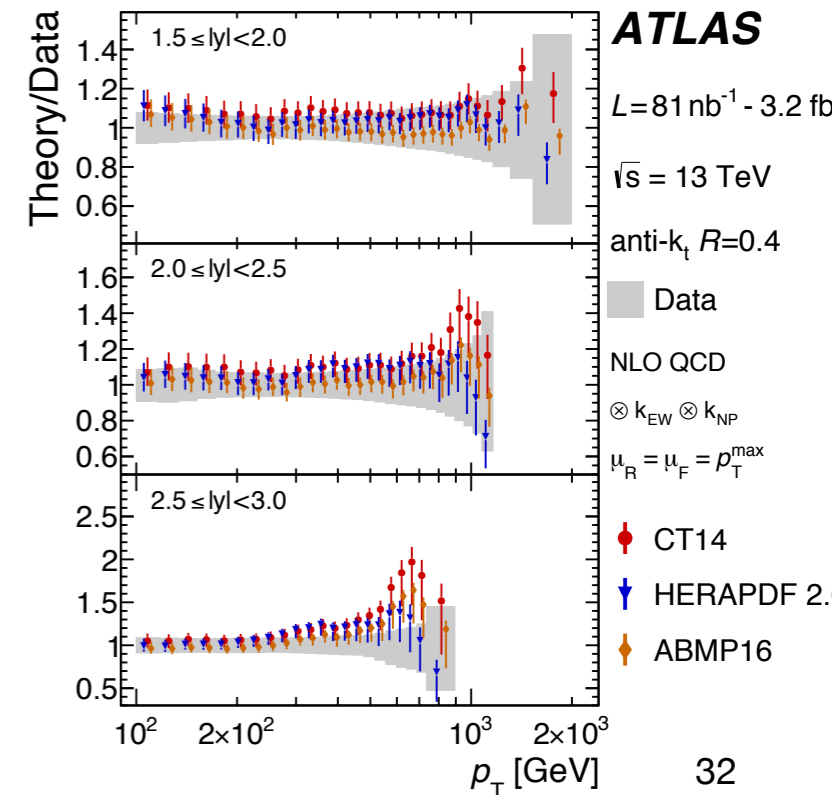
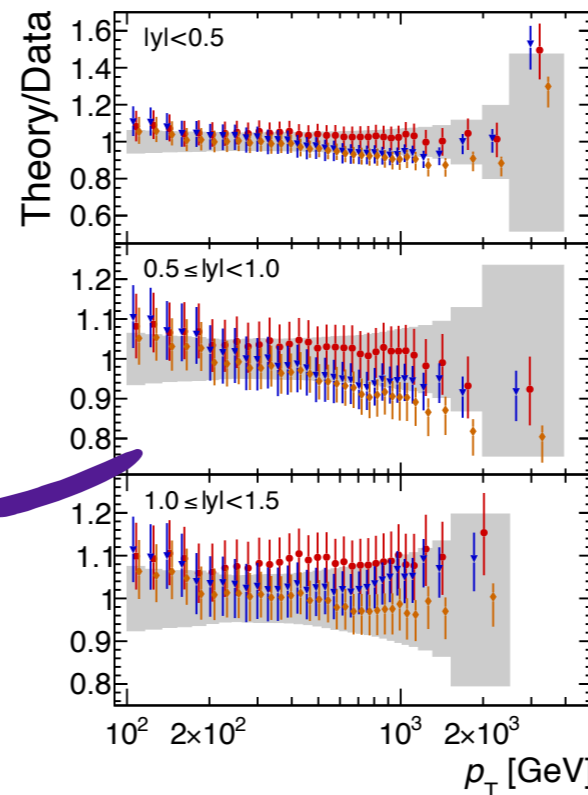
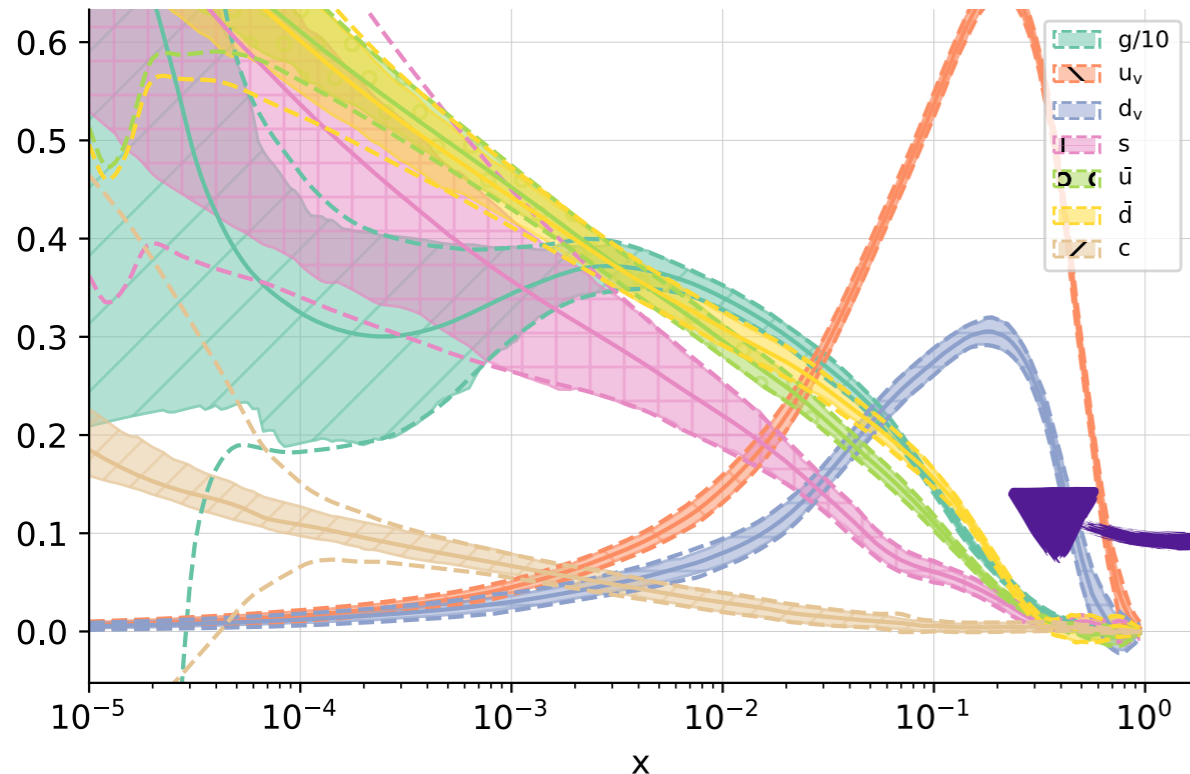
arXiv:1703.09127



Search becomes limited by SM prediction accuracy/uncertainties

Measurement provides new input for theory predictions

NNPDF 3.1 NNLO Q= 2.0 GeV

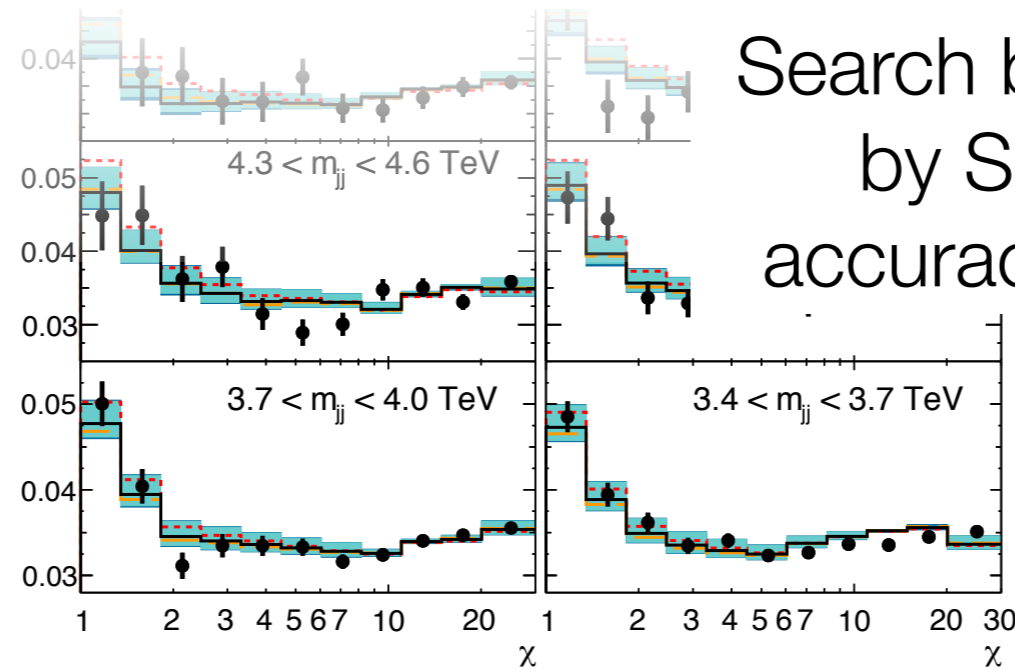


ATLAS
 $L = 81 \text{ nb}^{-1} - 3.2 \text{ fb}^{-1}$
 $\sqrt{s} = 13 \text{ TeV}$
 anti- k_t $R=0.4$
 Data
 NLO QCD
 $\otimes k_{EW} \otimes k_{NP}$
 $\mu_R = \mu_F = p_T^{\max}$
 CT14
 HERAPDF 2.0
 ABMP16

The search and measurement lifecycle

Predictions improve

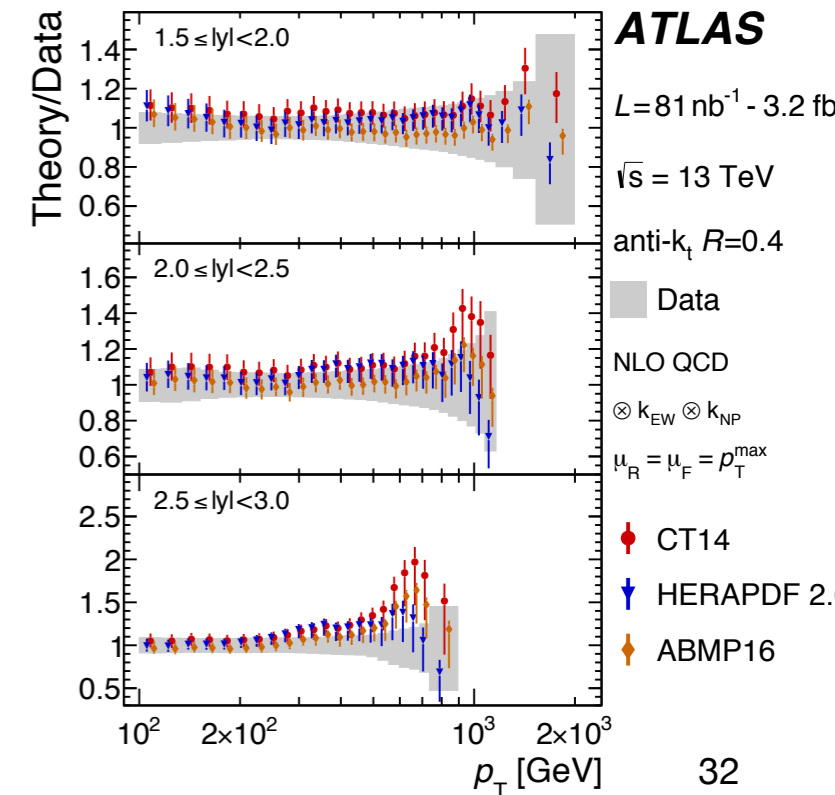
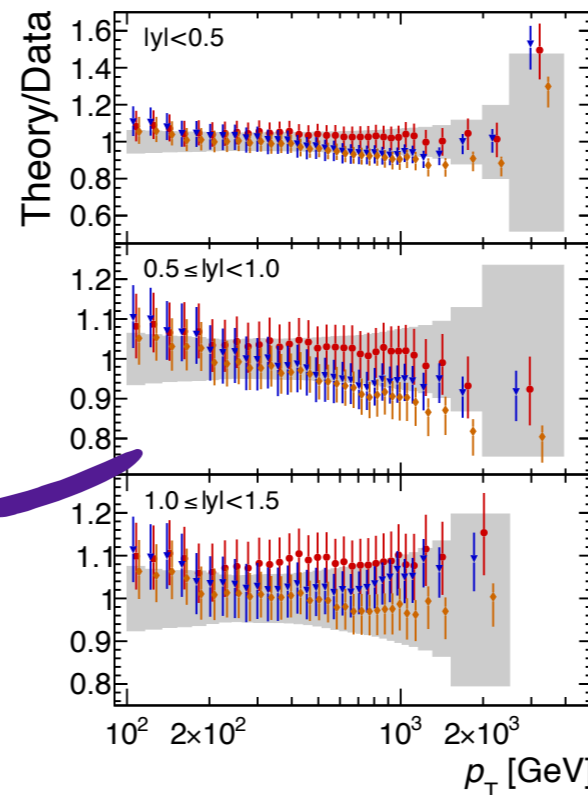
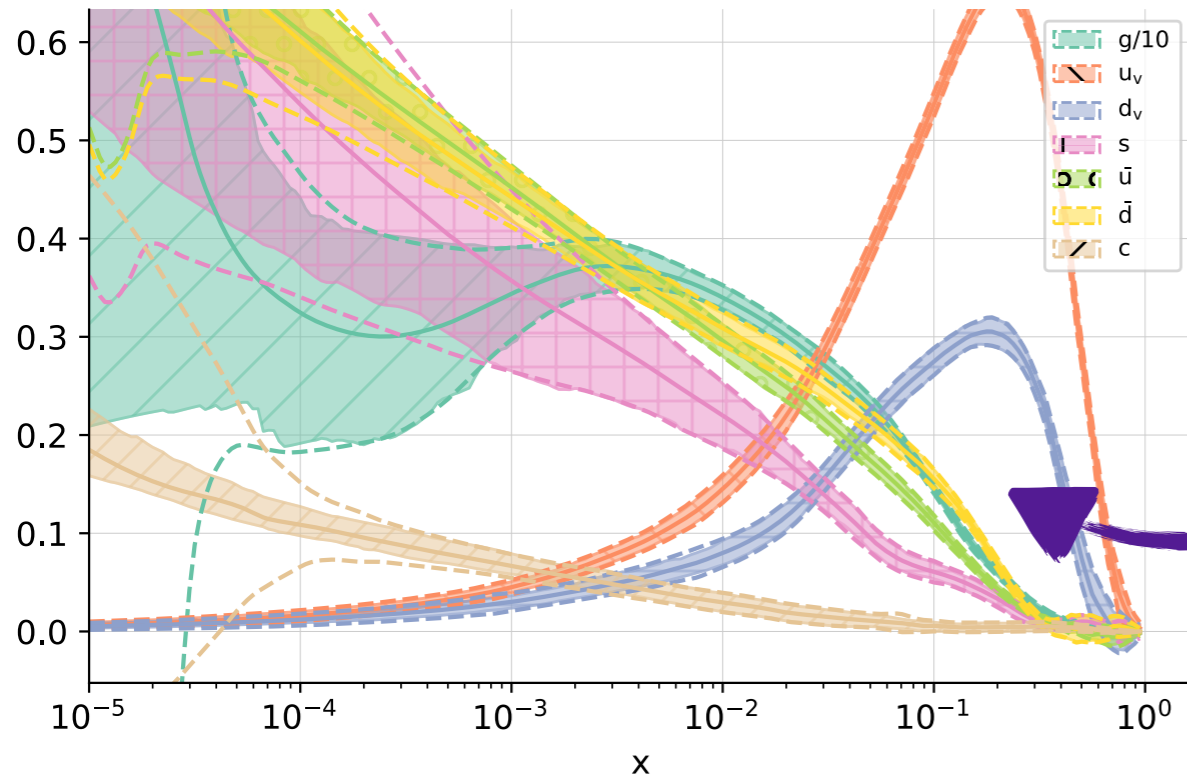
arxiv:1703.09127



Search becomes limited by SM prediction accuracy/uncertainties

Measurement provides new input for theory predictions

NNPDF 3.1 NNLO Q= 2.0 GeV





The BSM landscape at 13 TeV

Looked under most of the obvious rocks ...

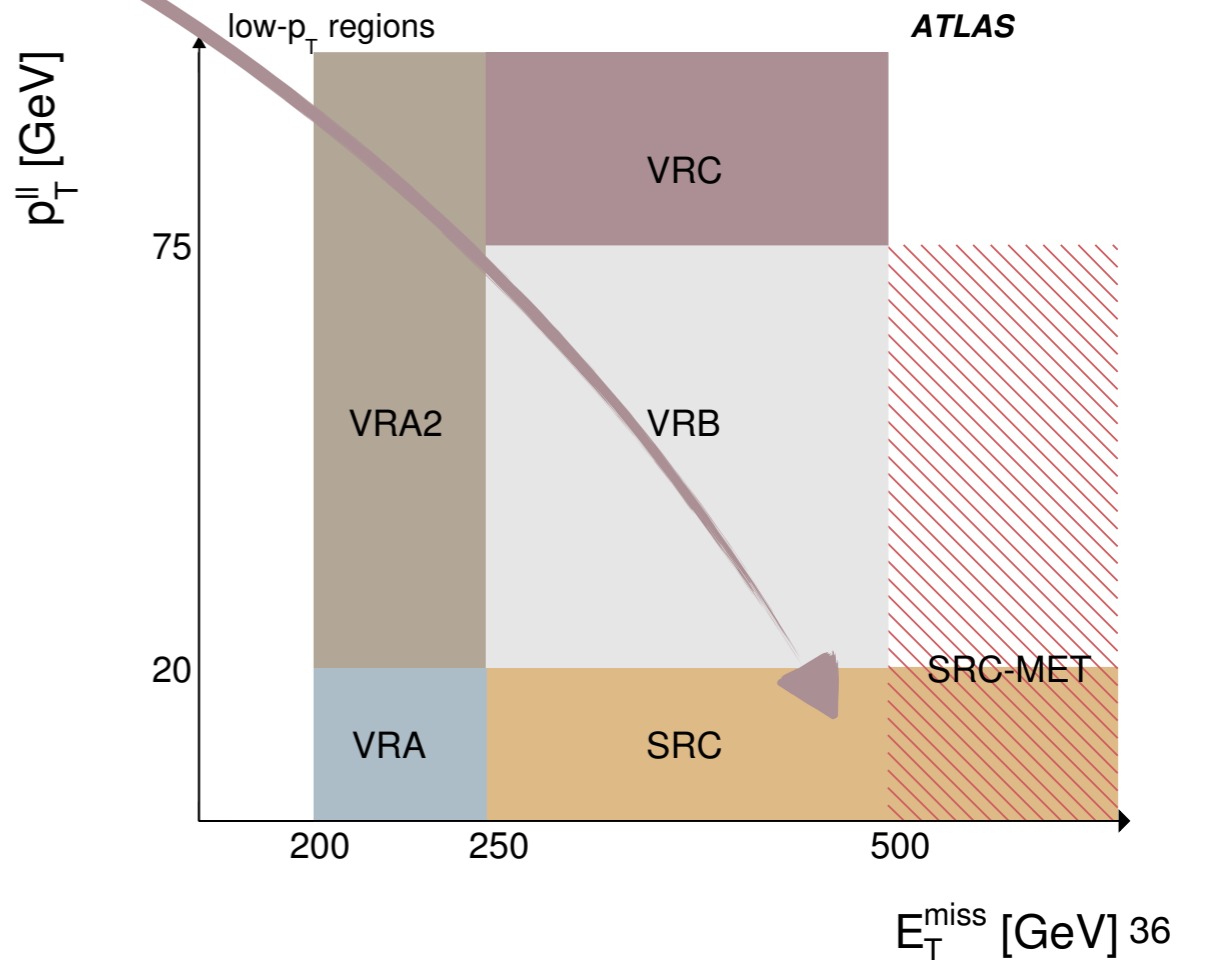
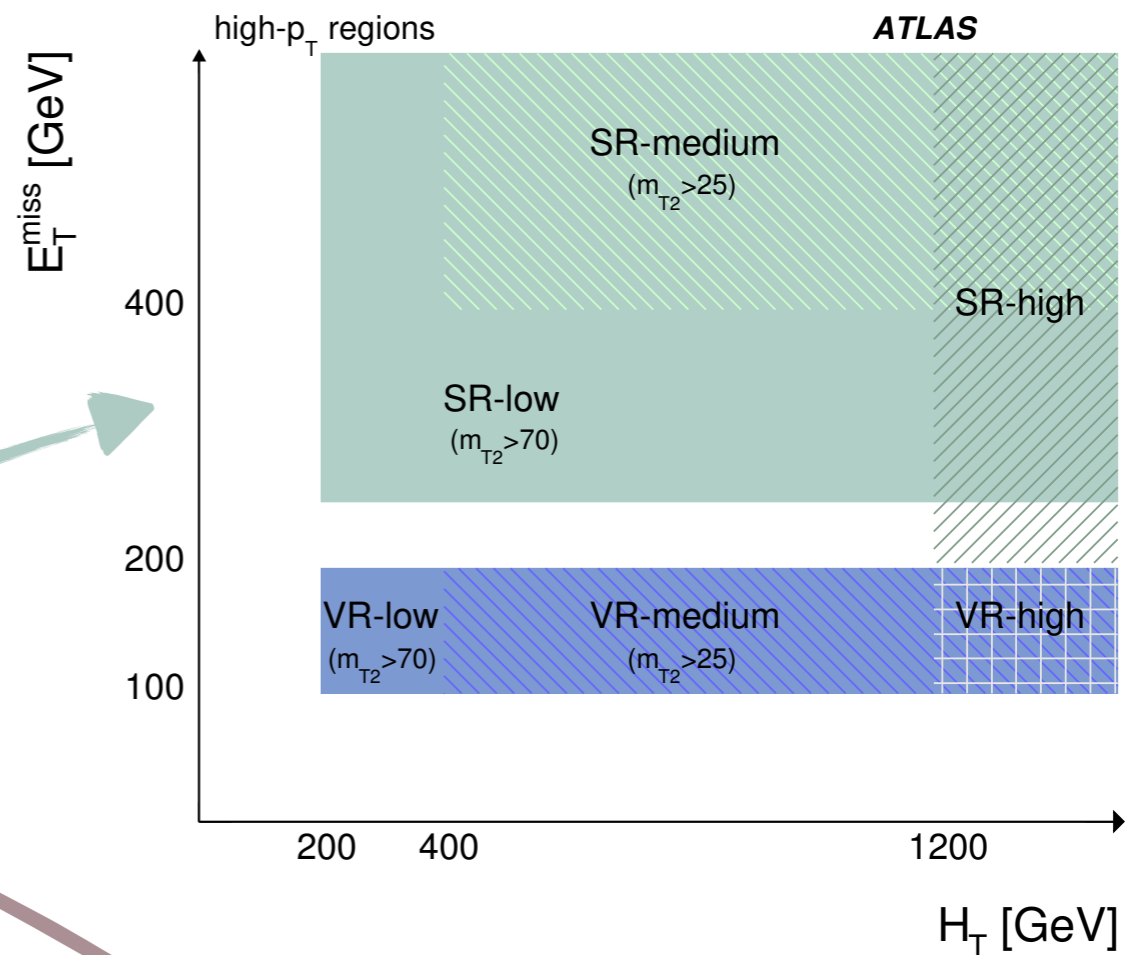
... time to start getting more complex!

Thanks! Any questions?

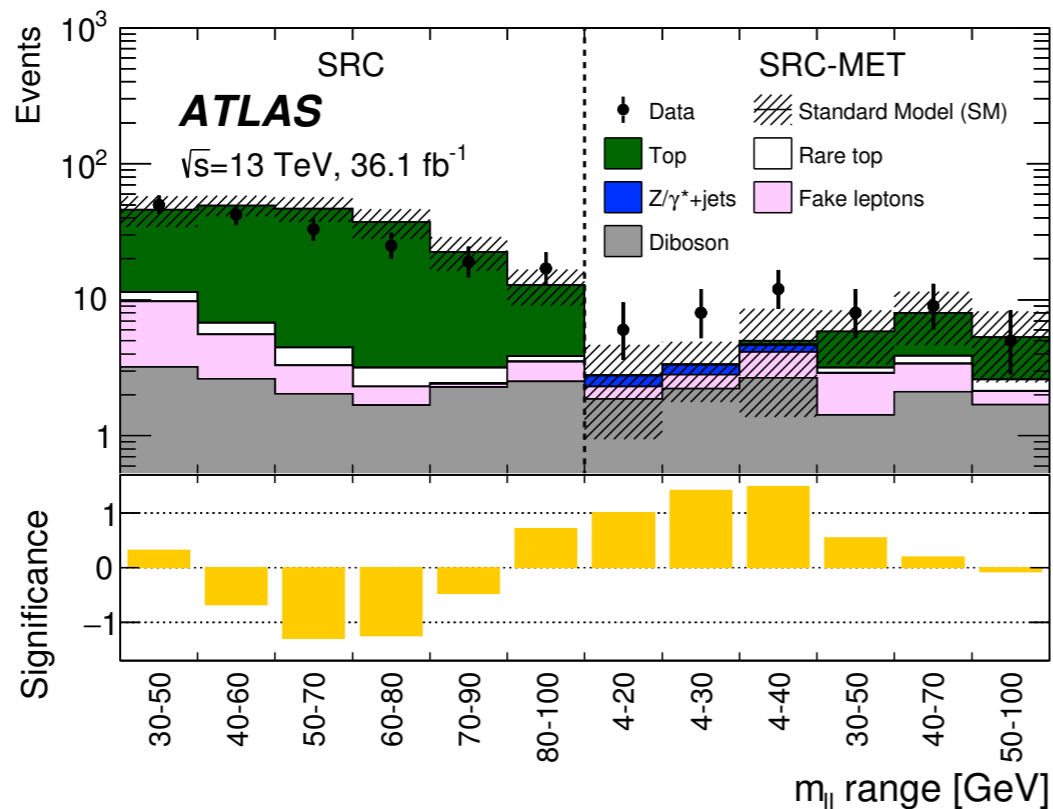
Backup

Additional info: SUSY opposite sign dilepton

- “High- p_T lepton search” addresses non-compressed cases where kinematic edge near the Z peak
- “Low- p_T lepton search” addresses small Δm between two lightest neutralinos: compressed scenario
- Simplified model: set masses of all not-relevant particles very high so they decouple
- Key backgrounds: $Z/\gamma^* + \text{jets}$, fake leptons, diboson and rare top processes



Low- p_T signal
region yields

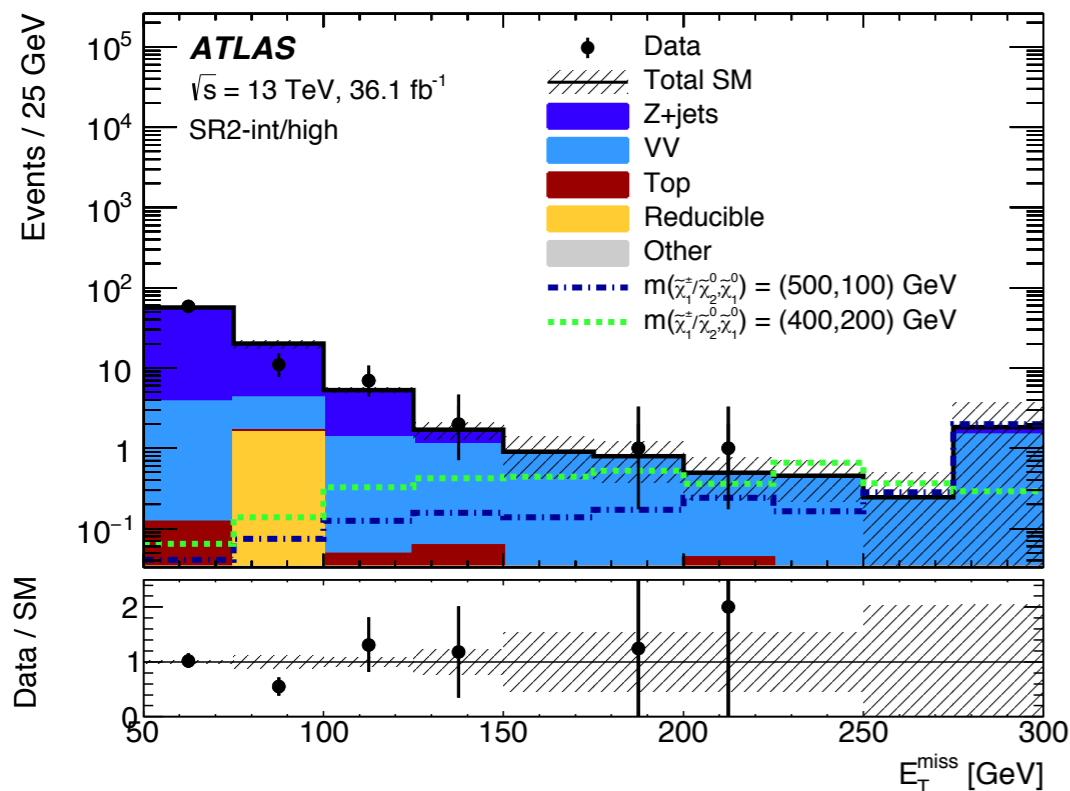


2L + no jets shown in main body!

Additional info: SUSY 2/3 lepton EW search

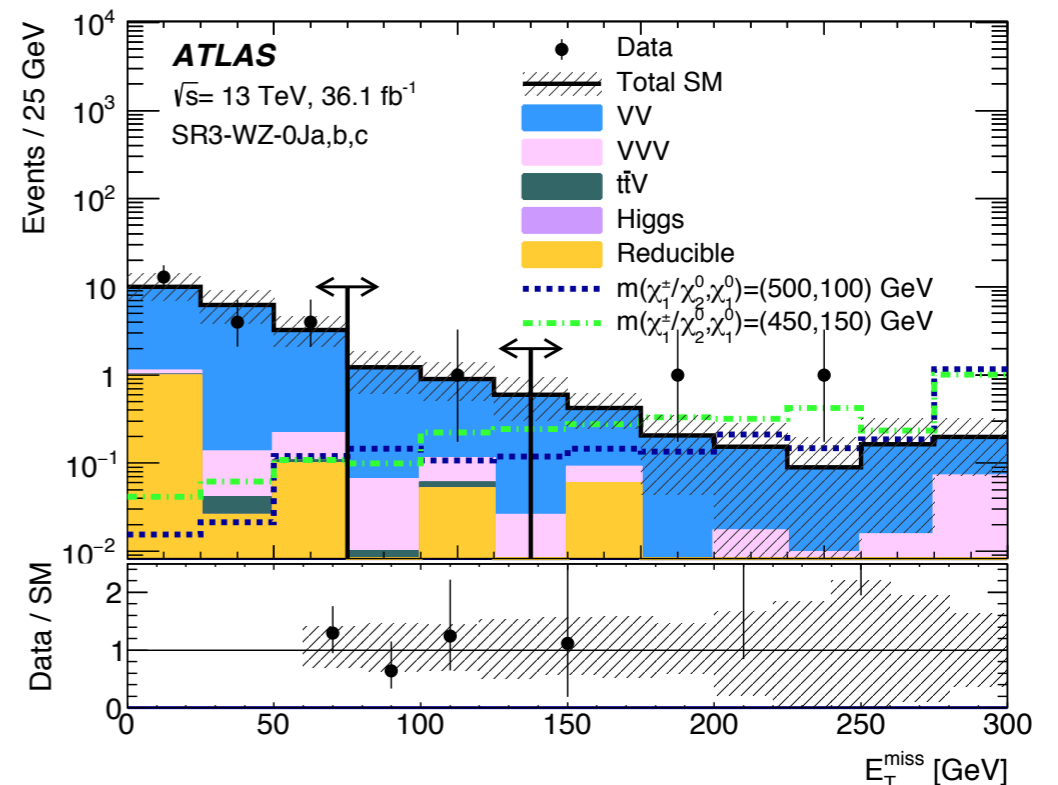
- The idea: if squarks & gluinos are a lot heavier than sleptons/ charginos/neutralinos, then higher cross sections doesn't benefit them in search
- Simplified model: take mass-degenerate, pure wino chargino1 & neutralino2; mass-degenerate sleptons
- Many individual signal regions defined by m_{H} , m_{T2} , number of jets, MET, ... Just a few sample distributions shown here!

And go look up the RJR analysis!

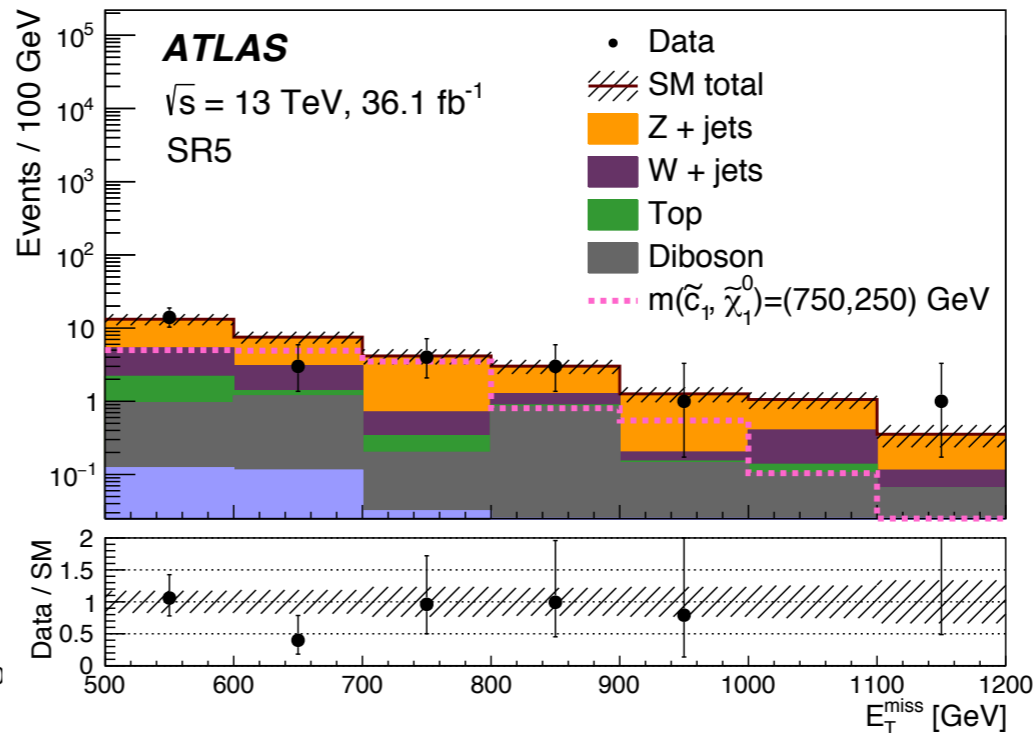
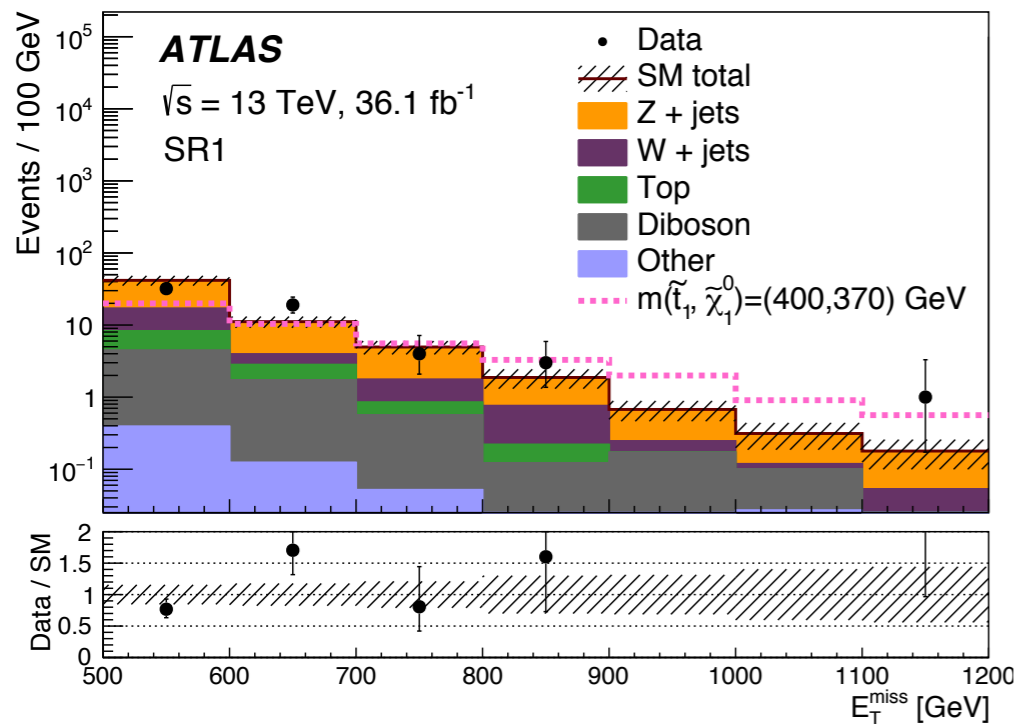


2L + jets

3 leptons



Additional info: SUSY stop to charm

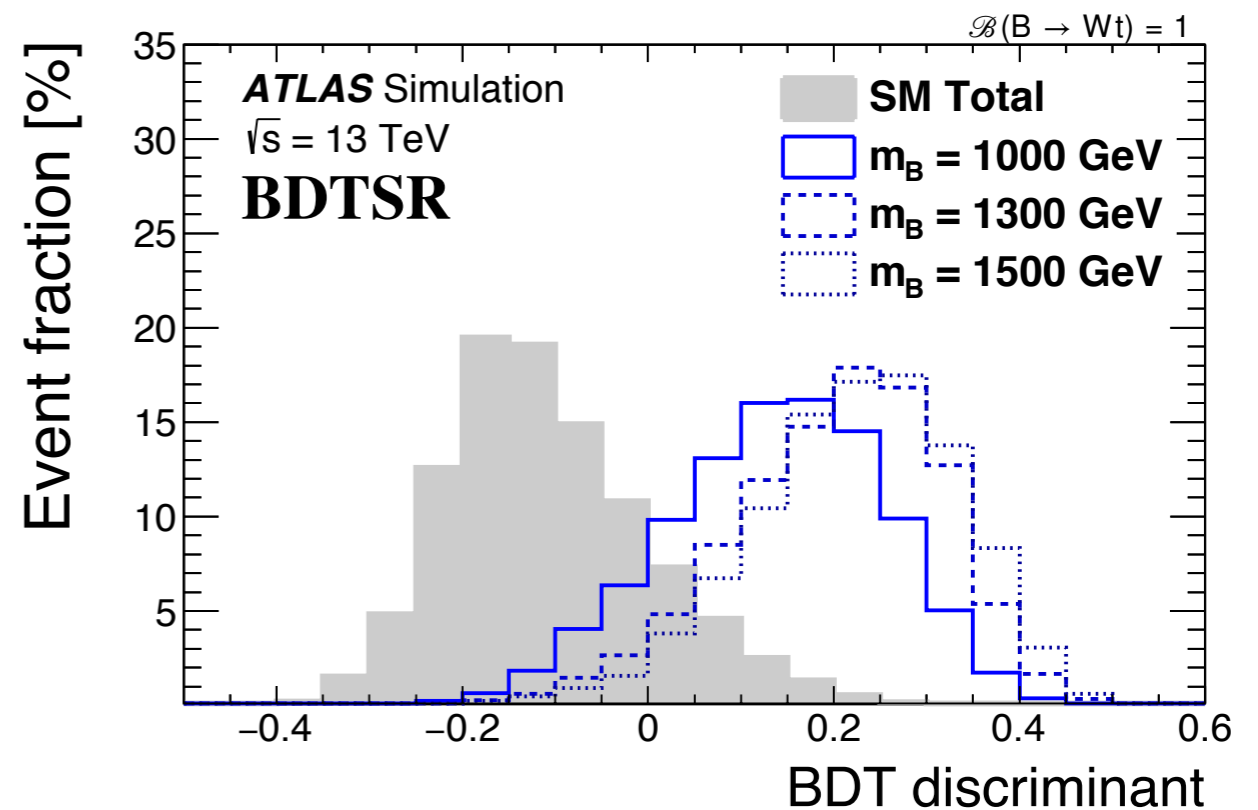
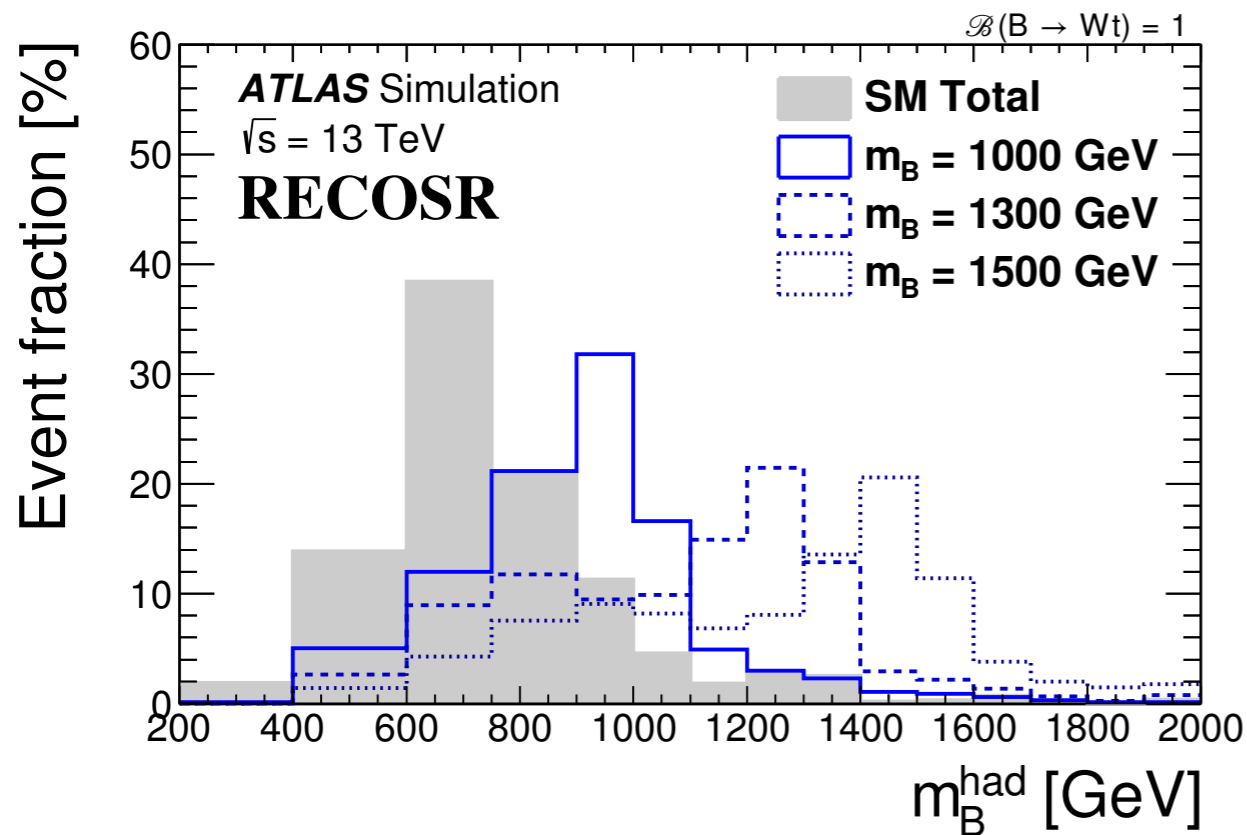


Main
 background:
 Z($\nu\nu$)+jets
 Other: W($\tau\nu$)
 +jets, diboson,
 ttbar, ...

- Model: stop pair production with flavour violation, allowing decay to charm + LSP, or flavour-conserving charm squark pair production. Assume 100% BR to c+LSP in both.
- Require 2j, ≥ 1 c-tagged jets, MET, lepton veto. SR's further cut on cjet+MET transverse mass to reduce τ contamination
- Separate signal regions with softer/harder, more/fewer jets for various levels of compression

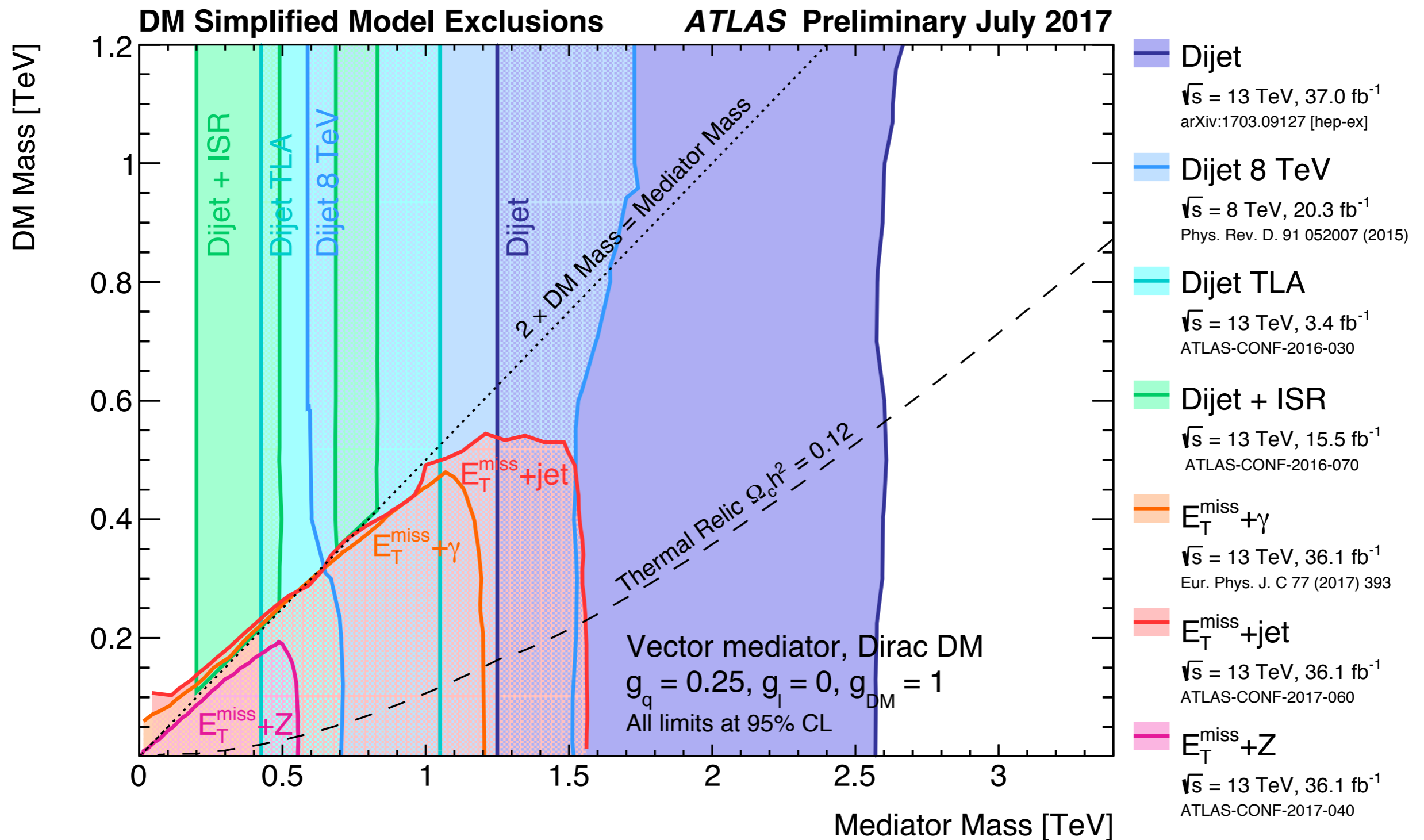
Additional info: Exotics VLQs

S_T , large-R jet mass
best BDT variables



- Vector-like quarks couple preferentially to 3rd generation and allow flavour-changing neutral currents as well as regular quark-like charged current decays
 - E.g. T VLQ can give $T \rightarrow (Wb, Zt, Ht)$
- Classify events by number of jets, b-jets, leptons.
- RECOSR: 3 large-R jets, one W-tagged. b-jet not near lepton. S_T (scalar sum of MET, lepton, small-R jet p_T s) must be large. BDTSR: trained and used on events which do not pass RECOSR.

Vector mediator DM summary plots: leptophobic



Vector mediator DM summary plots: leptophilic

