

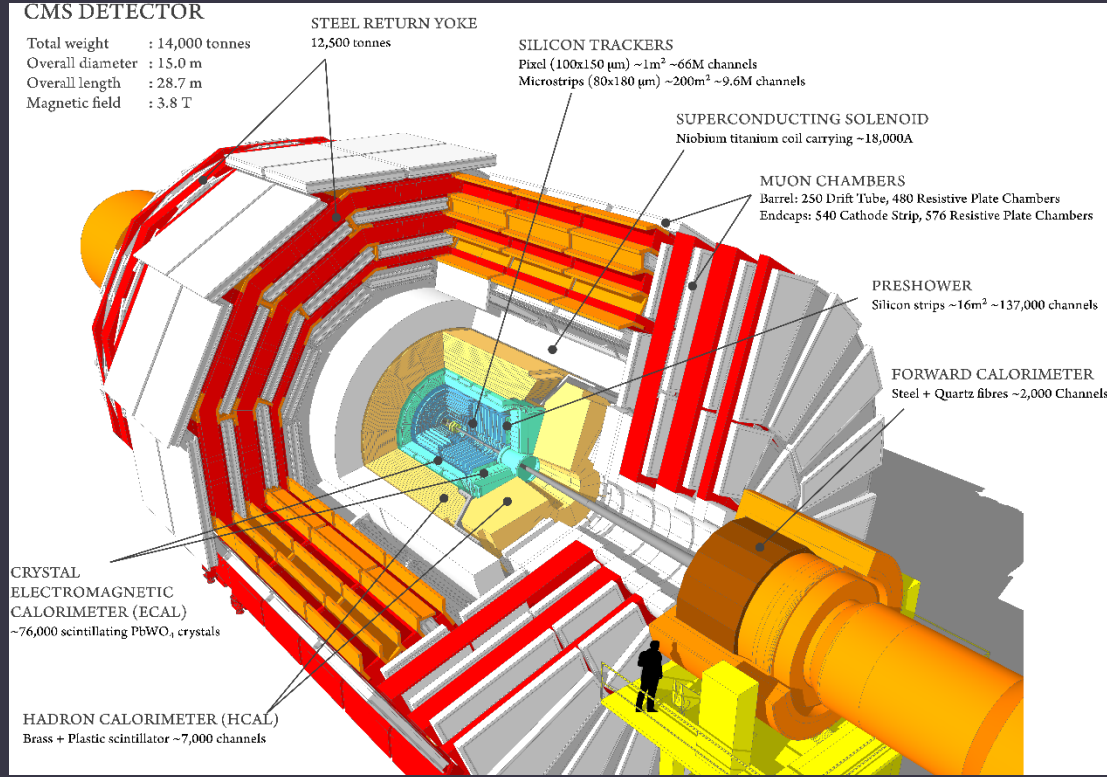
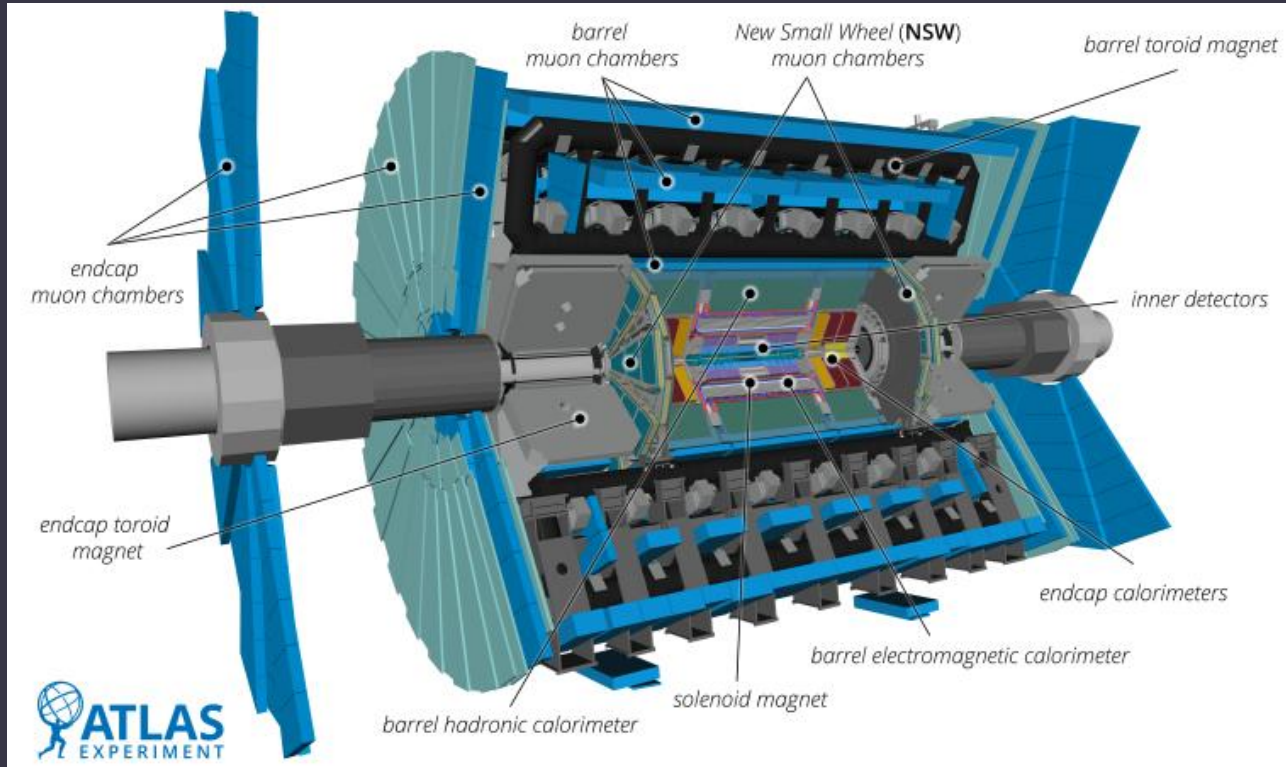
Holly Pacey

10/04/26

IOP HEP/APP 2026, Edinburgh



ATLAS & CMS: RECENT HIGHLIGHTS



ATLAS & CMS

LHC's General purpose detectors

All ATLAS public results; Moriond highlights
All CMS public results; Moriond highlights

ATLAS & CMS

Completing analysis of 140fb^{-1} 13 TeV Run-2 data

13.6 TeV Run-3 data-taking finishing in June.

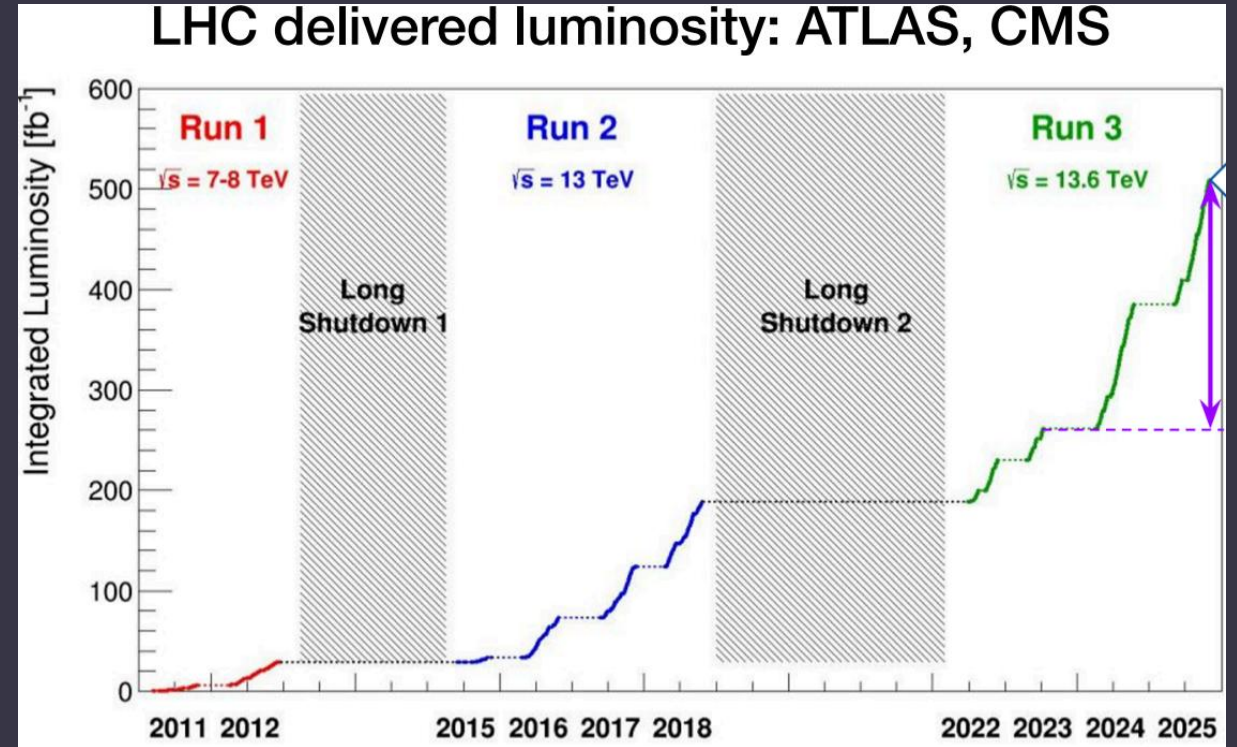
Total whopping 0.51ab^{-1} !

- New results starting to analyse our early Run-3 data!

Alongside analysis/reco./trigger/... Improvements:

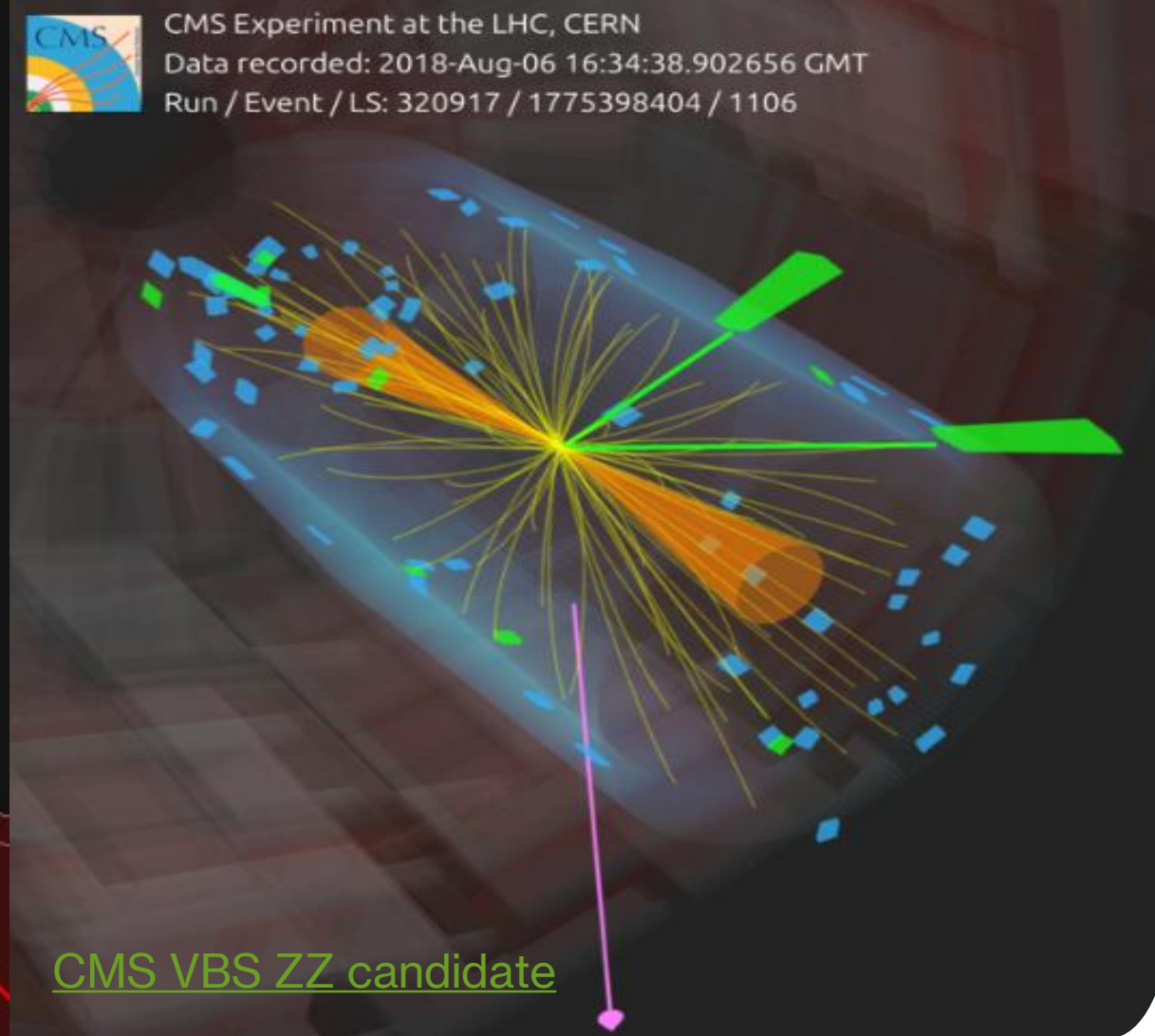
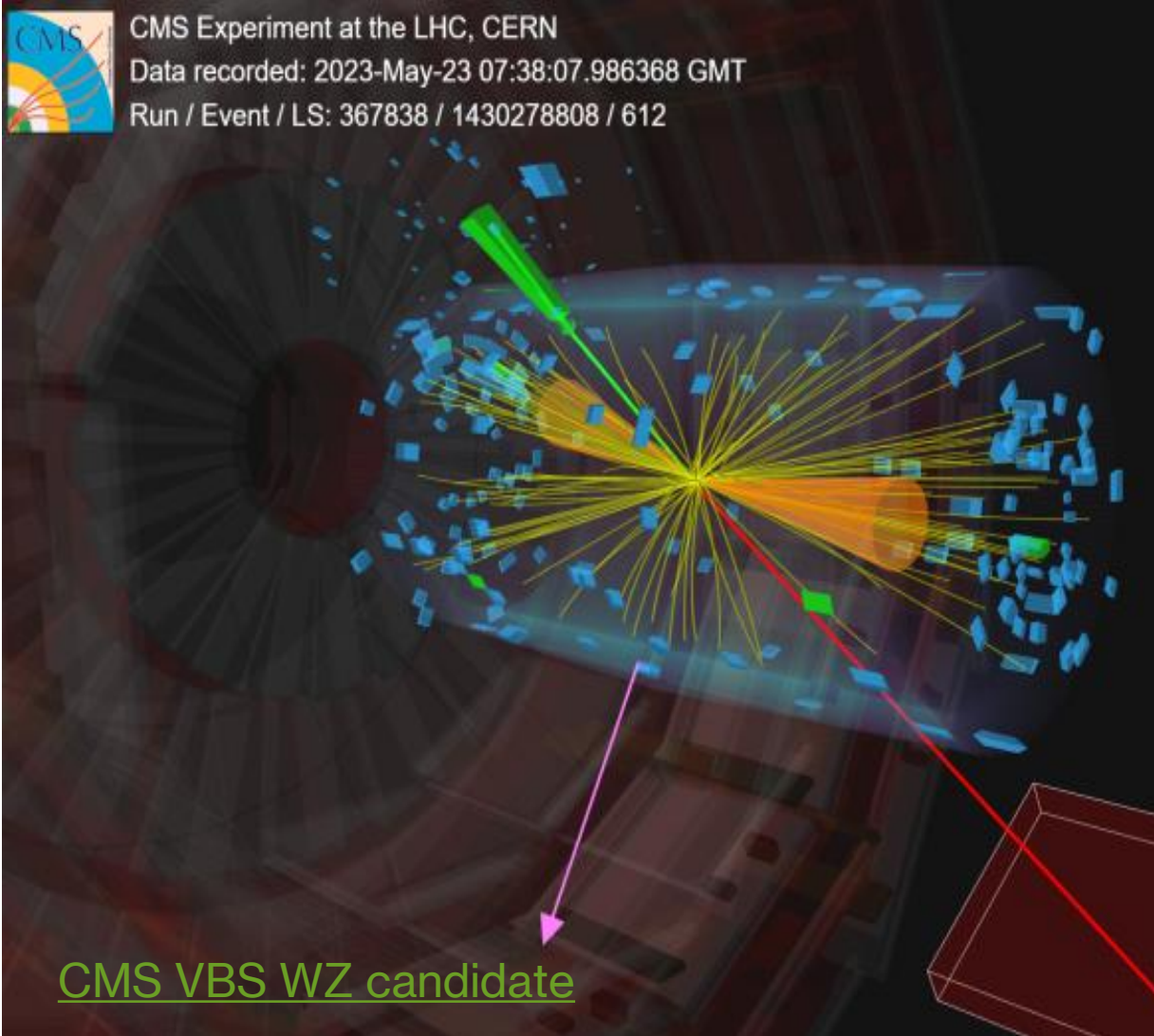
- ever increasing sensitivity to rare processes and new phase space.

Today: a small subset of new results!



[ATLAS Lumi results](#)
[CMS Lumi results](#)

Half total data recorded in the last 2 years!

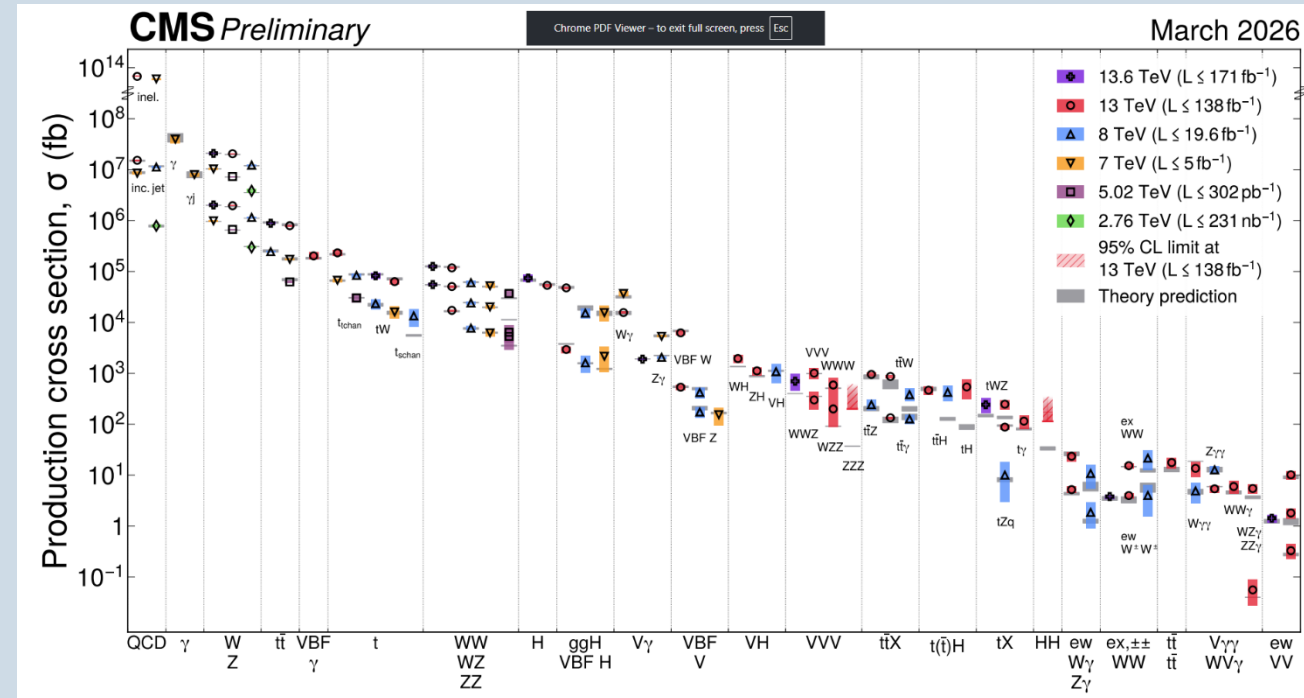
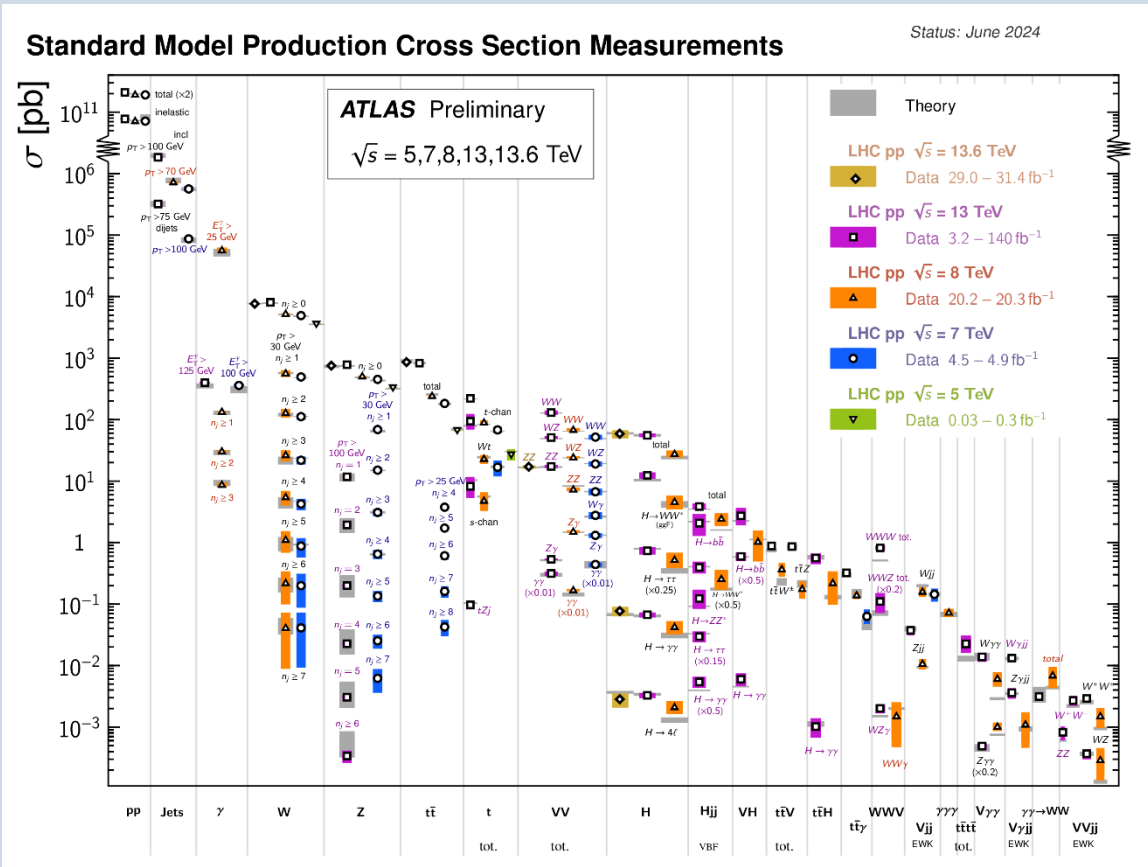


STANDARD MODEL MEASUREMENTS

LHC, n. *A Precision measurement machine.*

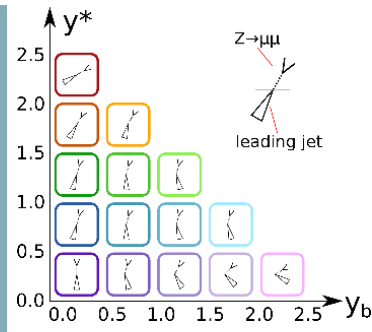
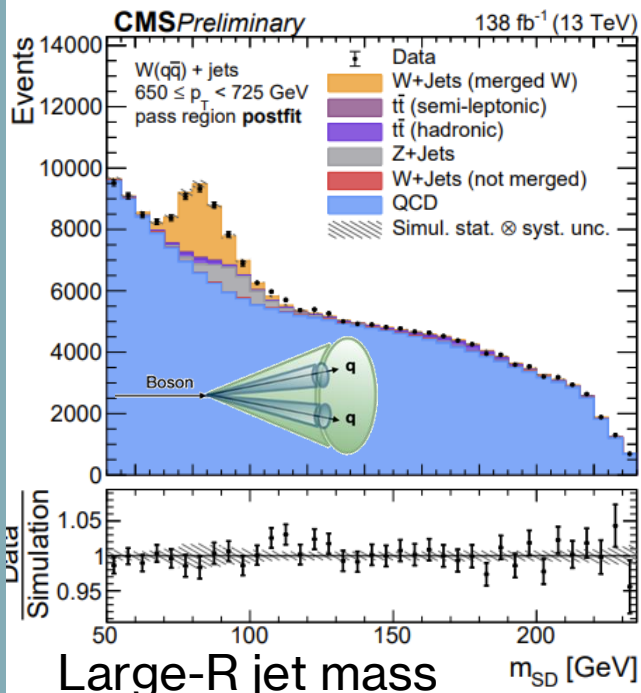
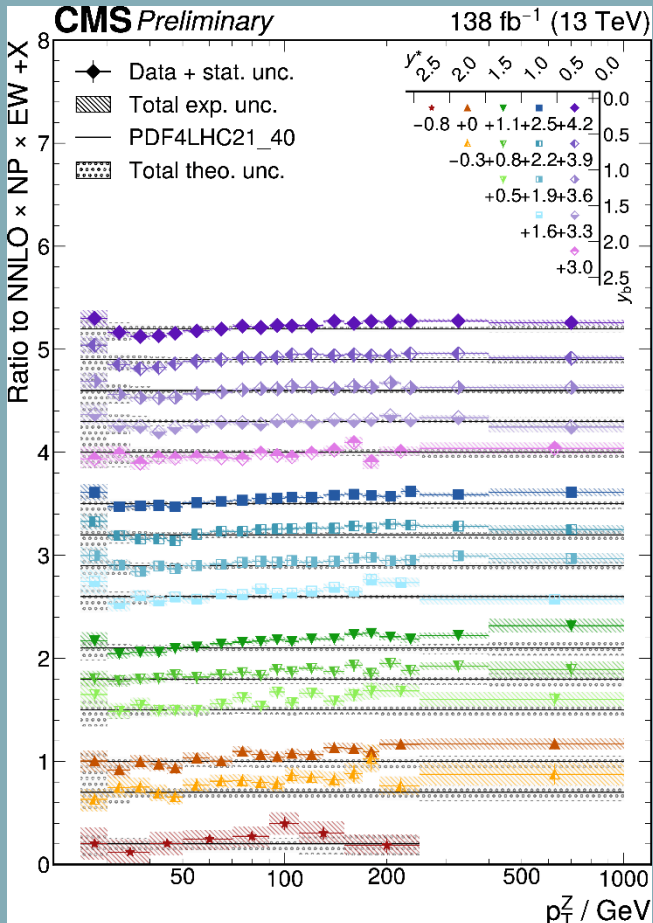
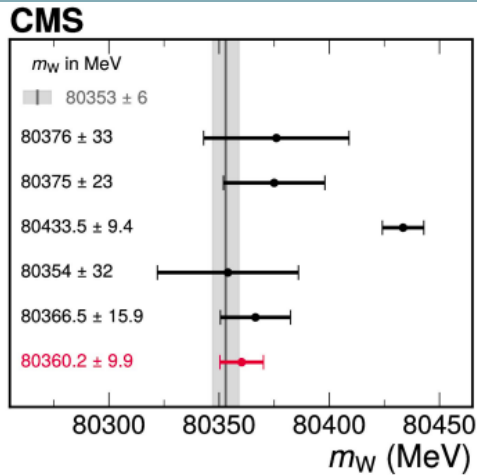
STANDARD MODEL

With 1st Run-3 results: Better tested and more precisely known than ever



[ATL-PHYS-PUB-2024-011](#)
[CMS Summary Plots](#)

Electroweak fit
 PRD 110 (2024) 030001
LEP combination
 Phys. Rep. 532 (2013) 119
D0
 PRL 108 (2012) 151804
CDF
 Science 376 (2022) 6589
LHCb
 JHEP 01 (2022) 036
ATLAS
 arXiv:2403.15085
CMS
 This work



W/Z NEWS

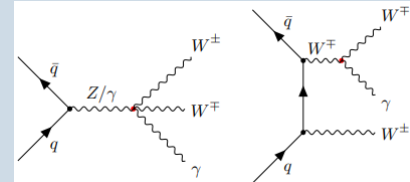
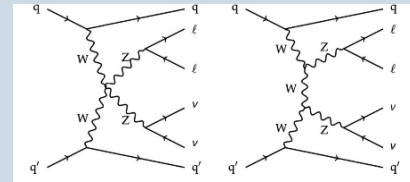
$M(W)$ measured to 0.7% precision in high- p_T boosted $W + jets$ by CMS: 80.83 ± 0.55 GeV

- C.f. best 0.1% precision CMS result
- New measurements e.g. CMS Triple-diff. $Z\mu\mu + jets$
- Assess MC modelling, generally good performance
- sensitive to PDFs, complements triple-diff jj

New SM rare process Observation:

- CMS VBS ZZ @ 5.0σ , $0.39 fb$ (+1st Run-3 VBS-WW/WZ observation!)
- ATLAS $WW\gamma$ @ 5.9σ , $6.1 fb$ (Complemented by ATLAS Evidence of $ZZ\gamma$ 4.4σ for rare $0.144 fb$ process.)

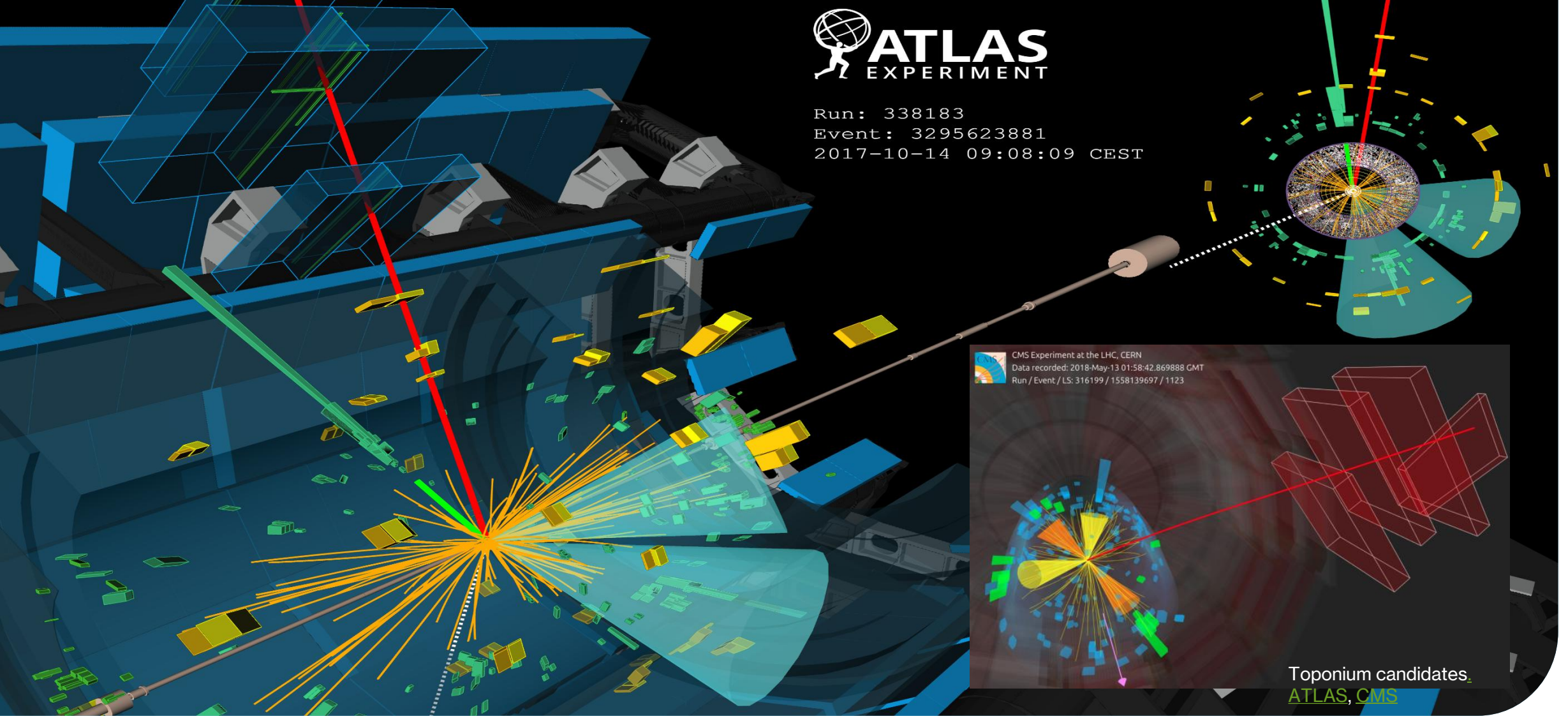
...More WW measurements in A. Plebani's talk



[arxiv:2603.19963](https://arxiv.org/abs/2603.19963)
[arxiv:2412.13872](https://arxiv.org/abs/2412.13872)
 CMS-PAS-SMP-24-010
 Eur. Phys. J. C 85, 72 (2025)

[arxiv:2602.17165](https://arxiv.org/abs/2602.17165)
 CMS-SMP-23-001
 CMS-PAS-SMP-25-013
 Physics Letters B 873 (2026) 140050
 H. Pacey IOP HEP/APP 2026 Edinburgh

Run: 338183
Event: 3295623881
2017-10-14 09:08:09 CEST



TOP

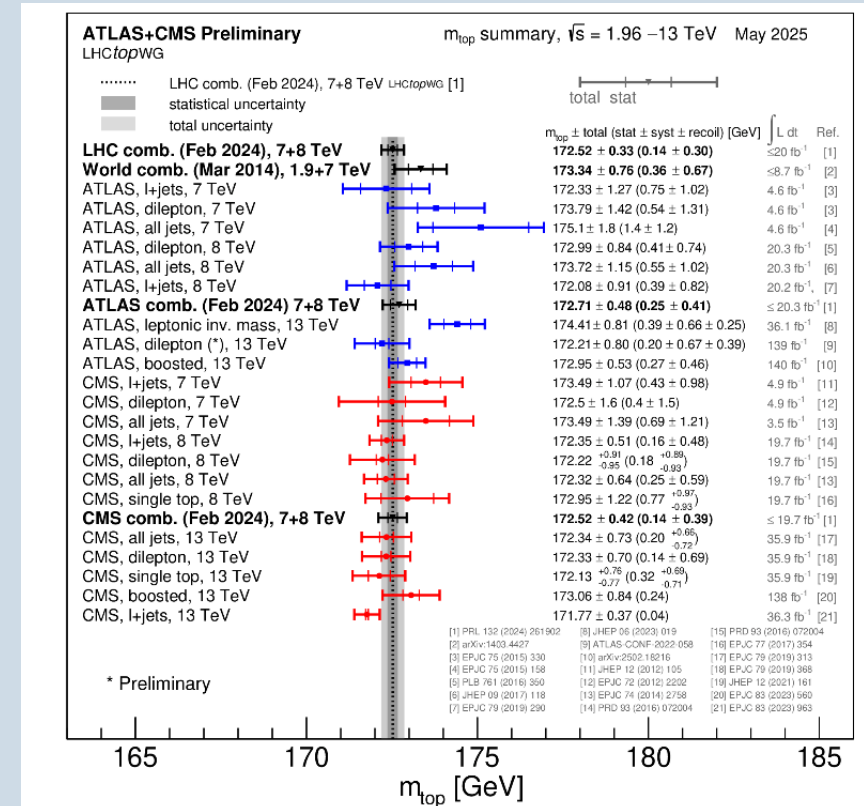
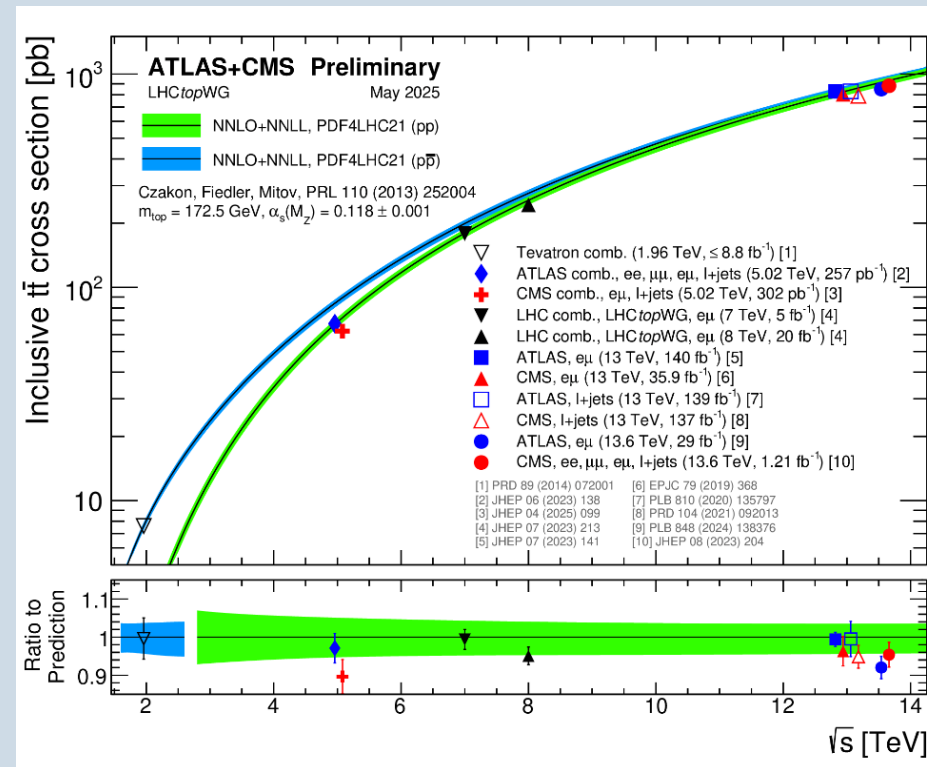
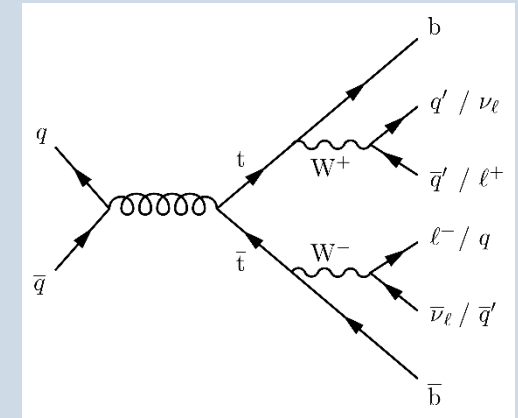
LHC, n. *A Top quark factory.*

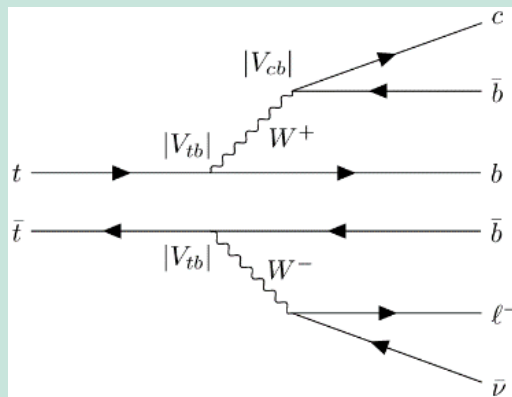
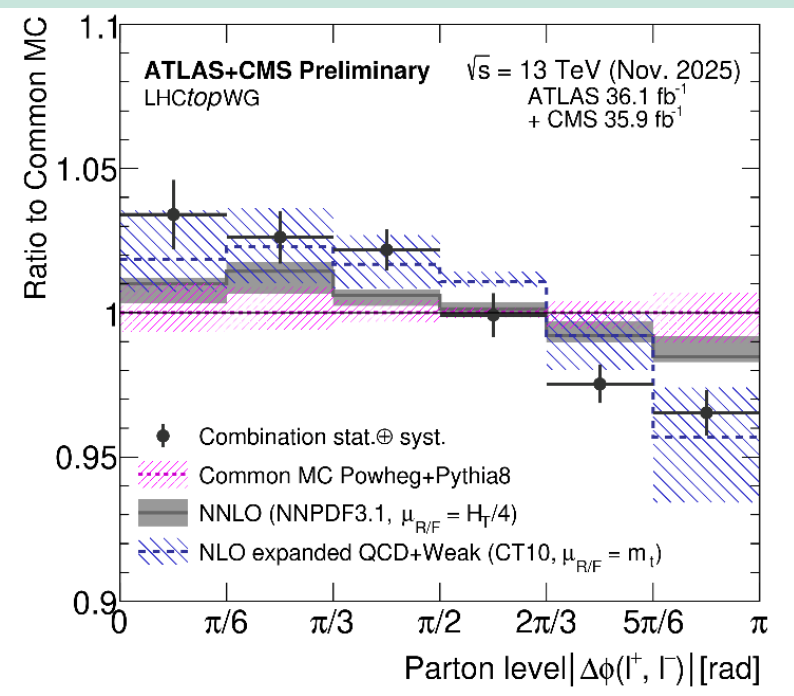
TOP PROPERTIES

40x heavier than b quark,
uniquely observable 'bare' decays before hadronisation

Dominant LHC process is $t\bar{t}$: **O(380M) Run-2+3 events!**

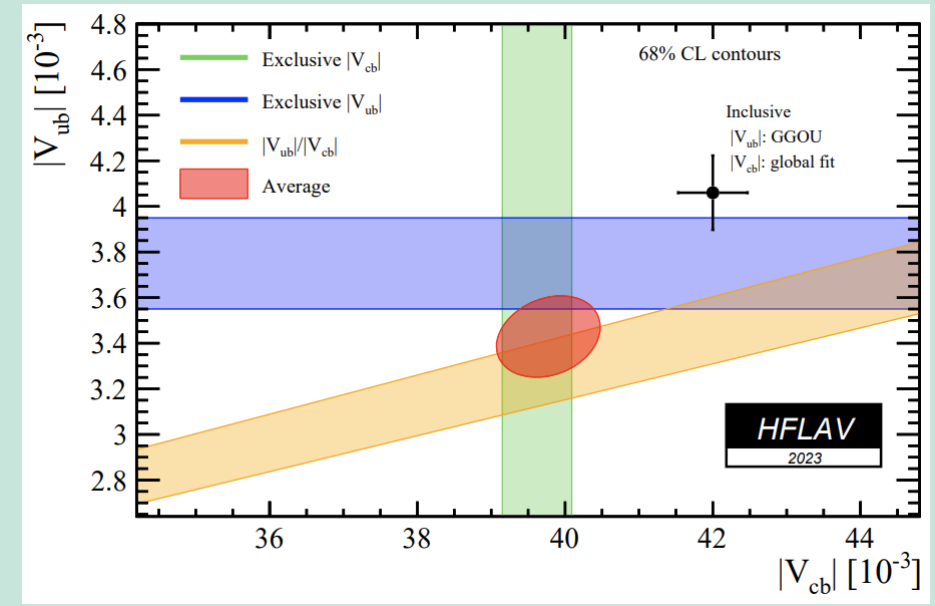
- $t\bar{t}$ cross-section as expected in 13.6 TeV
- $M(t)$ to 0.2% precision so far, with Run-1.





Current world-average:
 $|V_{cb}| = (41.1 \pm 1.2) \times 10^{-3}$ [PDG 2024]

$$|V_{cb}| = (50^{+7}_{-9}(\text{stat.})^{+9}_{-10}(\text{syst.})) \times 10^{-3}$$



ATLAS+CMS spin-correlation Run-2 combination

- Disagrees with standard Powheg+Pythia8 MC.
- Much improved with NLO QCD+EW corr. 😊

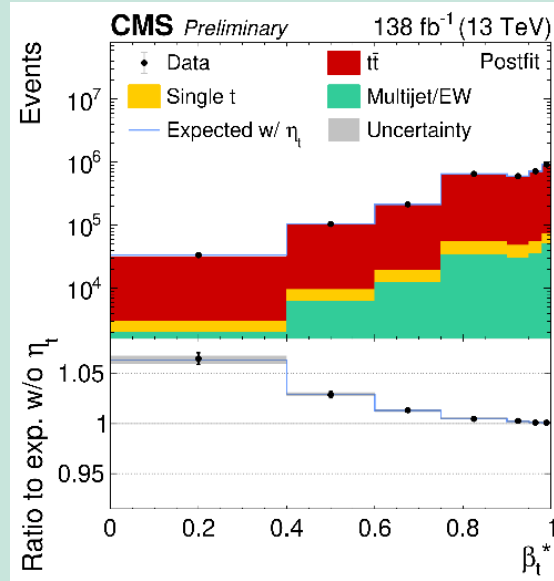
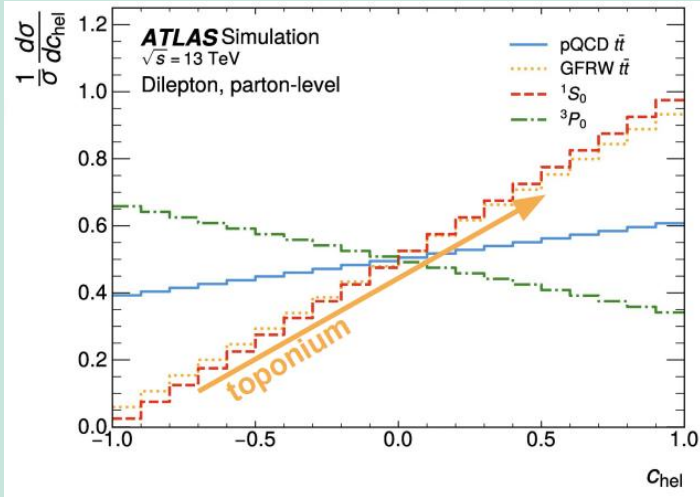
1st CKM $|V_{cb}|$ measurement at the weak scale, by ATLAS.

- Uses W decays, instead of B -hadrons, $t\bar{t}$ modelling dominates uncertainties.
- Consistent with other results but Sensitivity not competitive with LHCb.

TOP MEASUREMENTS

[CMS-PHY-TOP-22-004](#)
[arxiv:2603.16414](#)
[PRD 113, 012008 \(2026\)](#)

TOPONIUM



Cross-section enhancement near $M(t\bar{t})$ threshold

- Quasi-bound spin-singlet state.
- Predicted in Non-relativistic QCD; not included in pQCD MC, assumed undetectable @ LHC!

CMS lj NEW, ATLAS ll NEW, (CMS ll (2025));

Strategy:

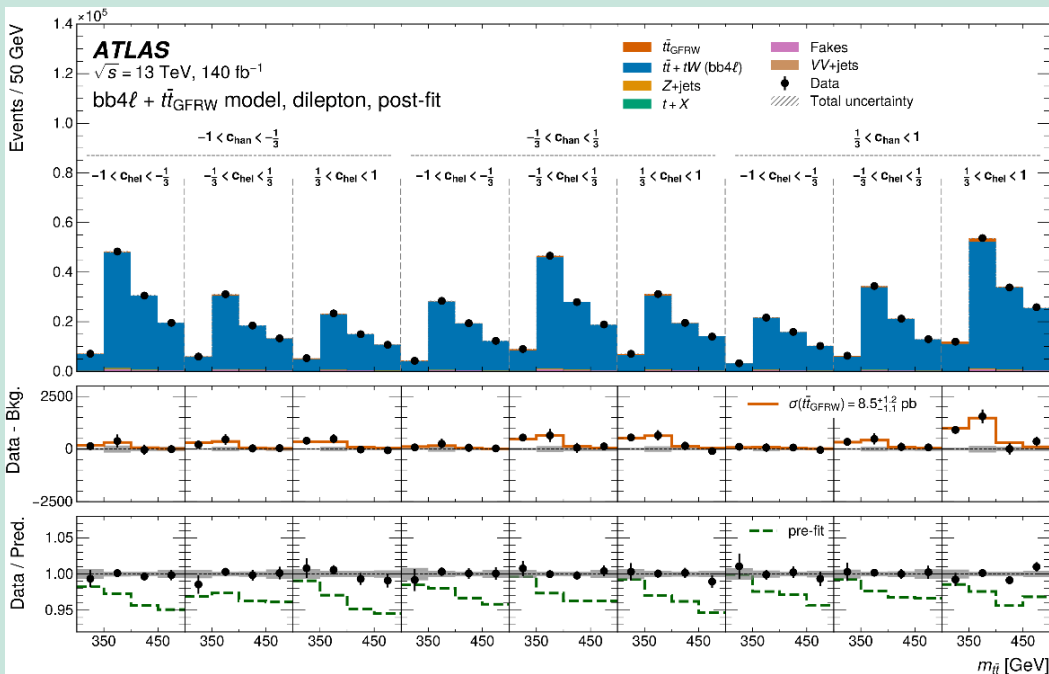
- Categorise in spin-sensitive C vars; fit in M -based vars
- Top modelling systematics dominate
- ATLAS rejects pQCD-only at 8σ , CMS observed 6σ . Note different MC signal models used, see backup.

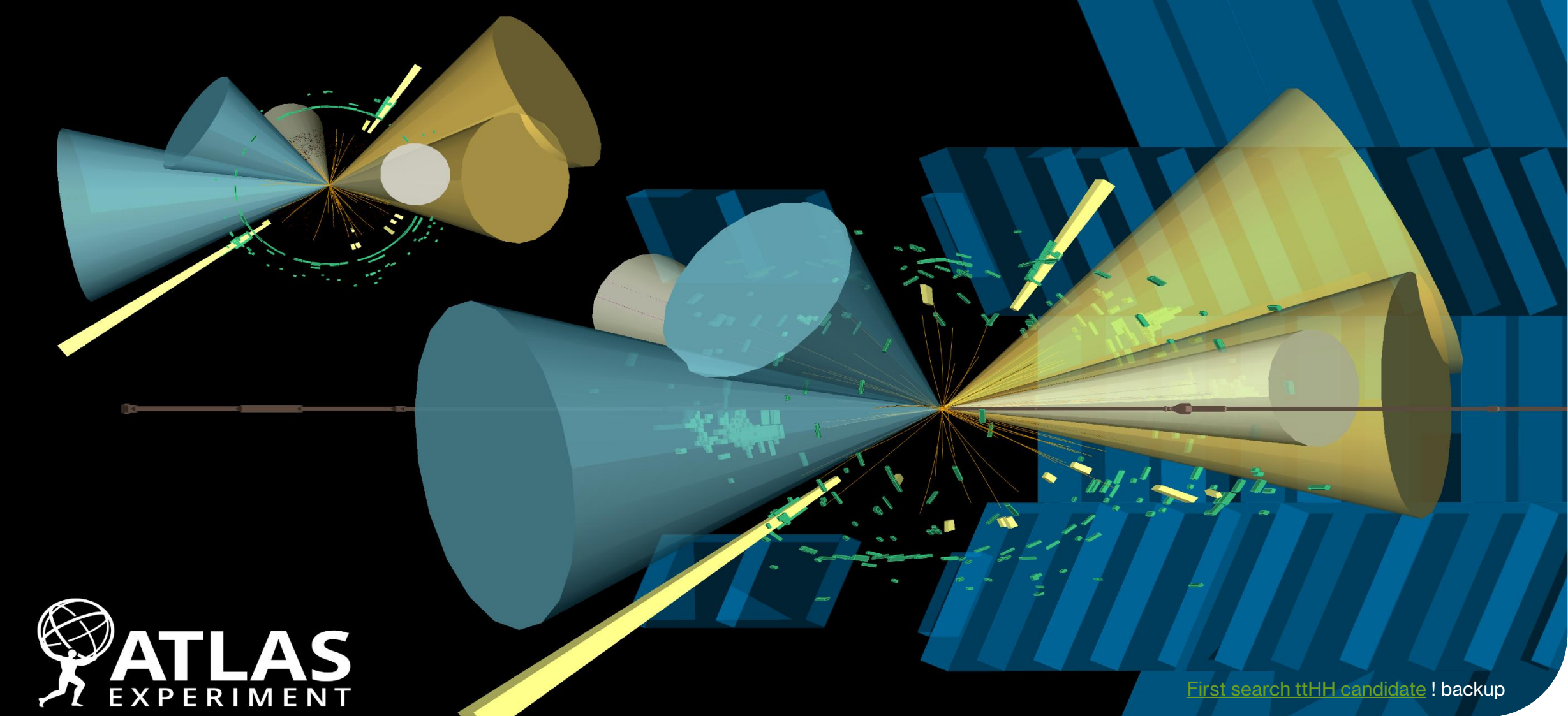
More in I. Young's [talk](#)

[CMS-PAS-TOP-25-002](#)
[arxiv:2601.11780](#)
[RPP 88 087801 \(2025\)](#)
[JHEP 2024 99 \(2024\)](#)
[EPJC 85 157 \(2025\)](#)
[PRD 104, 034023 \(2021\)](#)

$$\sigma(t\bar{t}_{\text{GFRW}}) = 9.3_{-1.0}^{+1.1} (\text{stat.}) \pm 0.8 (\text{syst.}) \text{ pb}$$

$$\sigma(\eta_t) = 8.8 \pm 0.5 (\text{stat.})_{-1.3}^{+1.1} (\text{syst.}) \text{ pb}$$





[First search ttHH candidate ! backup](#)

HIGGS

LHC, n. *A discovery machine.*

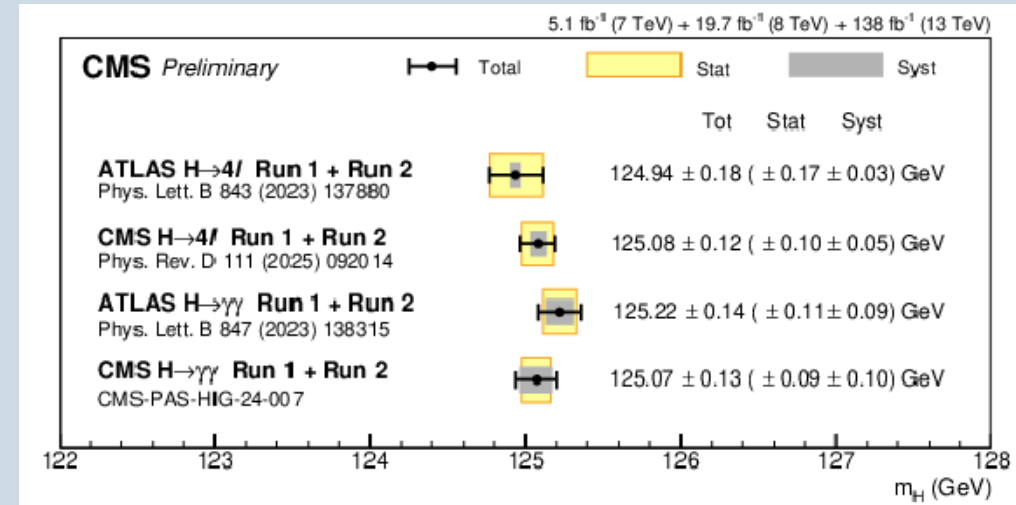
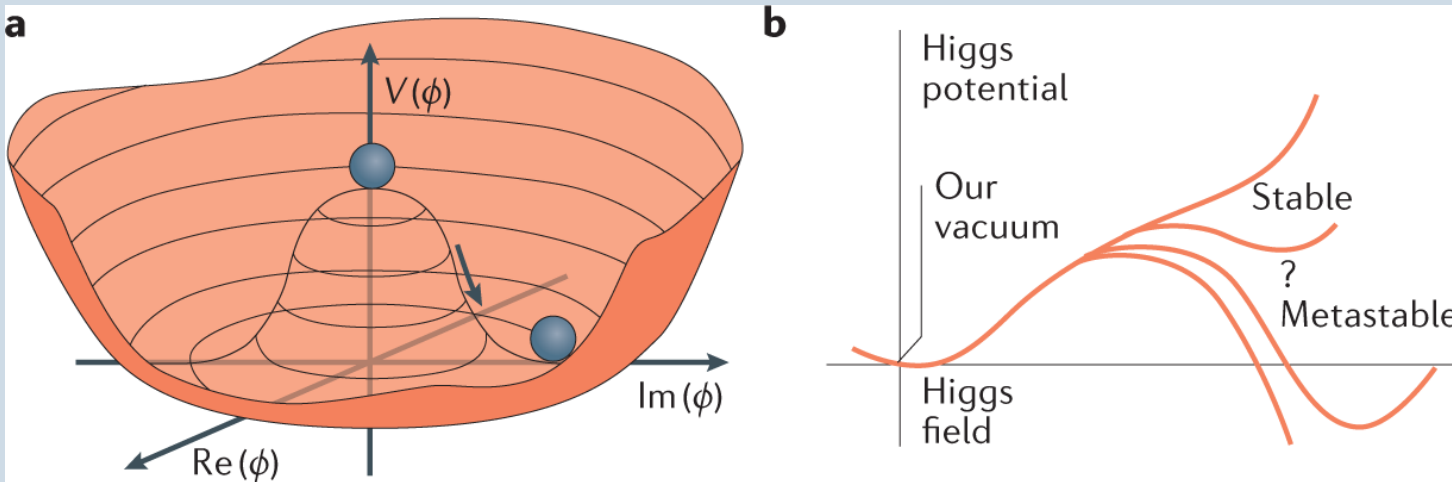
SM HIGGS BOSON

Comprehensive programme to precisely measure Higgs properties & uncover any hints of BSM

So far consistent with SM and between experiments.

- [E.g. CMS](#) new $M(h)$ measurement in $h \rightarrow \gamma\gamma$ in [T. Runting's talk!](#)

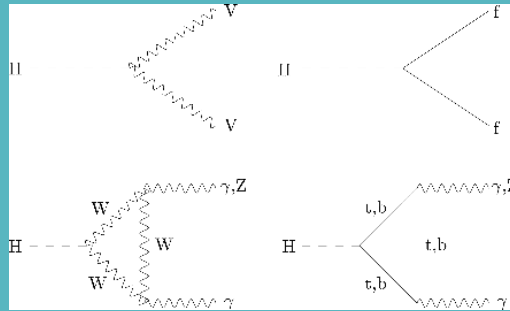
$$V(\phi) = \frac{1}{2}\mu^2\phi^2 + \frac{1}{4}\lambda\phi^4$$



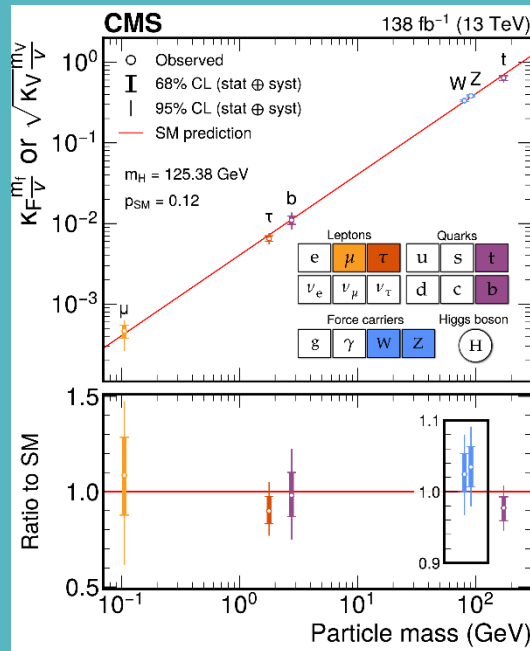
HIGGS PROPERTIES

- **New CMS** Run-2 combo.
-> see also prior **ATLAS result**
- Excellent SM agreement & mass-dependence in couplings.
- Even probing 2nd-gen couplings!
 - $|\kappa_c| < 3.5$ (4.7) in **CMS tth** (**ATLAS Vh**)
transformer-based **charm taggers!**
 - **ATLAS $h \rightarrow \mu\mu$** in **A. Avad's talk**

[arxiv:2602.18611](https://arxiv.org/abs/2602.18611)
[ATLAS-CONF-2025-006](https://arxiv.org/abs/2511.21911)
 Phys. Rev. Lett. 136, 011801 (2026)
[arxiv:2511.21911](https://arxiv.org/abs/2511.21911)

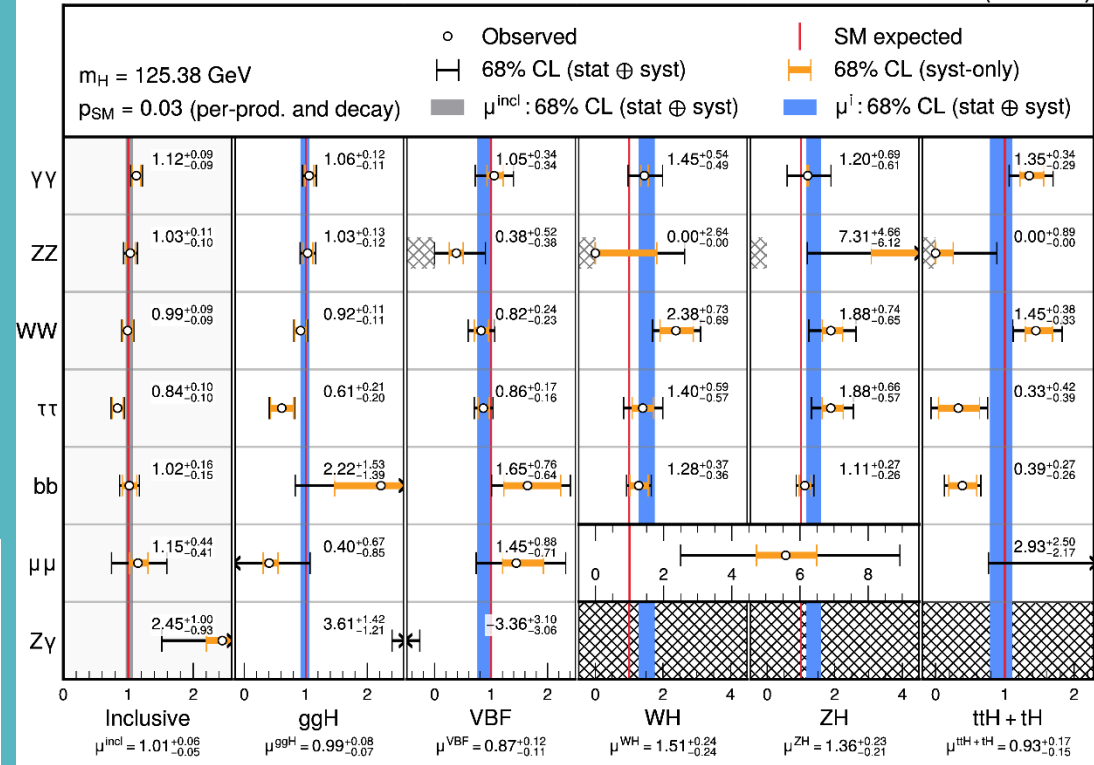


Rate modifiers: $\mu = \sigma/\sigma^{SM}$
 Coupling modifiers: $\kappa = \lambda/\lambda^{SM}$

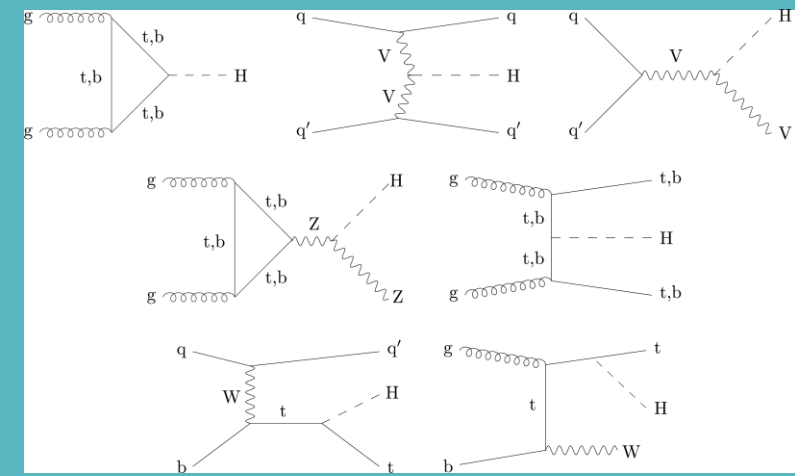


CMS

138 fb⁻¹ (13 TeV)



$$y_f = \frac{\sqrt{2}m_f}{v}$$



RUN-3 HIGGS

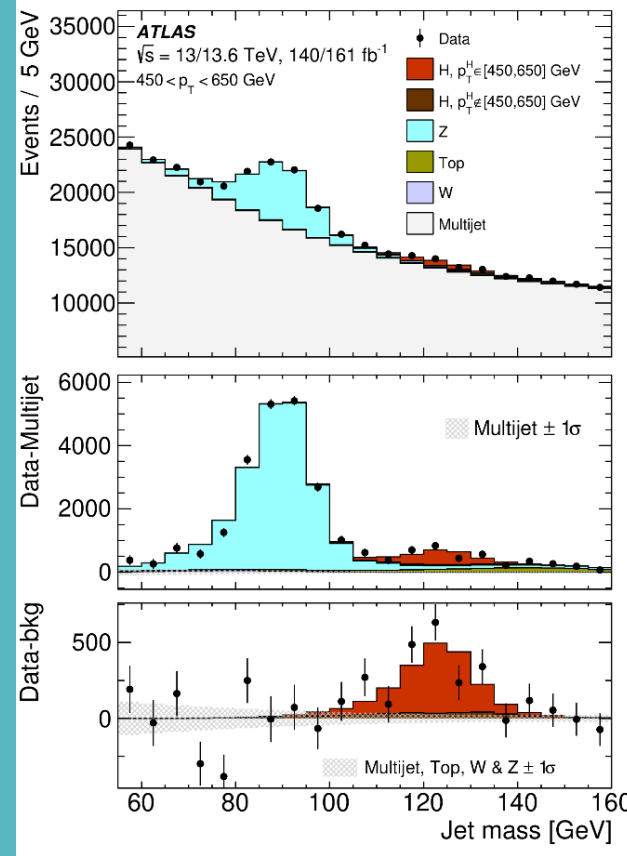
Still there (phew!) in e.g.

New [ATLAS \$h \rightarrow 4l\$](#) measurement.

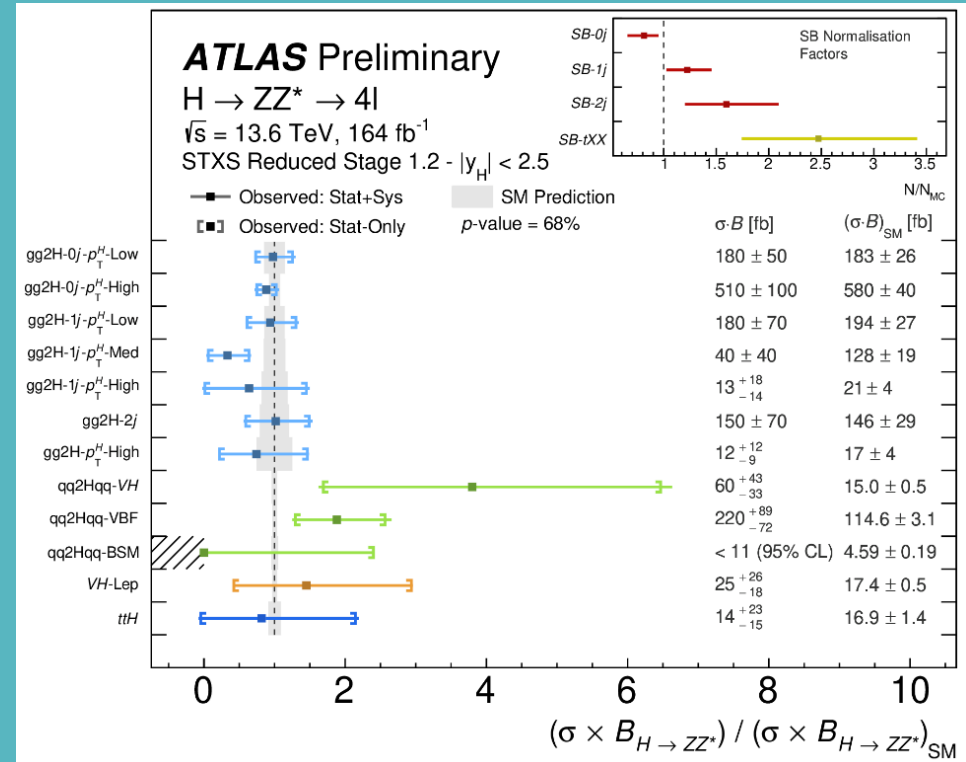
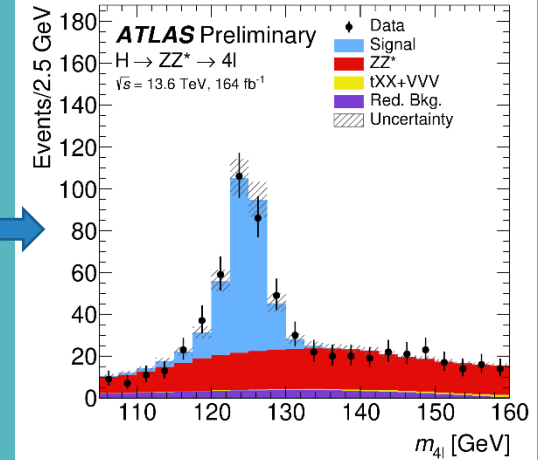
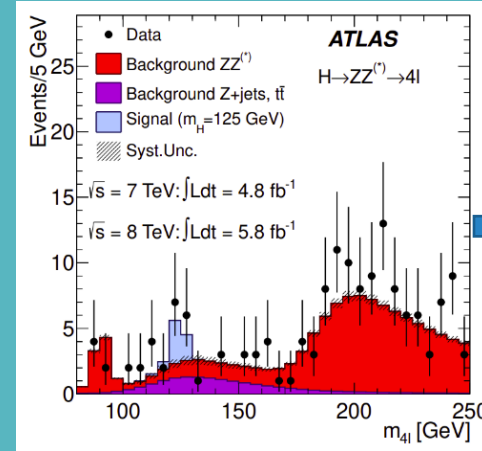
- 16x more lumi. And 3x cross-section vs [discovery dataset!](#)
- Still SM-consistent cross-sections.

1st [evidence](#) for high- p_T $h \rightarrow bb$
@ 3.8σ in ATLAS!

- 10x improvement vs [Run-2 result](#) via Run-3 data + new transformer-based boosted $h \rightarrow bb$ tagger.



ATLAS-CONF-2026-003
arxiv:2603.19369

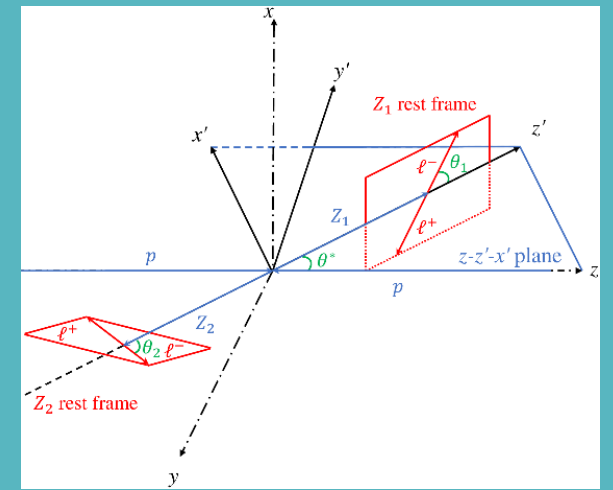
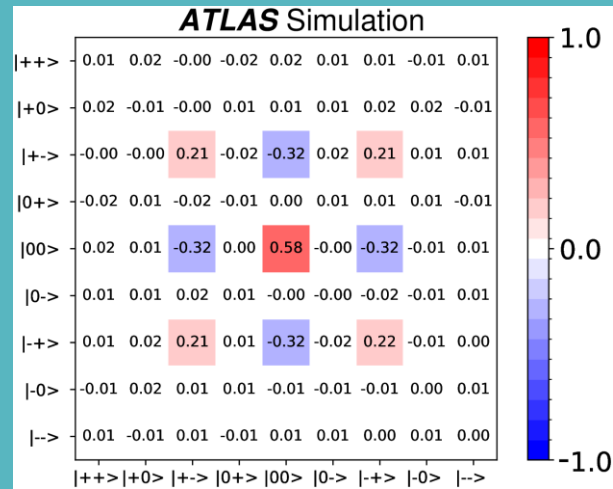


MORE HIGGLIGHTS

ATLAS Run-2+3 1st measurement of Quantum Entanglement in $h \rightarrow ZZ!$

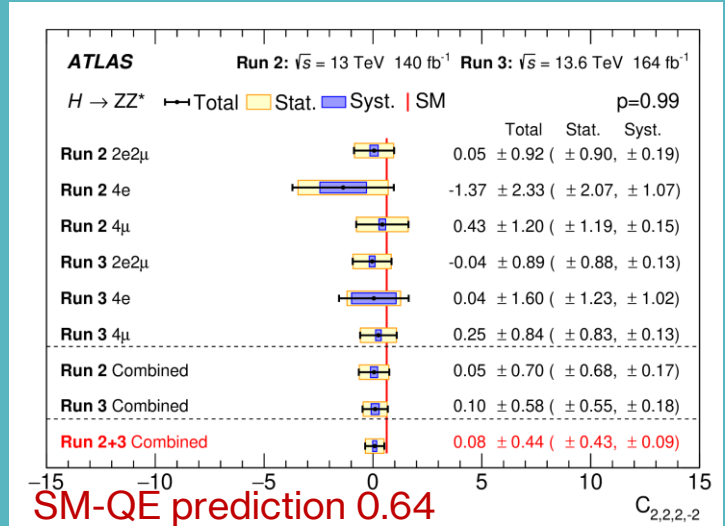
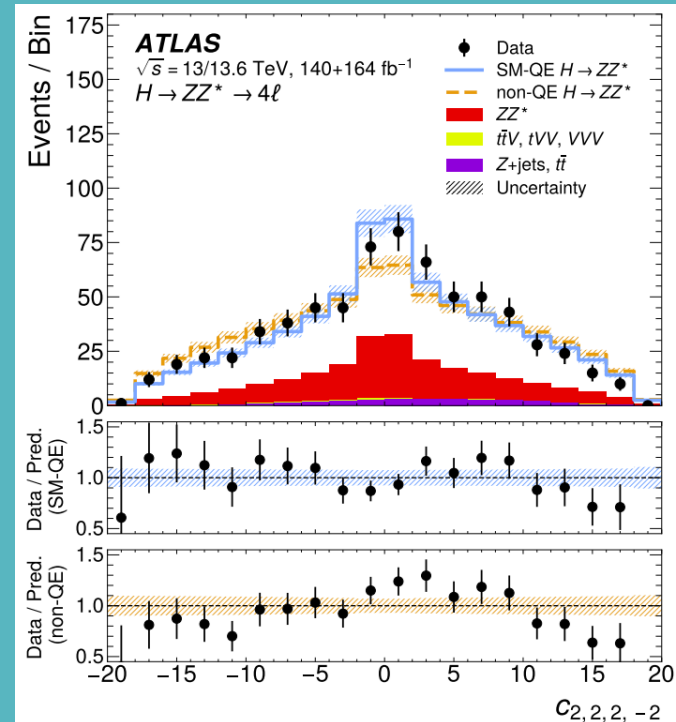
- Fit in $C_{2,2,2,-2}$, $C_{2,1,2,-1}$ vars in 4l system sensitive to ZZ spin-density matrix.
- Non-zero C = entanglement
- Reject non-QE separable state ($|00\rangle$ only) to 4.7σ ! Supports QE.

See also CMS $h \rightarrow \tau\tau$ L. Russell's [talk](#)
More in backup!



[arxiv:2603.20087](#)
[arxiv:2603.20117](#)

[CMS-PAS-HIG-25-012](#)
[arxiv:2603.26463](#)



$$c_{2M_1 2M_2} = 40\pi \Re \left(Y_2^{M_1}(\theta_1, \phi_1) \times Y_2^{M_2}(\theta_2, \phi_2) \right)$$

DI-HIGGS

hh gives direct access to self-coupling κ_λ

- Crucial for Higgs potential & vacuum stability!
- New [ATLAS+CMS Run-2 combination](#) approaching SM-sensitivity.

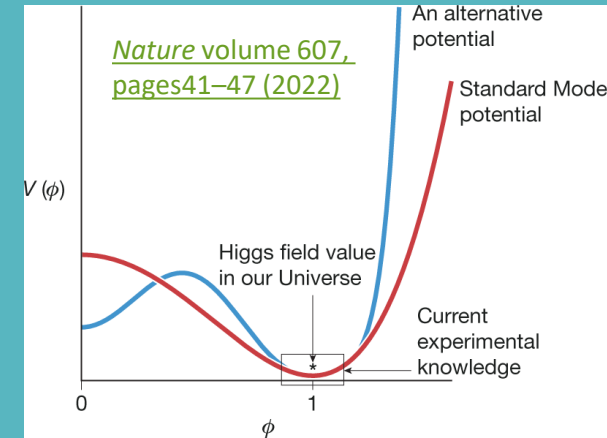
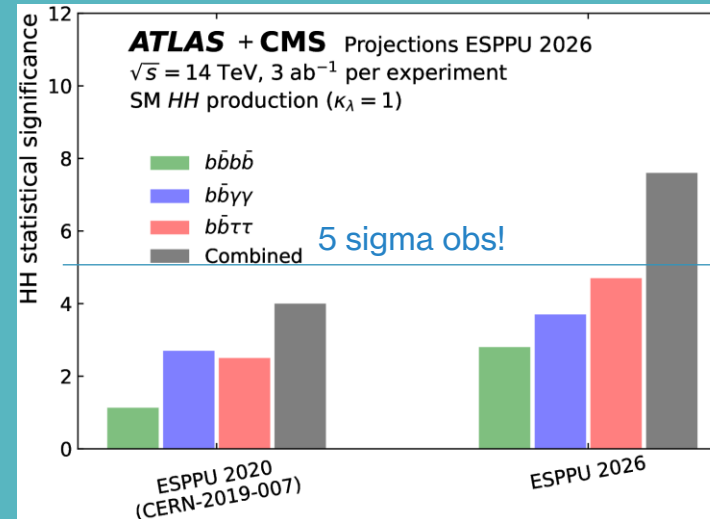
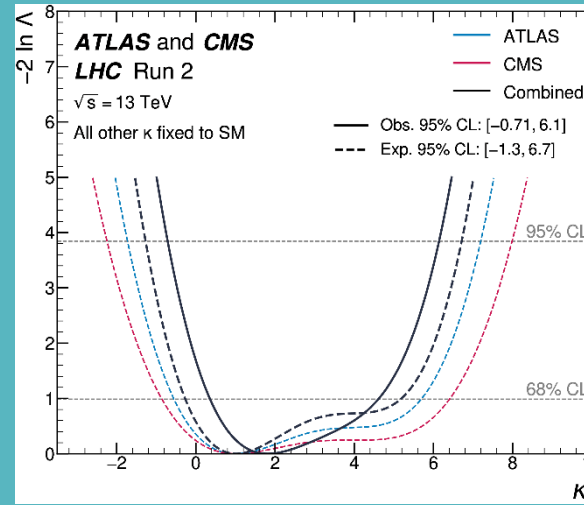
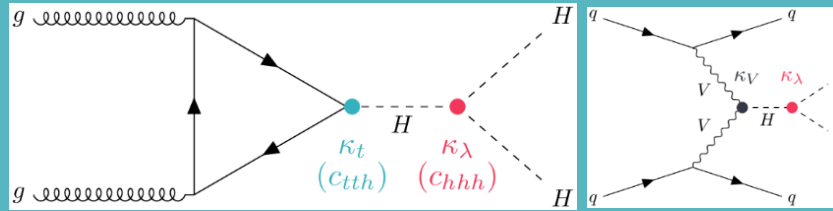
Run-3 in full swing, comparable / slightly improved limits to Run-2 so far.

- [CMS 4b](#); [CMS \$bb\gamma\gamma\$](#) , [CMS \$bbWW\(2l\)\$](#)
[ATLAS \$bb\gamma\gamma\$](#) . [ATLAS \$bb\tau\tau\$](#) : B. Dixit's talk

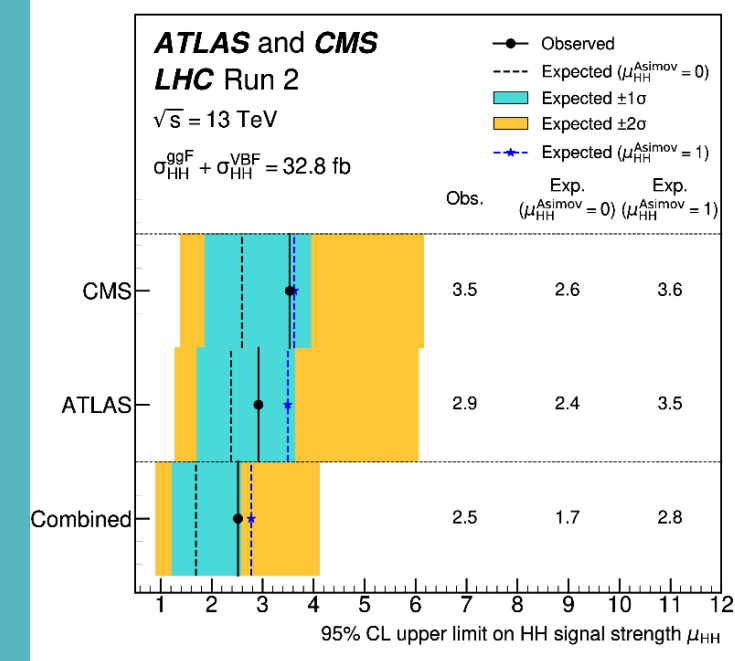
On-track for 5σ observation at HL-LHC

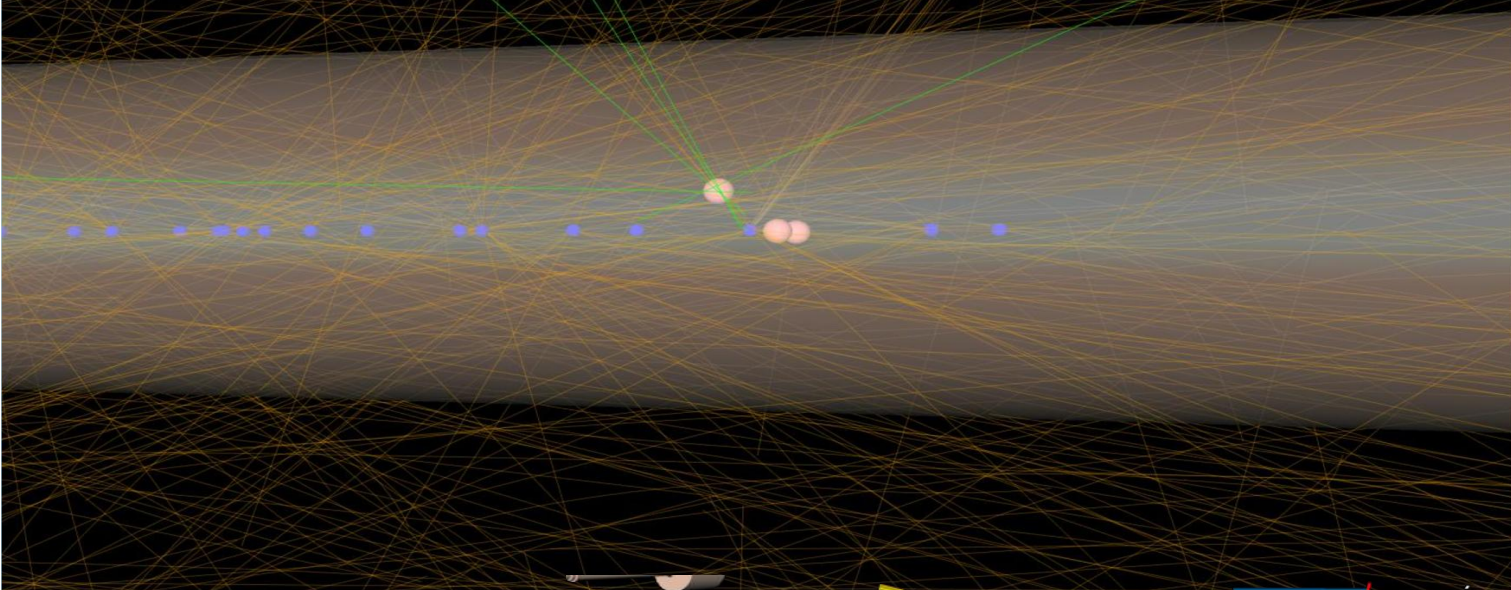
- LHC reco./analysis improvements since 2020 boost our [projections](#)!

(...Even starting to look at rarer $tthh$ and hhh : backup slides!)



arxiv:2602.23991
 CMS-PAS-HIG-24-010
 CMS-PAS-HIG-25-007
 CMS-PAS-HIG-25-018
 arxiv:2507.03495
 ATL-PHYS-PUB-2025-018





1FDV SR

E_T^{miss} properties

$$E_T^{miss} = 197 \text{ GeV}$$

$$\Phi_T^{miss} = -1.56$$

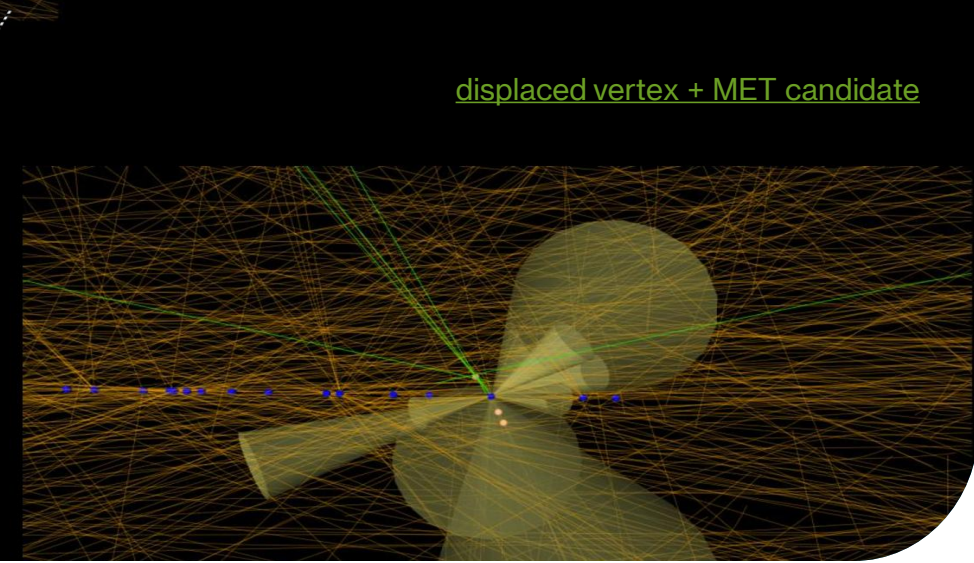
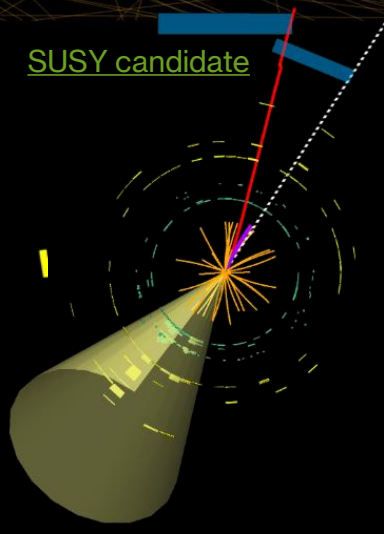
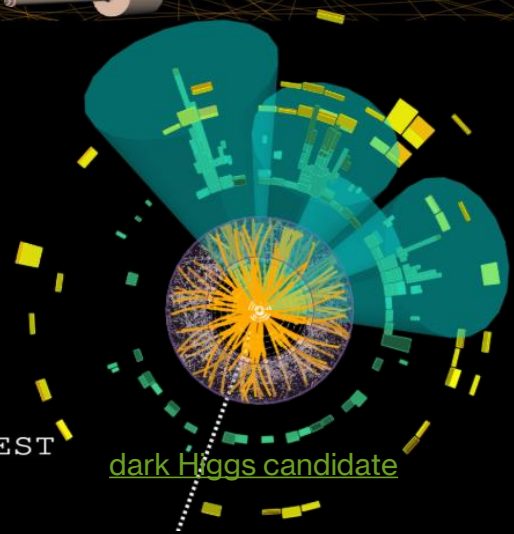
FDV properties

$$(x_{DV}, y_{DV}, z_{DV}): (5.6, -0.0, -59.1) \text{ mm}$$

$$m_{DV} = 14.5 \text{ GeV (5 tracks, 9 seeds)}$$



Run: 329964
 Event: 1037644853
 2017-07-18 17:12:50 CEST



BEYOND-SM SEARCHES

LHC, n. *An energy frontier Observatory.*

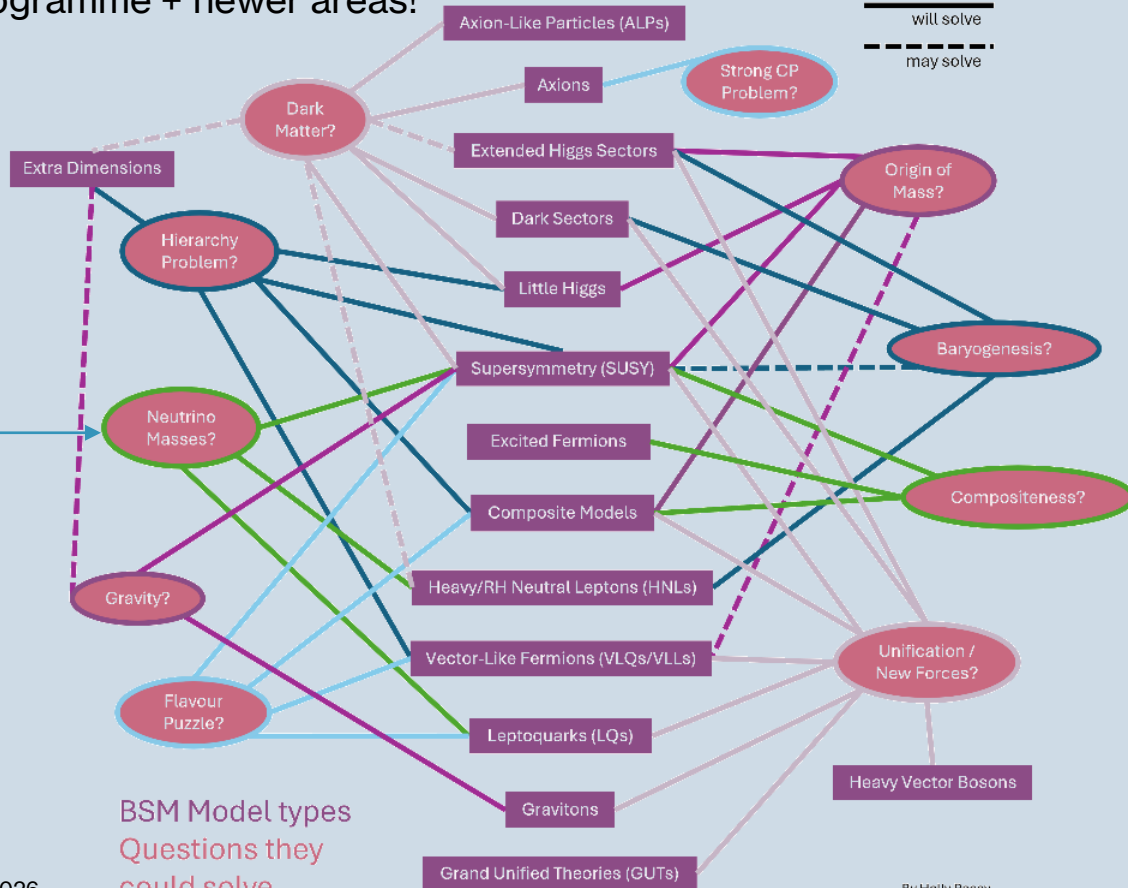
BSM SEARCHES

O(100) new BSM results since last IOP... Summary plots: [ATLAS](#); [CMS](#)

Today: highlights of new ideas/signatures & models with a recent focus.

Much more to come with Run-3; discovery potential remains across our core programme + newer areas!

Heavy neutrino updates in backup



BSM Model types
Questions they could solve

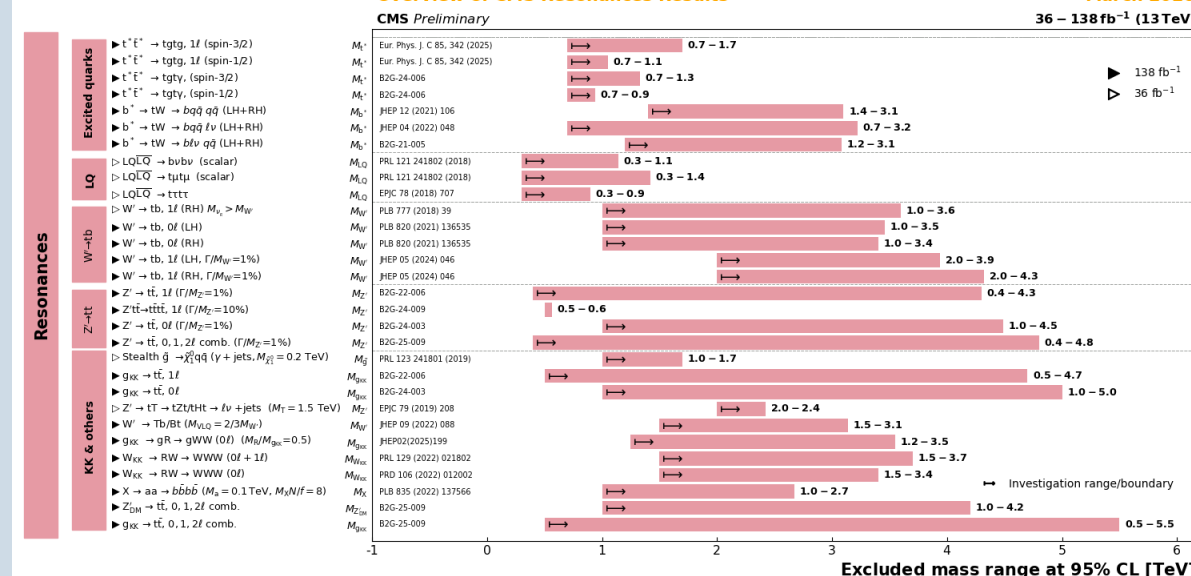
By Holly Paacy

09/04/2026

Model	Signature	$\int \mathcal{L} dt \text{ (fb}^{-1}\text{)}$	Mass limit	Reference			
				$\sqrt{s} = 13 \text{ TeV}$	$\sqrt{s} = 13, 13.6 \text{ TeV}$		
Inclusive Searches	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q}$	0 e, μ	2-6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 400 \text{ GeV}$	2010.14293
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} + \text{jet}$	0 e, μ	1-3 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) - m(\tilde{\chi}') = 5 \text{ GeV}$	2102.10874
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} + 2 \text{ jets}$	0 e, μ	2-6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) = 0 \text{ GeV}$	2010.14293
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z$	1 e, μ	2-6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 400 \text{ GeV}$	2010.14293
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + \text{jet}$	0 e, μ	7-11 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	2101.01629
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + 2 \text{ jets}$	0 e, μ	6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	2307.01094
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + 3 \text{ jets}$	0 e, μ	3 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	2211.08028
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + 4 \text{ jets}$	0 e, μ	6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	1909.08457
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + 5 \text{ jets}$	0 e, μ	6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	2101.12527
	$\tilde{\chi}\tilde{\chi} \rightarrow q\bar{q} W Z + 6 \text{ jets}$	0 e, μ	6 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{\chi}) < 200 \text{ GeV}$	2101.12527
3 rd gen. squarks direct production	$\tilde{t}\tilde{t} \rightarrow t\bar{t}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + \text{jet}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 2 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 3 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 4 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 5 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 6 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 7 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 8 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 9 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527
$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 10 \text{ jets}$	0 e, μ	2 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2101.12527	
EIV direct	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + \text{jet}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2106.01676, 2108.07586
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 2 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 3 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 4 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 5 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 6 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 7 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 8 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 9 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 10 \text{ jets}$	Multiple ℓ jets	$\geq 1 \text{ jet}$	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	1911.12609
Long-lived particles	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + \text{jet}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 2 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 3 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 4 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 5 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 6 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 7 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 8 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 9 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 10 \text{ jets}$	Disapp. trk	1 jet	$L_{\text{had}}^{\text{miss}}$	137	$m(\tilde{t}) < 400 \text{ GeV}$	2603.08315
RPV	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + \text{jet}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 2 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 3 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 4 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 5 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 6 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 7 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 8 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 9 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543
	$\tilde{t}\tilde{t} \rightarrow t\bar{t} + 10 \text{ jets}$	3 e, μ	0 jets	$L_{\text{had}}^{\text{miss}}$	140	$m(\tilde{t}) < 400 \text{ GeV}$	2011.10543

*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.

Overview of CMS Resonances Results



March 2026

36 - 138 fb⁻¹ (13 TeV)

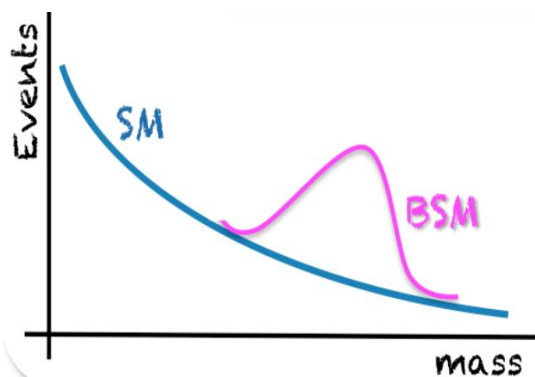
138 fb⁻¹

36 fb⁻¹

Investigation range/boundary

Excluded mass range at 95% CL [TeV]

HEAVY RESONANCES



Standard candle BSM search: Final-state mass bump, sensitive to e.g....

Spin-0 heavy Higgs (e.g. 2HDMs, extended Higgs sectors):

- New CMS $X \rightarrow hh$ summary ~4 TeV limits

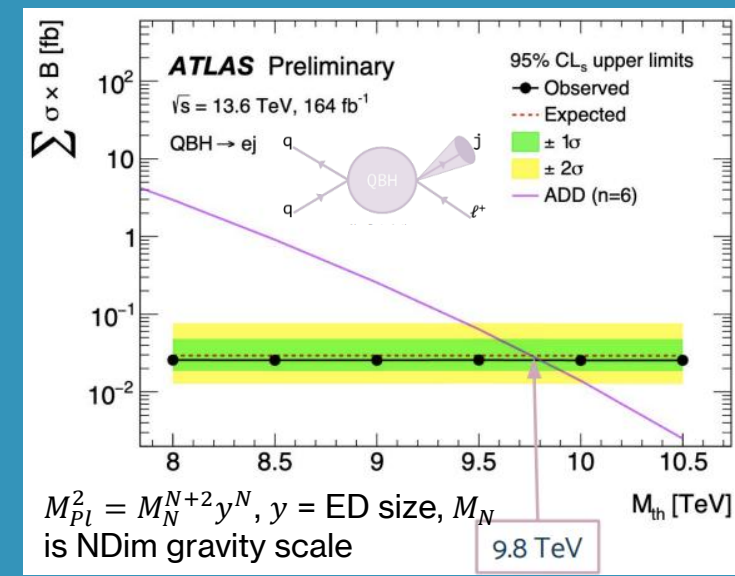
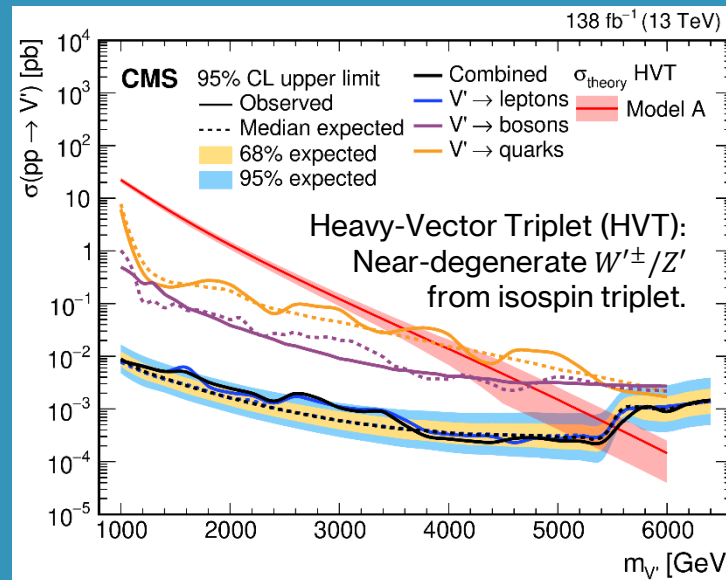
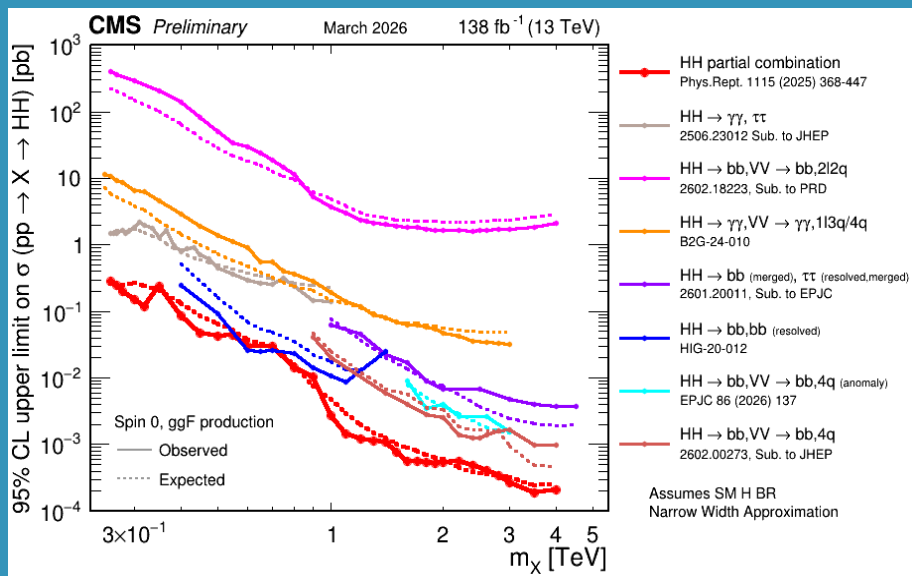
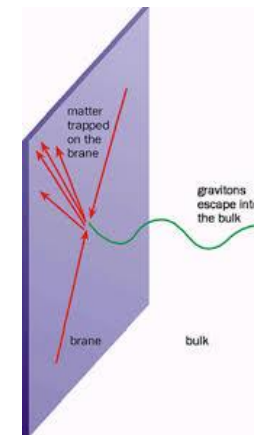
Spin-1 Heavy Z'/W' (e.g. dark-matter mediator) New CMS Spin-1 combination:

- $M = 5.5 \text{ TeV}$ limits, driven by leptonic decays (echoes ATLAS results).
- Run-3 preview: ATLAS $Z' \rightarrow ll$ in T. Elliotts' talk;

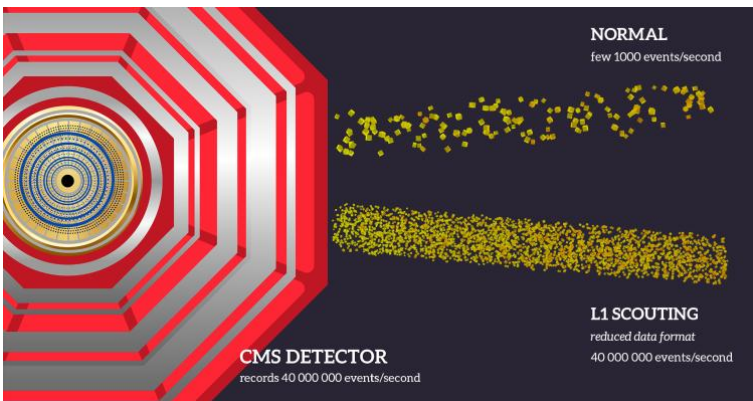
Extra dimensions, (ED, address gravity/hierarchy) via Quantum Black Holes

- New ATLAS results Run-3, limits $M_{th} \sim M_N \sim 10 \text{ TeV}$ in large-ED model!

[arxiv:2601.12583](https://arxiv.org/abs/2601.12583)
[JHEP 2024 118 \(2024\)](https://arxiv.org/abs/2601.12583)



NEW DATA STREAMS



ATLAS latest jj search exploits trigger-level analysis (TLA).

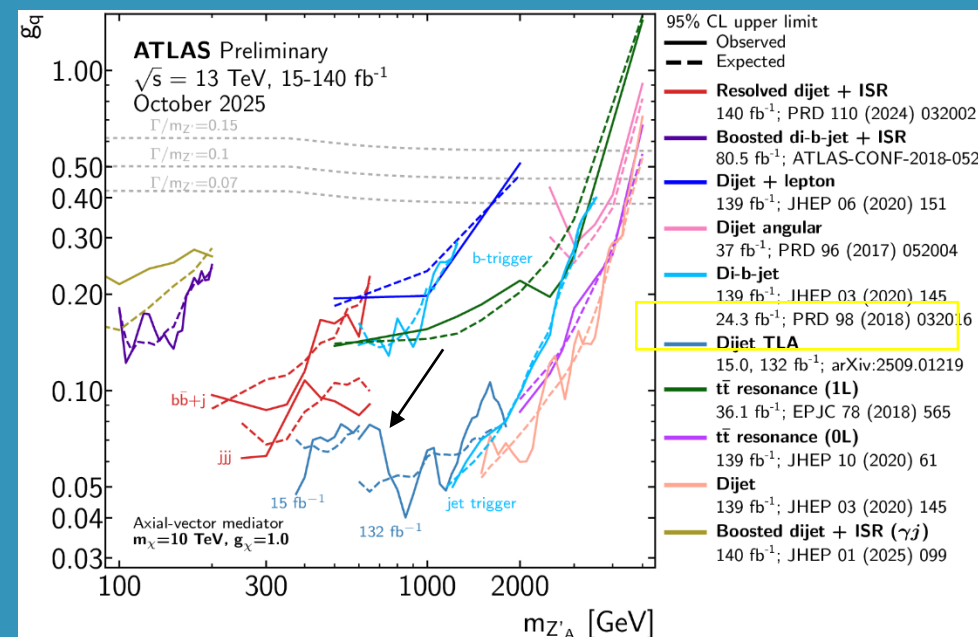
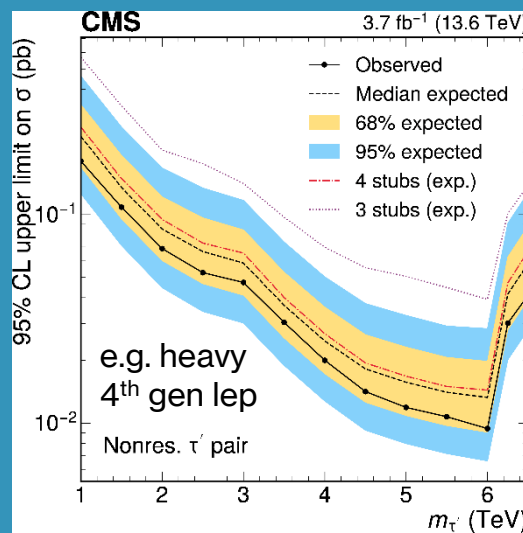
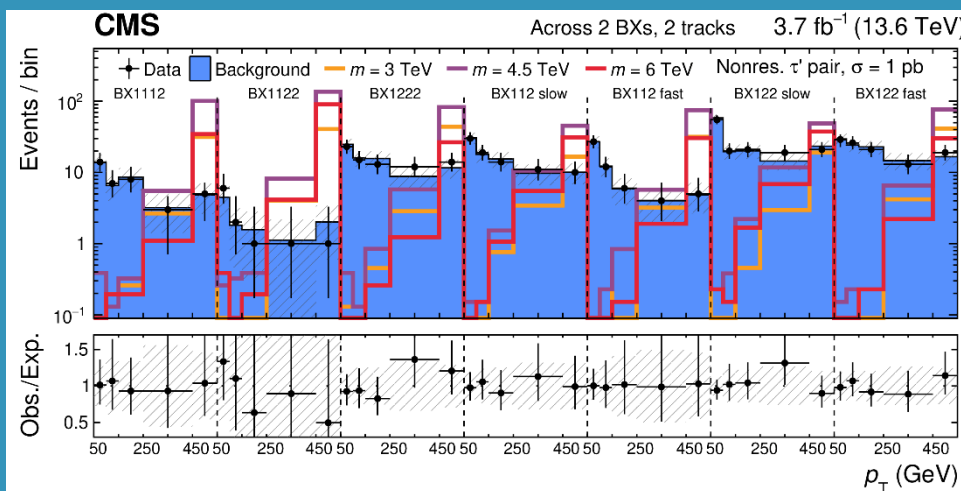
- Store limited event info for single-jet triggers, overcome bandwidth limitations and can store more events.

- Best ATLAS low-coupling constraints for Z' mediators (latest ATLAS CMS plots)

CMS search 1st with new Level-1 trigger scouting @ Run-3.

- No trigger selection, store limited L1-info, at full 40MHz.
- Can probe correlations *between* bunch crossings (BXs)!
- Best sensitivity to low $\beta = v/c$ heavy charged LLPs

Phys. Rev. D 112, 092015 (2025)
arxiv:2601.20063



ALPS

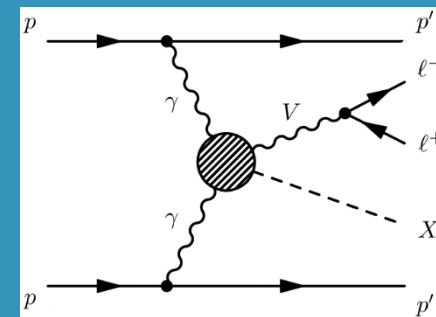
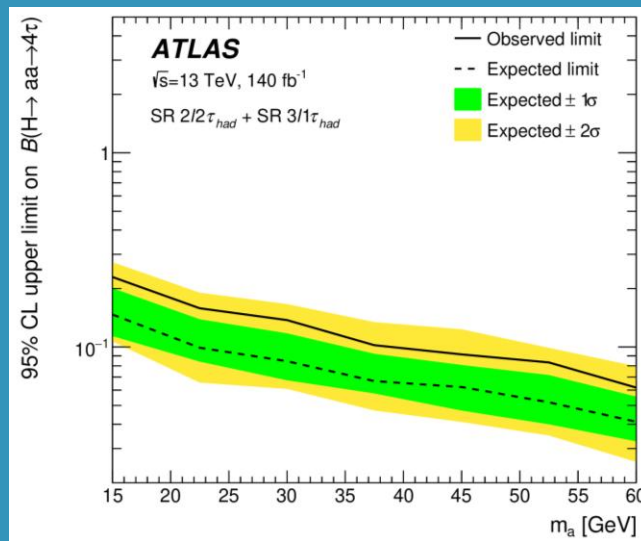
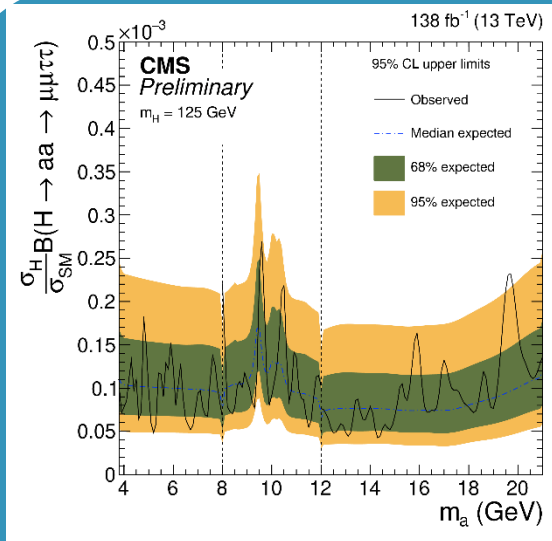
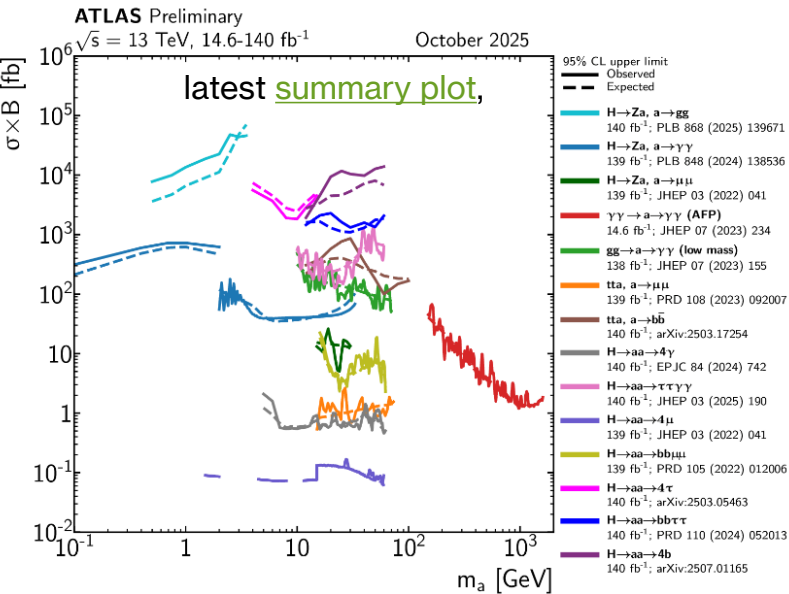


In the hunt for **lighter** resonances - recent focus on Axion-like particles a : models may address strong-CP problem.

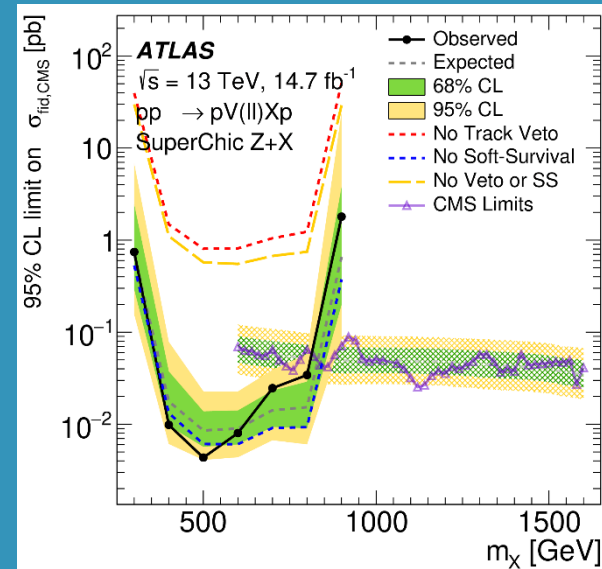
- New searches with complementary mass reach
CMS $h \rightarrow aa \rightarrow \mu\mu\tau\tau$; **ATLAS** $h \rightarrow aa \rightarrow 4\tau$.

2-ALP interpretation in **ATLAS** search for missing-mass with ATLAS forward-proton detector AFP.

- Rare use of AFP in a BSM search to tag final state scattered protons, with $V \rightarrow ll$.
- Complements **CMS results**



[CMS-PAS-SUS-23-005](#)
[arxiv:2603.08323](#)
[arxiv:2603.20837](#)
[EPJC 83 827 \(2023\)](#)



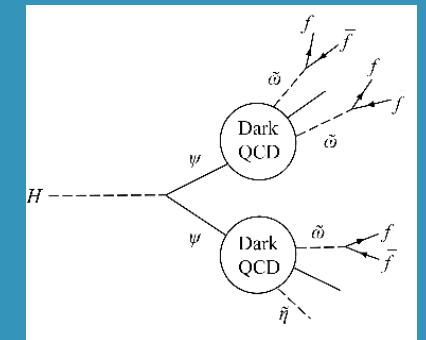
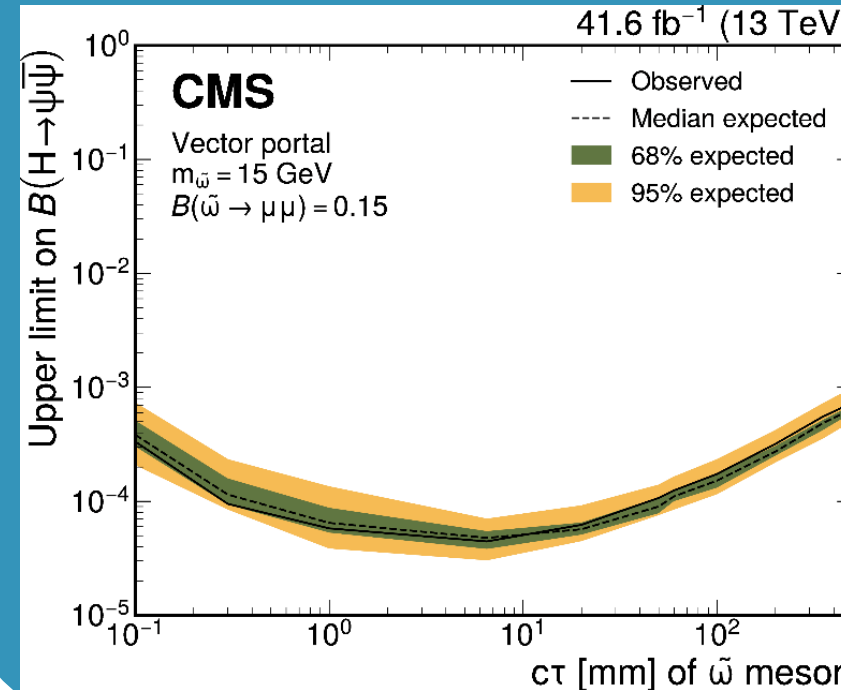
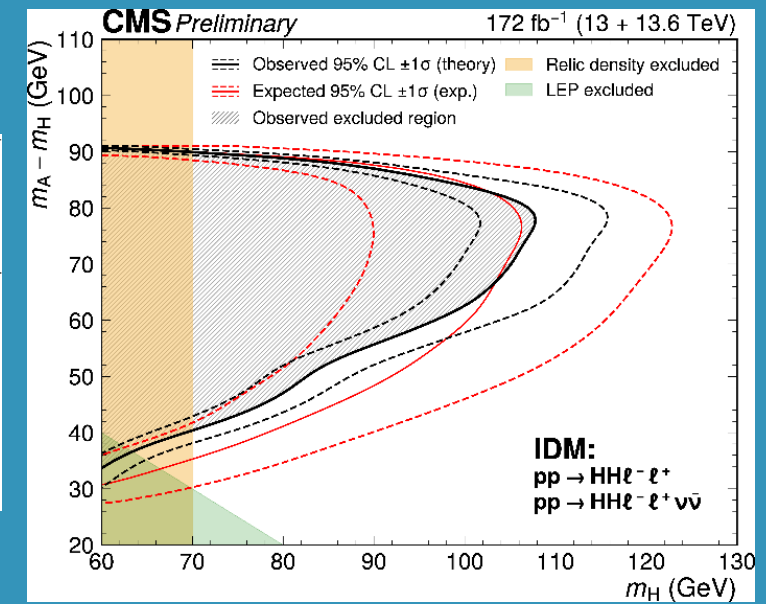
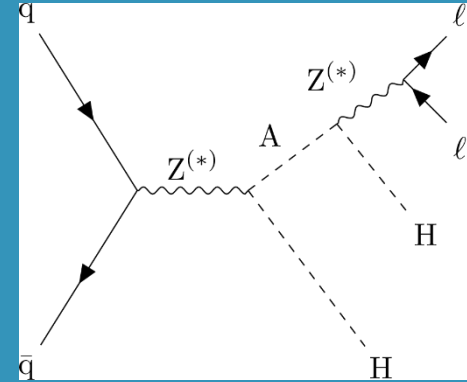
DARK MATTER

Run-2 set strong limits on key benchmarks

- [ATLAS plots](#), [S-chan](#), [2HDM+a](#), [CMS Summary](#), [H->inv](#)
- WIP to update them for Run-3 search effort.

New results expanding to consider different scenarios e.g.:

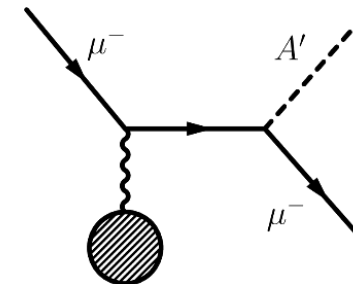
- Inert doublet model ($HDM + Z2$, scalar H WIMP DM):
 - 1st IDM [search](#) ll+MET Run-2+3 @ CMS
 - ([New Type-I 2HDM](#), [ATLAS search: R. Pickering talk](#))
- Complete dark sector! e.g. Dark QCD, with DM from stable dark hadrons, and unstable decaying to SM.
 - [CMS](#) dark shower search with displaced vertices (from interaction point) $\rightarrow \mu\mu$.
 - Broad limits on e.g. dark mesons
 - Strong programme for related [emerging/semi-visible jet](#) signatures e.g. [S. Valjee's talk](#).



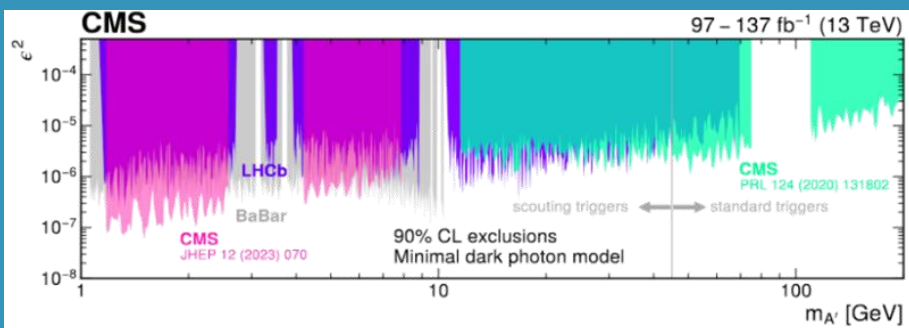
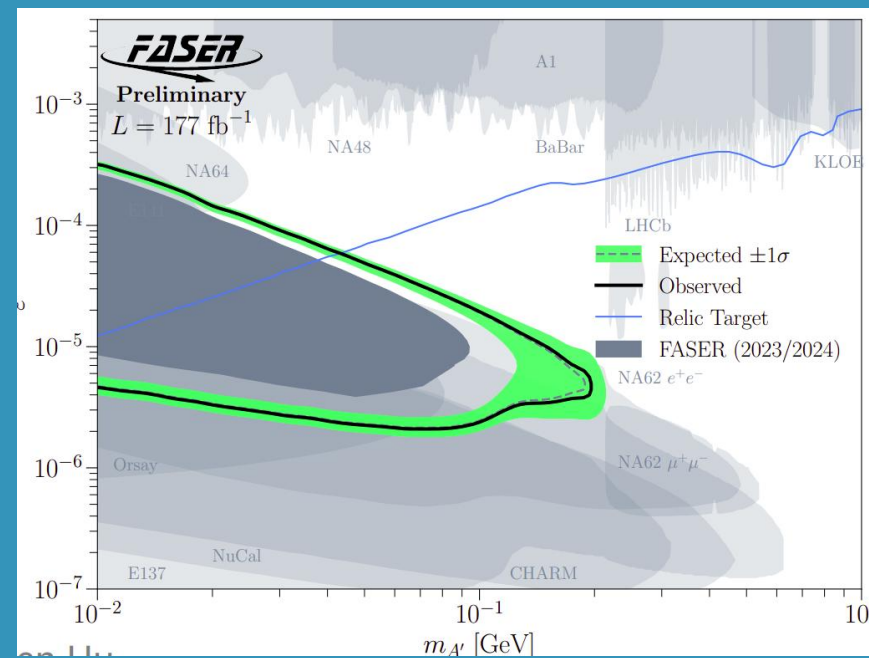
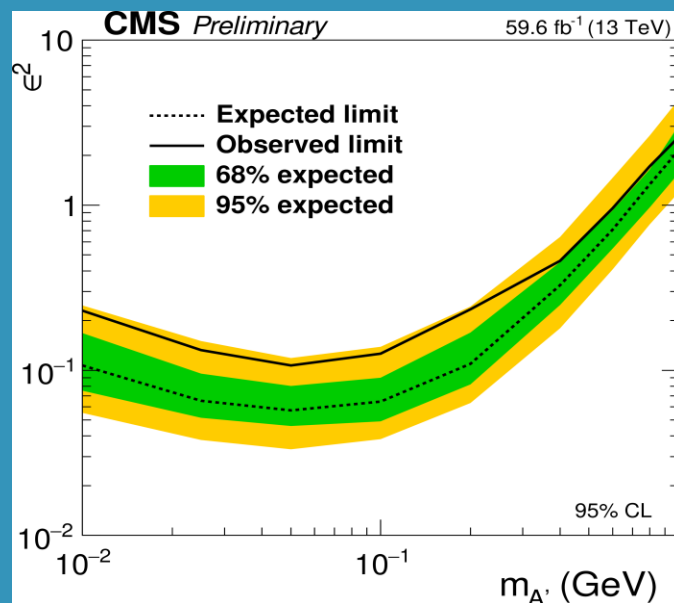
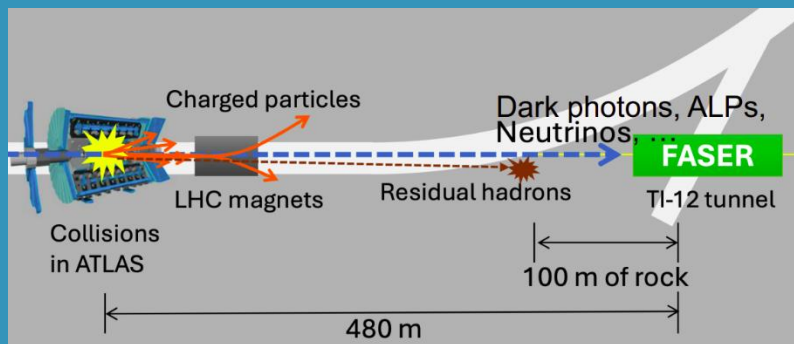
CMS-PAS-NPS-25-002
 CMS-PAS-EXO-23-008
 JHEP 03 (2026) 189

DARK MATTER 2

- Dark photon (A') light mediator for $O(\text{GeV})$ DM, mixes with SM γ by ϵ
 - [CMS](#) dark bremsstrahlung with endcap calo. material!
 - Lowest CMS mass limits to date on ϵ (vs [summary](#))
 - Same mass range as highly sensitive new Run-3 [search](#) from [FASER](#) forward experiment!



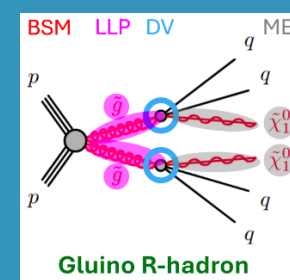
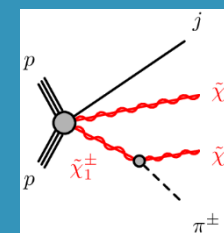
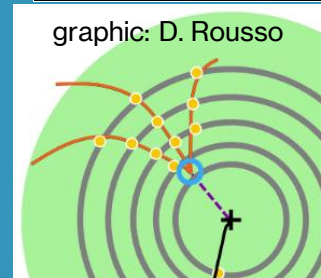
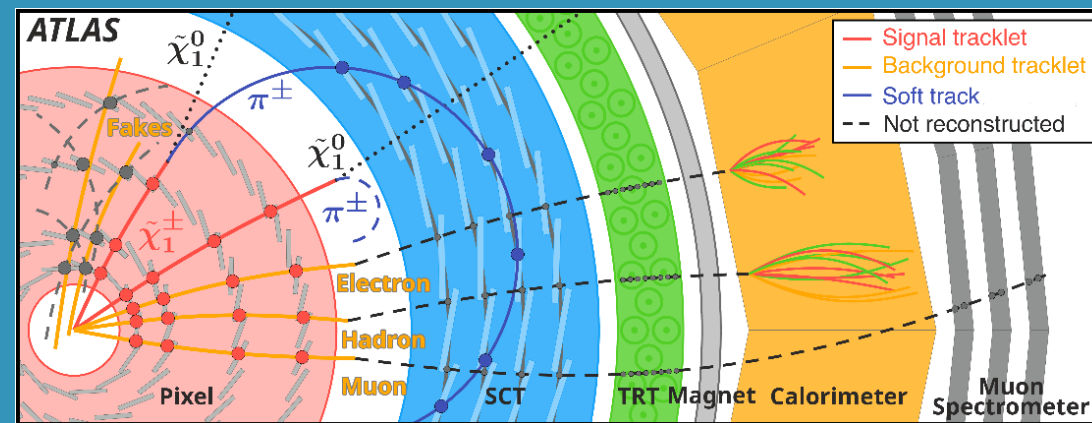
[CMS-PAS-NPS-25-002](#)
[CMS-PAS-EXO-23-008](#)
[JHEP 03 \(2026\) 189](#)
[CERN-FASER-CONF-2026-001](#)



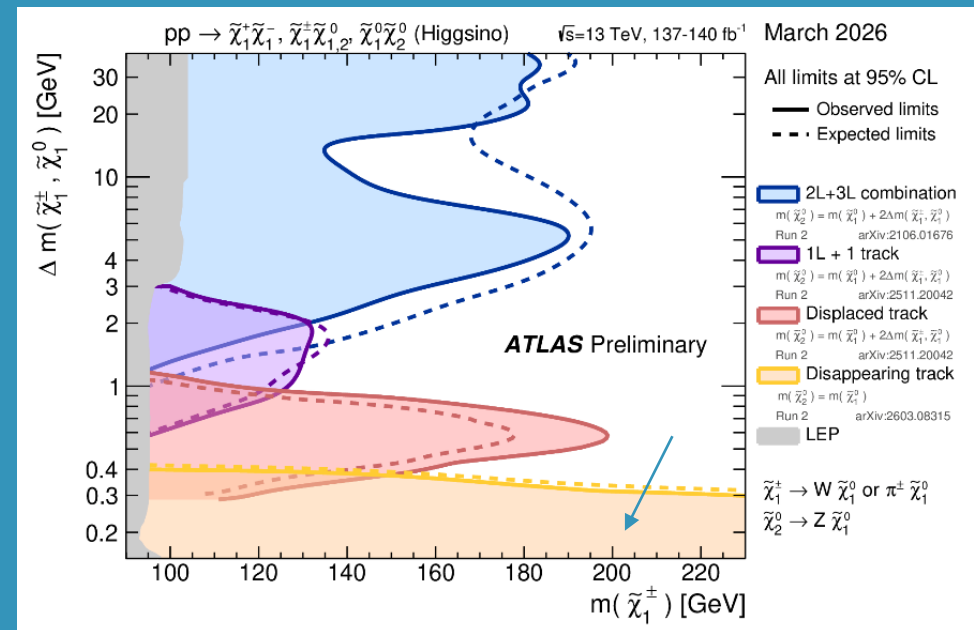
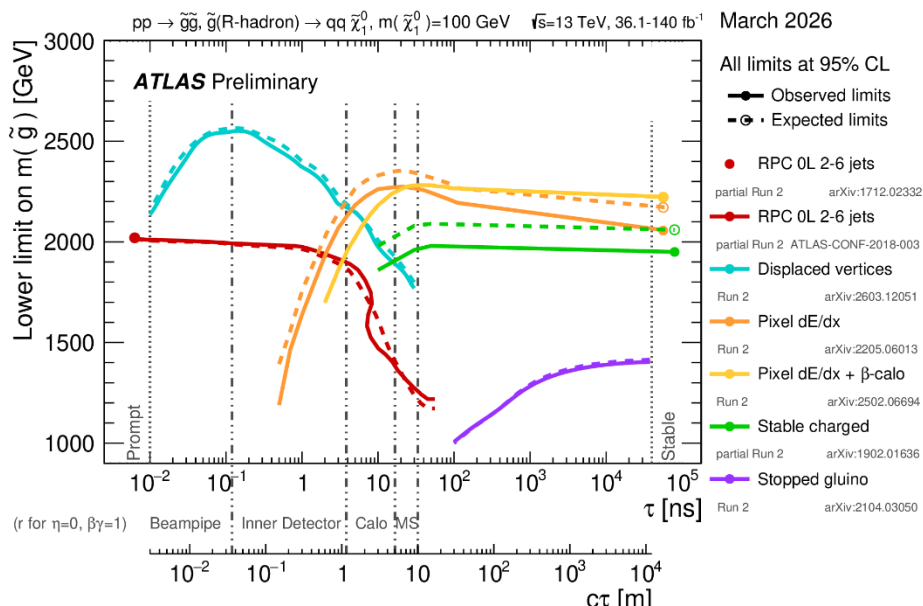
THE 'NEW' SUPERSYMMETRY

Beyond classic searches, complementary 'unconventional signatures' now a central part of SUSY effort. Many new results e.g.:

- [ATLAS](#) Disappearing track in soft pion + DM decay.
 - Awesome sensitivity to e.g. higgsino $\tilde{\chi}_1^\pm$!
- Displaced vertex + [muons](#) / [4l](#) / [low-pT tracks](#) / ...
 - [MET](#) E_T^{miss} (ATLAS), best R-hadron limits.
 - ([J. Wack talk](#) for DV in muon spectrometer.)
- Displaced taus? [ATLAS A Veltman talk](#); CMS new [results](#).

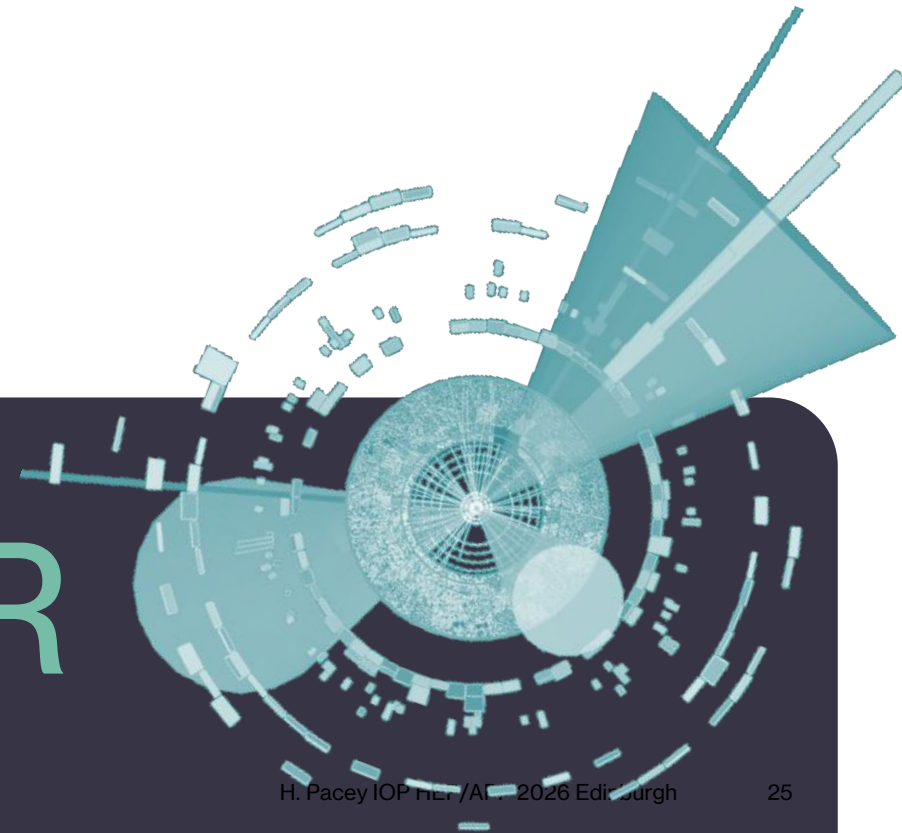


- [arxiv:2603.08315](#)
- [arxiv:2603.01991](#)
- [arxiv:2601.05664](#)
- [arxiv:2511.08212](#)
- [arxiv:2603.12051](#)



- Exciting physics programme starting to explore Run-3! have only given a brief glimpse here.
- Lots of novel ideas and dedicated effort allowing us to exploit experiments beyond their intended uses!
- Have barely mentioned the ML-fueled enhancements to analysis strategies!
[e.g. Tau-ID S. Pradhan's [talk](#) & J. Davidson's [talk](#) , boosted Top ID Y Zhu's [talk](#), ML jet calib. S Chakraborty's [talk](#) e/γ ID H. Davie's [talk](#), AD trigger M Moallemi's [talk](#) on Run-3/HL-LHC ideas!]
- Also no time for heavy Ion:
e.g. 1st O+O, Ne+Ne collision results coming!
Complement existing Pb+Pb results [ATLAS CMS](#)

SUMMARY SO FAR



LOOKING FORWARD...

End of Run-3 marks only ~10% of our total data!

Many more years to come with HL-LHC.

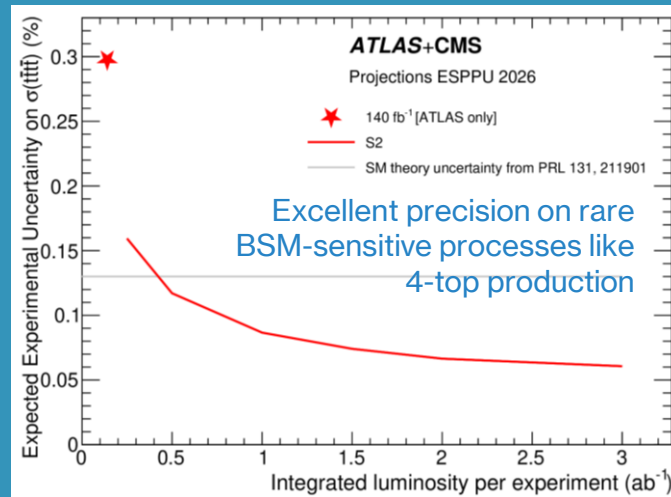
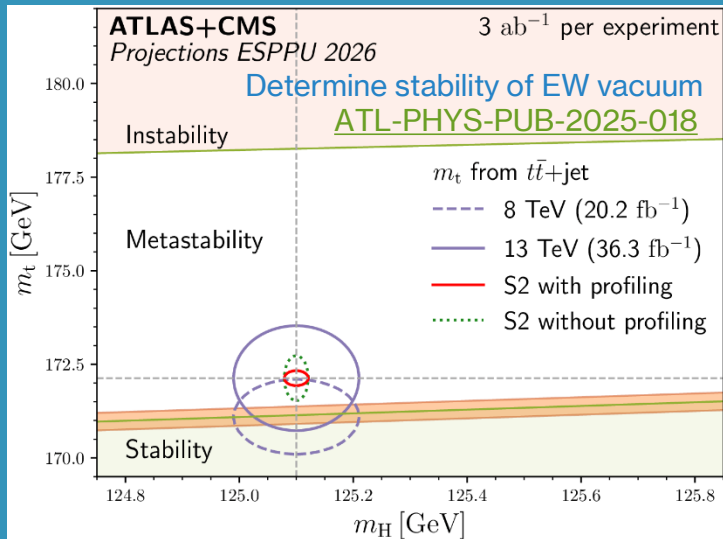
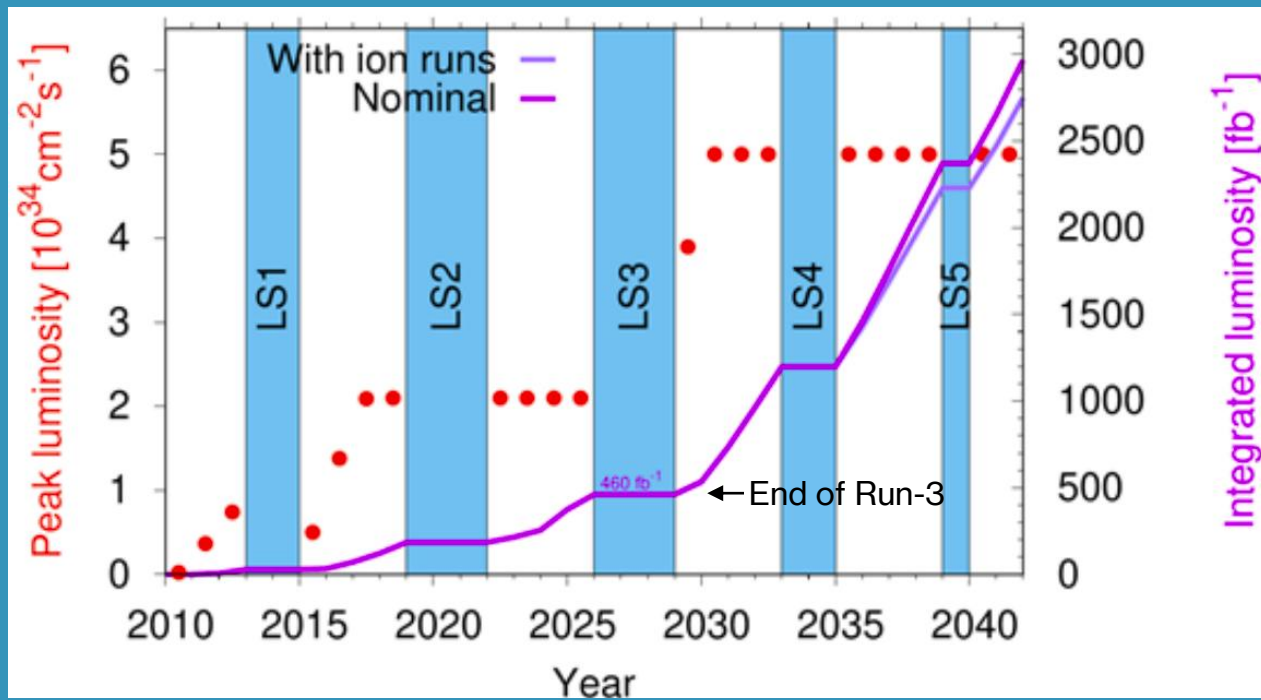
Will upgraded detectors equipped with new...

- Trackers with better acceptance,
- Timing detectors for pileup rejection,
- More sophisticated Trigger systems, etc...

Designed+built with strong UK leadership

Can provide unprecedented discovery potential + precision

...**if** we have enough funding and support to exploit it fully.





THANKS FOR LISTENING
QUESTIONS?

BACKUP

& OTHER NEW RESULTS I DIDN'T HAVE TIME TO INCLUDE...

HEAVY NEUTRINOS



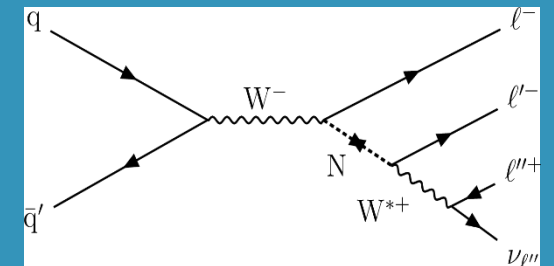
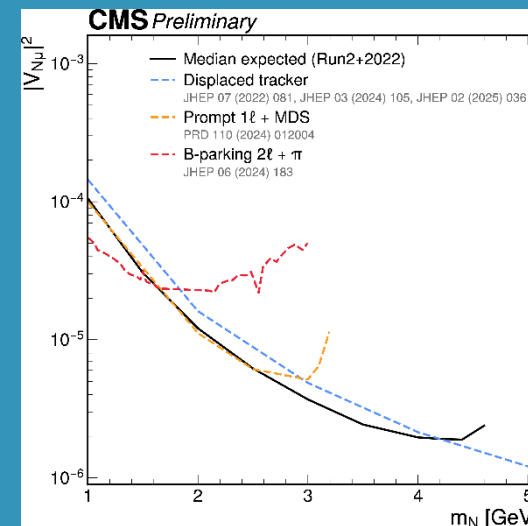
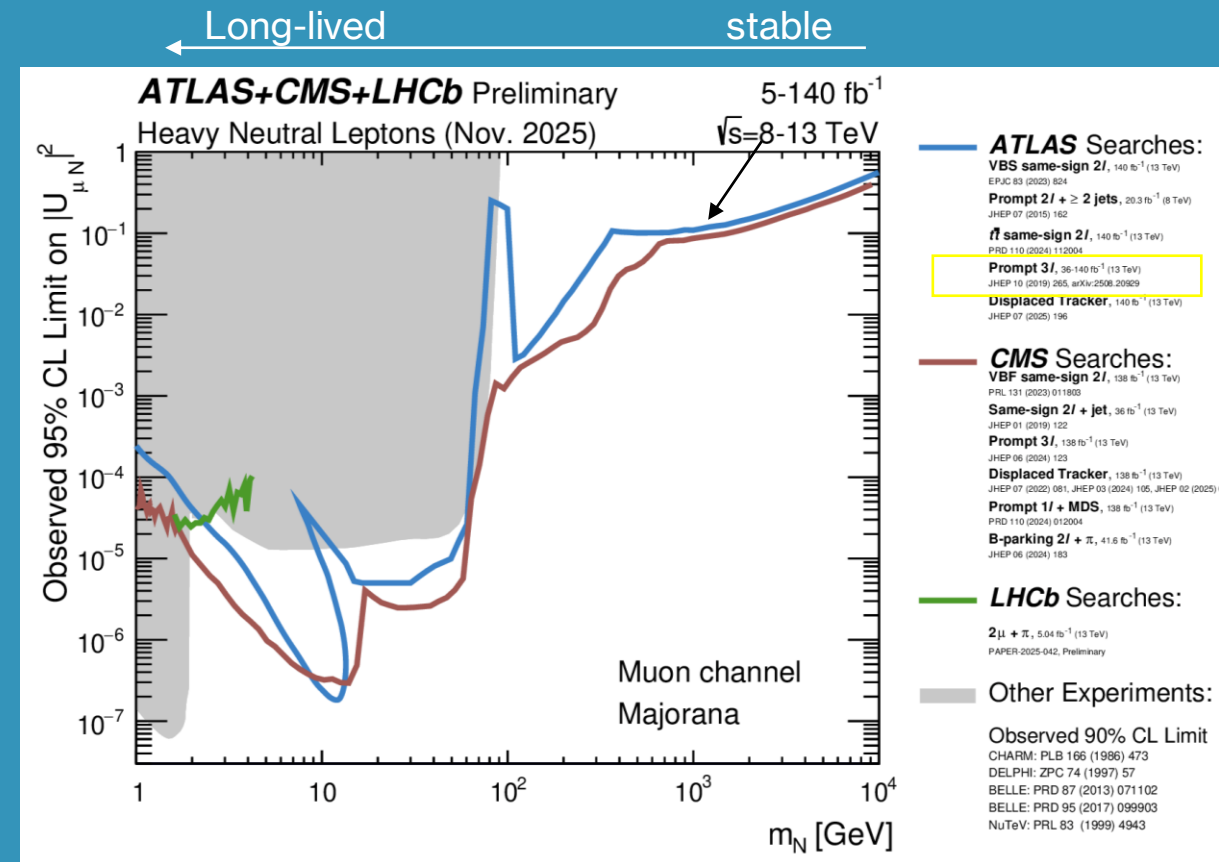
Probe origin of neutrino masses.

Newest results consider type-I SeeSaw models

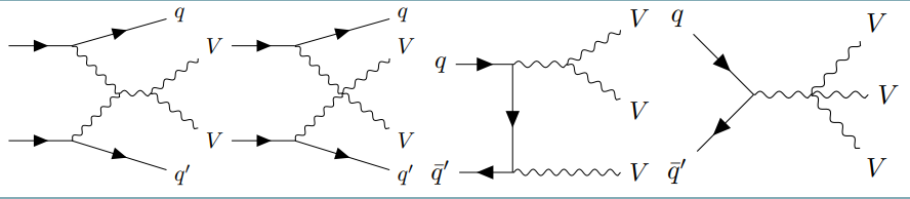
- BSM Heavy Right-handed neutrino (N) + light SM ν .
- [Summary](#) plots: Colliders have broad sensitivity across mass/lifetime range ($\tau \propto M^{-5} |V|^{-2}$)

Look for N in W decays in different regimes.

- ATLAS [search](#): prompt + high mass
- CMS 1st Run-3 [search](#): low-mass, prompt+displaced μ s.

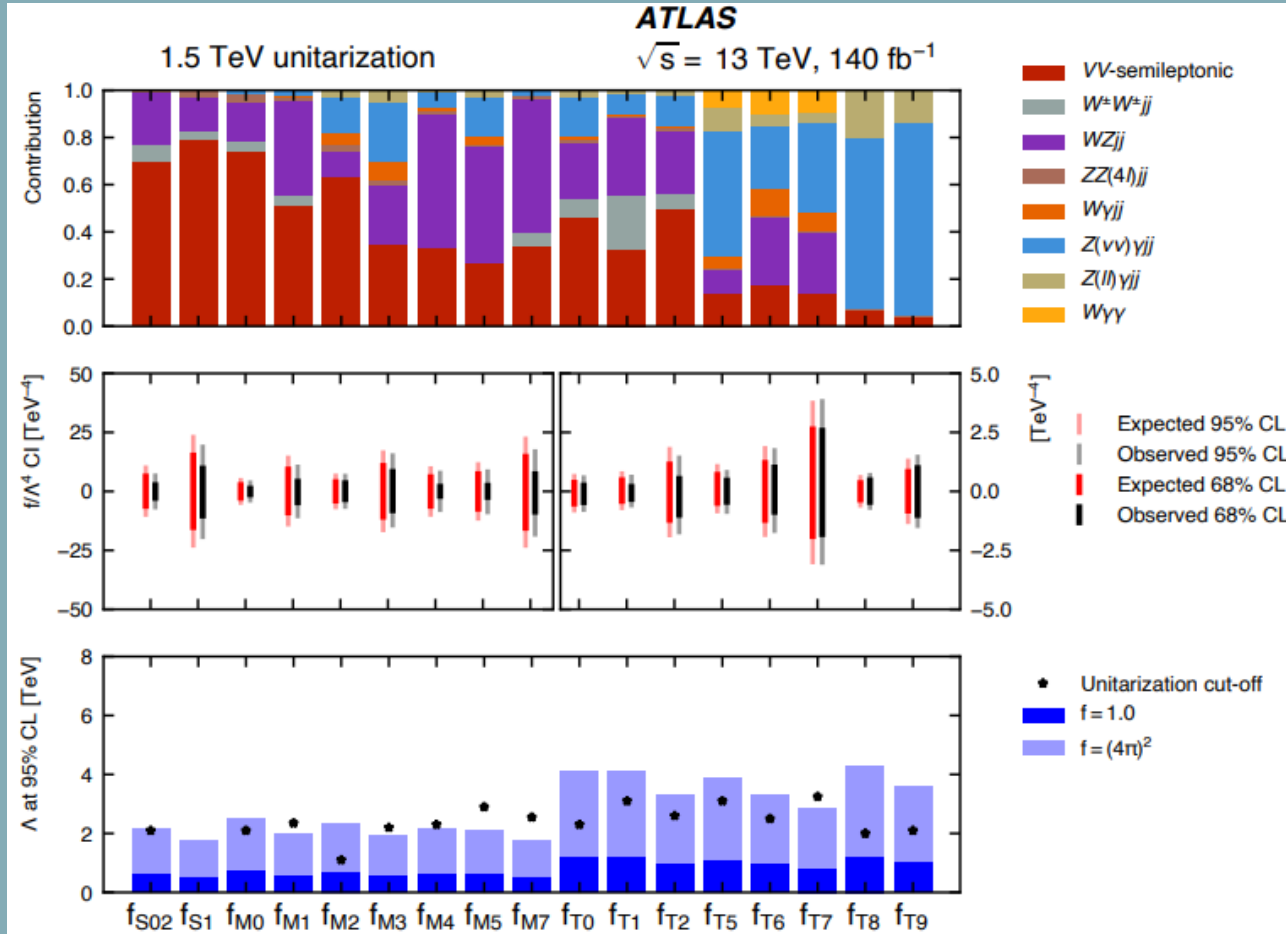


[EPJC 86 153 \(2026\)](#)
[CMS-PAS-EXO-24-015](#)



$$\mathcal{L}_{\text{Eff}} \approx \mathcal{L}_{\text{SM}}^{(4)} + \sum_j \frac{f_j^{(8)}}{\Lambda^4} \mathcal{O}_j^{(8)}$$

arxiv.org:2603.18630



EFFECTIVE FIELD THEORIES

EFTs: generic way to constrain BSM operators with a mass scale Λ that may be too large for direct production.

Many SM measurements recently include EFT interpretations, blurring search-measurement line

[ATLAS](#) quartic gauge coupling comb. of 7 Run-2 results.

- Sensitive to order-8 operators & coefficients.
- Tightens Wilson coefficient constraints up to 96%.

EFT interpretations in other recent results too, such as...

- [Associated-top production, see B. Cunnett's Talk!](#)
- [ATLAS \$W\gamma\$ arxiv:2603.22478](#)
- [CMS \$\gamma\gamma \rightarrow WW\$ arxiv:2601.21574](#)
- [CMS \$jj\$ arxiv:2603.25458](#)
- [CMS \$Z\gamma\$ arxiv:2601.14102](#)
- [ATLAS \$ZZ\$ arxiv:2511.15569](#)
- [ATLAS single- \$t\$ arxiv:2510.23372](#)
- [3/4t CMS-PAS-TOP-24-008](#)

BEYOND DI-HIGGS

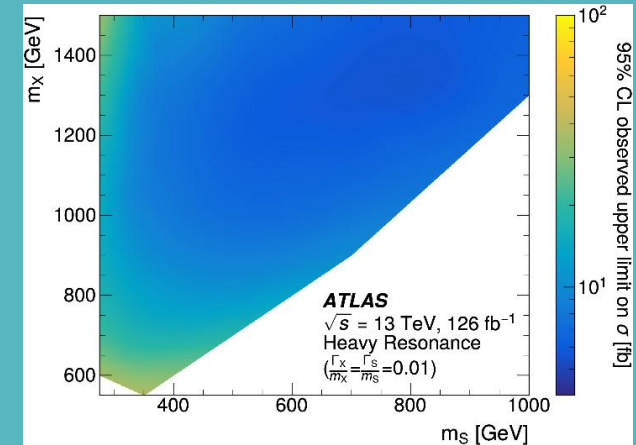
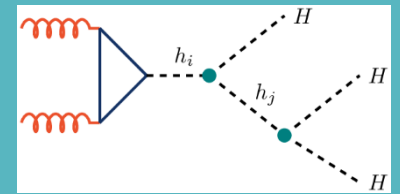
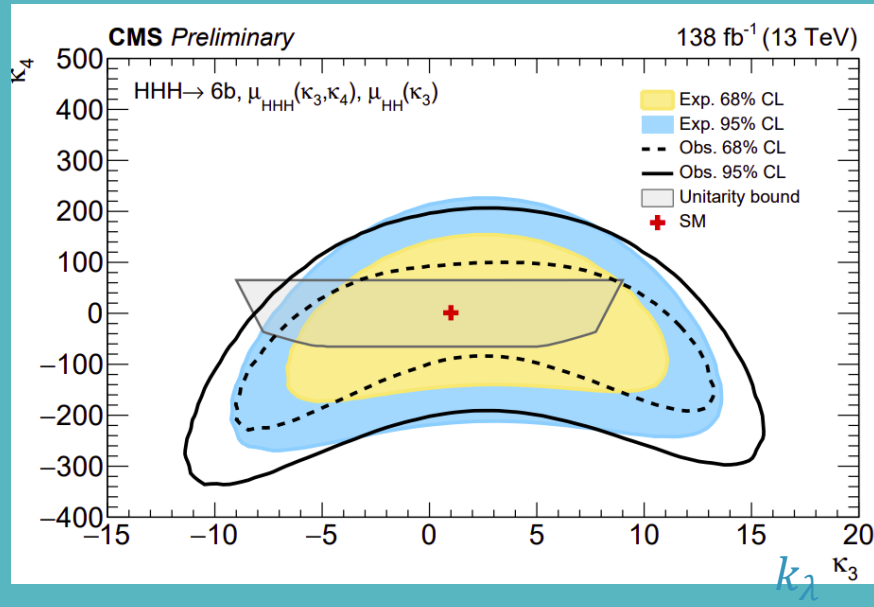
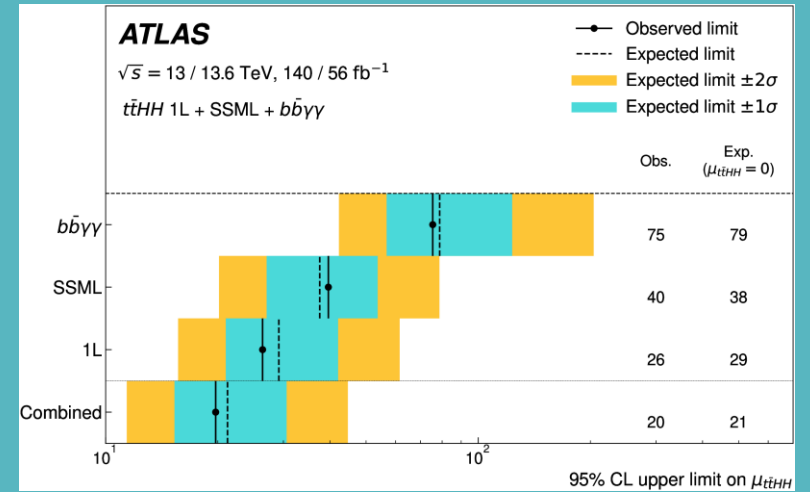
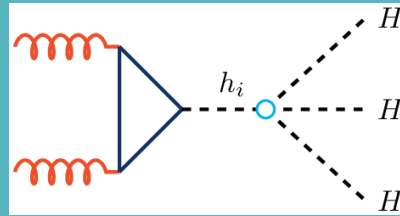
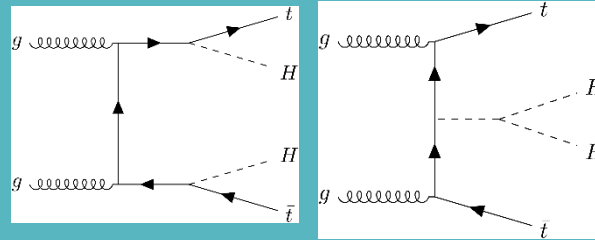
First ATLAS $t\bar{t}hh$ Run-2+3, multiple channels, k_t & k_λ .

- $\sigma^{SM} = O(0.8fb)$! Limit $20 \times$

First searches for Tri-Higgs $hhh \rightarrow 6b$

- Direct quartic coupling probe k_4 !
- $\sigma^{SM} = O(0.08fb)$! **CMS** Limit $580 \times$
- BSM resonances constrained at **ATLAS** $O(10 - 100fb)$ upper lims.

[arxiv:2603.13113](https://arxiv.org/abs/2603.13113)
[CMS-PAS-HIG-24-012](https://arxiv.org/abs/2508.00121)
[Phys. Rev. D 111, 032006 \(2025\)](https://arxiv.org/abs/2508.00121)



MORE TOP

TOPONIUM

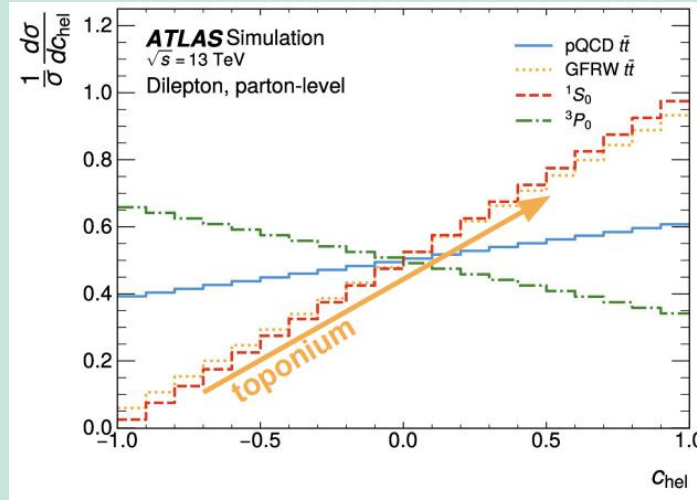
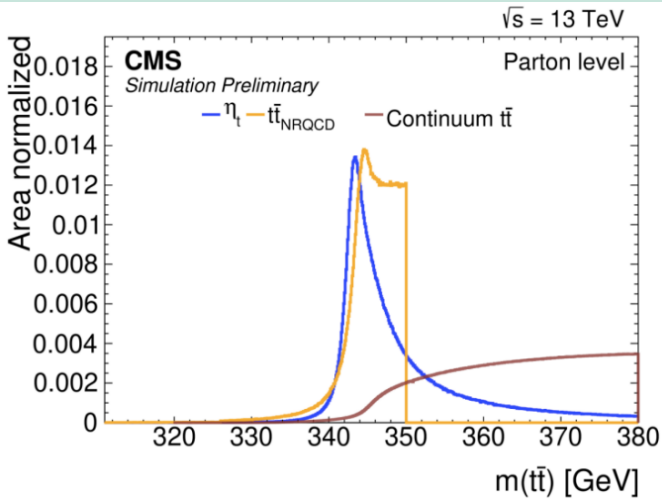
Signal Modelling is key:



- CMS: simpler tuned pseudo-scalar resonance (η_t).
- ATLAS: ttbar ME projected+reweighted with NRQCD Green's functions ($t\bar{t}_{NRQCD}$).
- Aim for common LHC model in future & further characterising excess in Run-3.

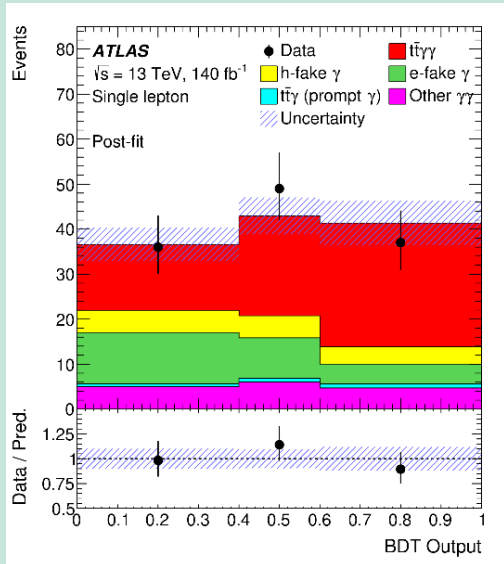
ATLAS result on xsec ~40% higher than NRQCD prediction!

More in I. Young's [talk](#)

Also recent Observation of Rare SM processes e.g. 1st $t\bar{t}\gamma\gamma$
Obs. 5.2σ by [ATLAS PLB 874 \(2026\) 140195](#)




 $\sigma(t\bar{t}_{GFRW}) = 9.3^{+1.1}_{-1.0} \text{ (stat.)} \pm 0.8 \text{ (syst.) pb}$

 $\sigma(\eta_t) = 8.8 \pm 0.5 \text{ (stat.)}^{+1.1}_{-1.3} \text{ (syst.) pb}$



$\sigma_{t\bar{t}\gamma\gamma} = 2.42 + 0.58 - 0.53 \text{ fb}$
 $\sigma_{t\bar{t}\gamma\gamma} \text{ (SM, LO)} = 1.5 + 0.5 - 0.4 \text{ fb (K-factor } \sim 1.7)$

[CMS-PAS-TOP-25-002](#)
[arxiv:2601.11780](#)
[RPP 88 087801 \(2025\)](#)
[JHEP 2024 99 \(2024\)](#)
[EPJC 85 157 \(2025\)](#)
[PRD 104, 034023 \(2021\)](#)

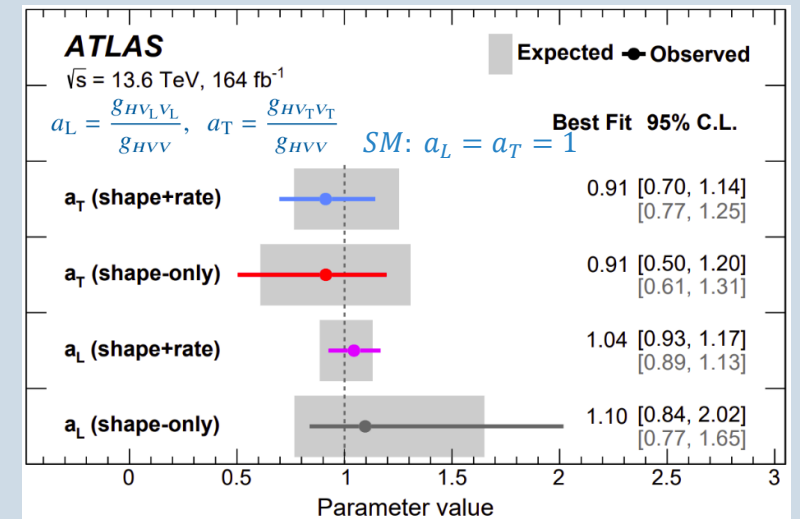
MORE SM HIGGS

Run-3 SM Higgs results:

- [CMS \$h \rightarrow 4l\$](#) + [spin correlations](#);
[CMS \$h \rightarrow \gamma\gamma\$](#) ; [ATLAS \$h \rightarrow \mu\mu\$](#) ; [ATLAS \$h \rightarrow Z\gamma\$](#) ; [ATLAS VBF \$h \rightarrow bb/cc + \gamma\gamma\$](#) ;

New CP studies e.g.

- [ATLAS \$Vh\$](#) Extended Higgs sectors:
- [ATLAS VBF \$h \rightarrow \gamma\gamma\$](#) Run-3 CP measurements agree with SM, set EFT limits. Also Constrain hVV interaction polarisation via fit in sensitive $\Delta\phi(jj)$ (image)
- see also CP in [CMS \$h \rightarrow \tau\tau\$](#) [L. Russell's talk!](#)



MORE BSM:

Light Res.

CMS [/SUS-23-005/](#) Mar 2026 | H->aa->2mu2ta, Ext. Scalar, Light Res., R2

CMS [/NPS-25-003/](#) Mar 2026 | H->phi1phi2->2b2tau, Light Res., Ext. Scalar., R2

CMS [/HIG-24-014/](#) Mar 2026 | phi->gamgam., Light Res., R2

CMS [/EXO-24-025/](#) Dec 2025 | h->aa->4gam., Light Res., R2

CMS [/EXO-24-031/](#) Nov 2025 | h->aa->4e, Light Res., R2

ATLAS [/HMBS-2024-35/](#) Mar 2026 | H->aa->4tau, [Light Res.](#), [Ext. Scalar](#), R2

ATLAS [/EXOT-2018-39/](#) Sep 2025 | dijet TLA, [Light Res.](#), [Weird-Sig](#), R2

ATLAS [/EXOT-2023-13/](#) Mar 2026 | AFP II, [Weird-Sig](#), [dark Sector](#), R2

Extended lepton sectors

CMS [/B2G-24-013/](#) Mar 2026 | VLB->tW, Ext. Lep., R2

CMS [/EXO-24-019/](#) Mar 2026 | PP LQ->eq, Ext. Lep., R2

CMS [/EXO-24-015/](#) Mar 2026 | LLP HNL DVmuons, Ext. Lep., [Weird-sig.](#), R2+3

CMS [/B2G-24-006/](#) Feb 2026 | excited top PP, Heavy Res., Ext. Lep., R2

ATLAS [/EXOT-2019-35/](#) Aug 2025 | HNL 3L prompt, [Ext. Lep.](#), R2

ATLAS [/EXOT-2024-12/](#) July 2025 | resonant LQ, [Ext. Lepton](#), R2+3

ATLAS [/EXOT-2018-60/](#) June 2025 | VLQ->Wlvb, [Ext. Lepton](#), R2

CMS [/TOP-24-017/](#) Mar 2026 | 4top tau VLL, [Ext.Lep.](#), R2

ATLAS [/EXOT-2021-34/](#) Aug 2025 | multilepton AD, [SUSY](#), [Ext.Lep.](#), R2

Dark Matter

CMS [/NPS-25-002/](#) Mar 2026 | IDM 2L+MET, [Dark Matter.](#), R2+3

CMS [/SUS-24-007/](#) Jan 2026 | h+MET dark higgs/hdm+a., [dark matter](#), R2

ATLAS [/HMBS-2024-13/](#) July 2025 | dark higgs HH+MET, [Dark Matter](#), [Ext. Scalar](#), R2

CMS [/EXO-24-011/](#) Mar 2026 | dijet angular, Heavy res., Extra Dim., [Dark Matter.](#), R2

Dark Sector

CMS [/EXO-23-008/](#) Mar 2026 | dark photon

muon brem., [Weird-Sig](#), [dark Sector](#), R2

CMS [/EXO-26-005/](#) Mar 2026 | semivisible jets s-chan tau, [Weird-Sig](#), [dark Sector](#), R2

CMS [/EXO-24-008/](#) Nov 2025 | dark showers., [dark Sector.](#), [Weird-Sig.](#), R2

ATLAS [/EXOT-2018-20/](#) Oct 2025 | emerging jets, [dark sector](#), [Weird-Sig](#), R2

ATLAS [/EXOT-2022-31/](#) May 2025 | emerging jets, [dark sector](#), [Weird-Sig](#), R3

ATLAS [/EXOT-2021-19/](#) May 2025 | semi-visible-jets, [dark sector](#), [Weird-Sig](#), R2

Saashiv Valjee talk

ATLAS [/HMBS-2024-28/](#) Jan 2026 | dark photon -> mumu, [Light Res.](#), [Dark Sector](#), R2

CMS [/EXO-23-001/](#) Mar 2026 | SUEP data scouting, [dark sector](#), R2

SUSY

CMS [/EXO-25-010/](#) Jan 2026 | heavy LLP L1-Scouting, [Weird-Sig.](#), [SUSY](#), R3

CMS [/EXO-24-020/](#) Jan 2026 | LLP stau, [Weird-Sig.](#), [SUSY](#), R2

CMS [/SUS-24-003/](#) Nov 2025 | higgsinos low-pT lepton-track, [SUSY](#), [Weird-Sig.](#), R2

CMS [/EXO-24-033/](#) Nov 2025 | DV low-pt tracks., [SUSY.](#), [Weird-Sig.](#), R2

ATLAS [/HMBS-2024-04/](#) Mar 2026 | RPC->RPV reinterpretation, [SUSY](#), R2

ATLAS [/SUSY-2022-15/](#) Mar 2026 | DV+MET, [SUSY](#), [Weird-Sig](#), R2

ATLAS [/HMBS-2024-66/](#) Mar 2026 | disappearing track LLP stau/Chrgno, [SUSY](#), [Weird-Sig](#), R2

ATLAS [/EXOT-2024-21/](#) Mar 2026 | DV+Dmuon, [SUSY](#), [Weird-Sig](#), R3

ATLAS [/SUSY-2020-08/](#) Jan 2026 | dV->4L, [SUSY](#), [Ext. Scalar](#), [Weird-Sig](#), R2

ATLAS [/SUSY-2021-07/](#) Nov 2025 | EW-SUSY photon jet MET, [SUSY](#), R2

ATLAS [/HMBS-2024-65/](#) Nov 2025 | compressed Higgsino low-pt track, [SUSY](#), [Weird-Sig](#), R2

ATLAS [/HMBS-2024-05/](#) June 2025 | squark/gluon, [SUSY](#), R2+3

ATLAS [/HMBS-2025-06/](#) Mar 2026 | stop2L, [SUSY](#), R2+3

Heavy Res.

CMS [/EXO-24-039/](#) Mar 2026 | X->YY->2b2j, Heavy Res., R2

CMS [/EXO-24-021/](#) Mar 2026 | W', Heavy Res., R3

CMS [/B2G-25-004/](#) Mar 2026 | X->ZZ/ZH->2b2tau, Heavy Res., Ext. Scalar., R2

HH CMS [/B2G-24-022/](#) Feb 2026 | X->YH->bbZZ, heavy Res., Ext. Scalar., R2

HH CMS [/B2G-23-007/](#) Jan 2026 | X->YH->bb4q boosted, heavy Res., Ext. Scalar., R2

HH CMS [/B2G-24-014/](#) Jan 2026 | X->HH->2b2tau., heavy Res., Ext. Scalar., R2

CMS [/B2G-25-003/](#) Jan 2026 | HVT combo., Heavy Res., R2

CMS [/B2G-24-008/](#) Dec 2025 | H->tb. g2HDM., Ext. Scalar., R2

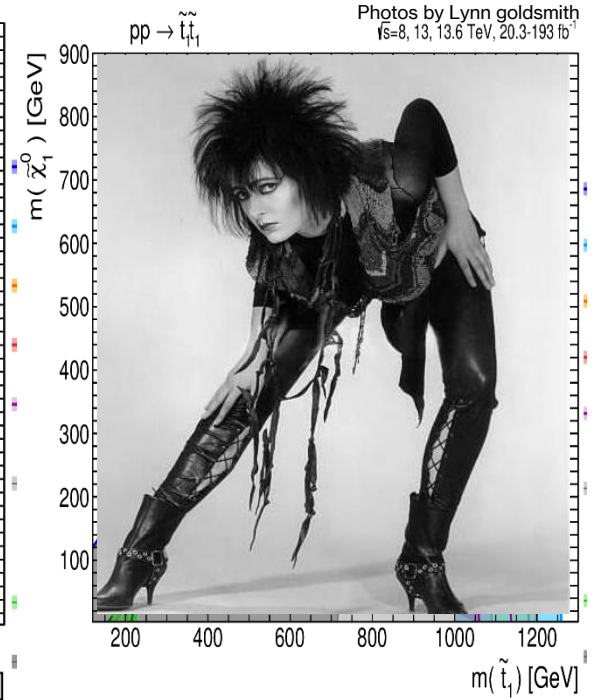
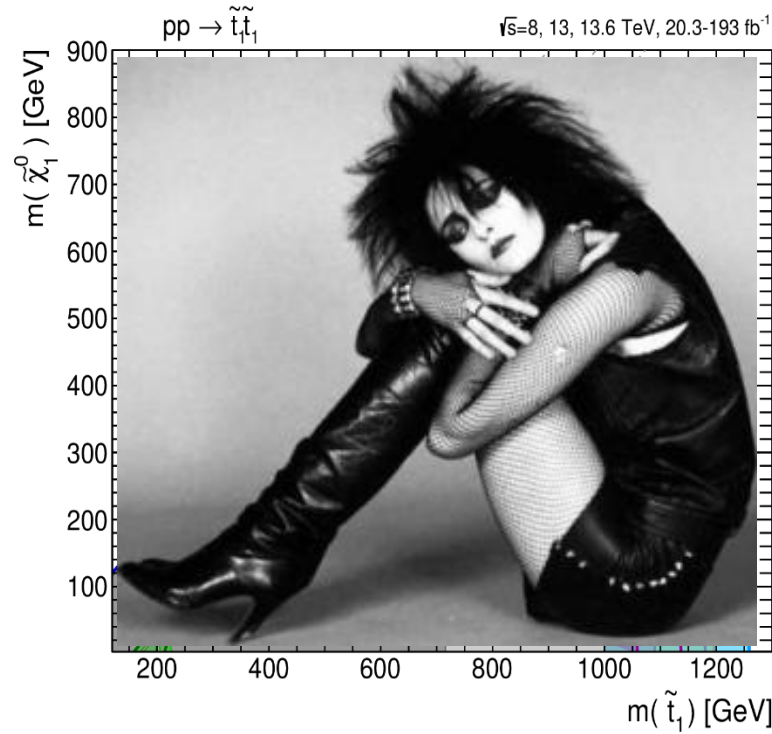
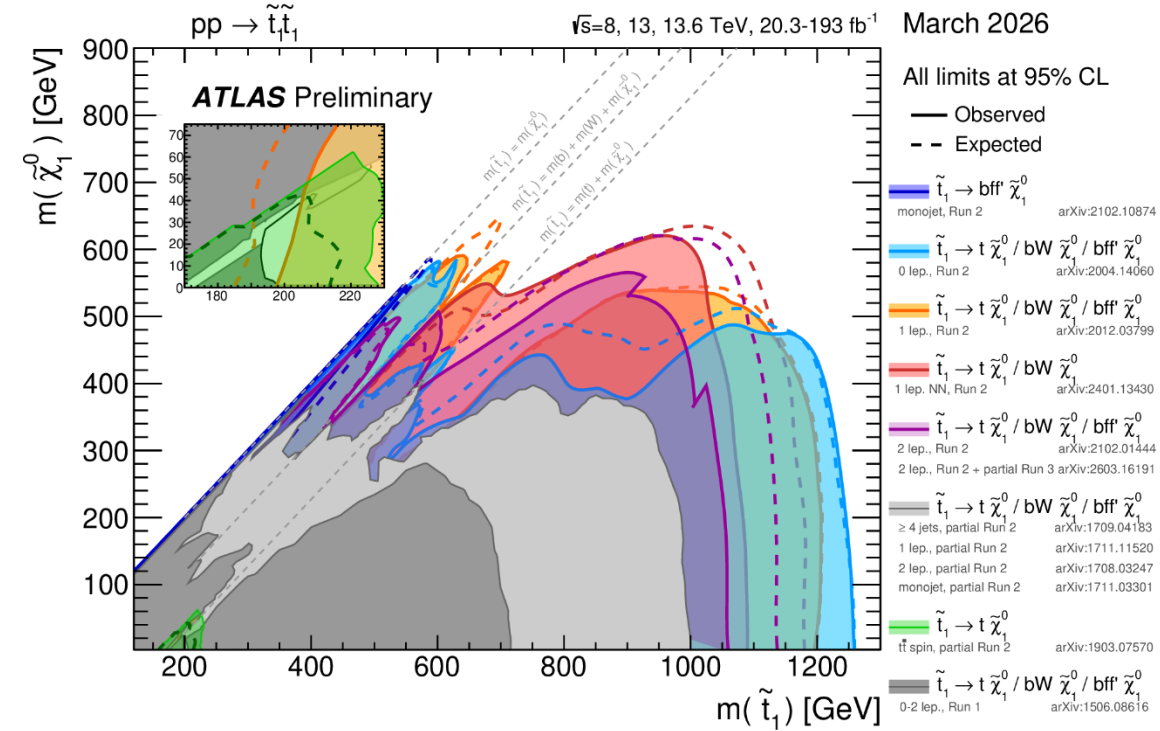
CMS [/B2G-24-007/](#) Nov 2025 | res.->Hgam/Zgam., Heavy Res., R2

HH CMS [/B2G-24-010/](#) X->HH->WWgamgam., Heavy Res., Ext. Scalar., R2

ATLAS [/EXOT-2018-49/](#) Dec 2025 | Heavy spin-1/2 -> ttbar, [Heavy Res](#), [Extra Dimensions](#), R2

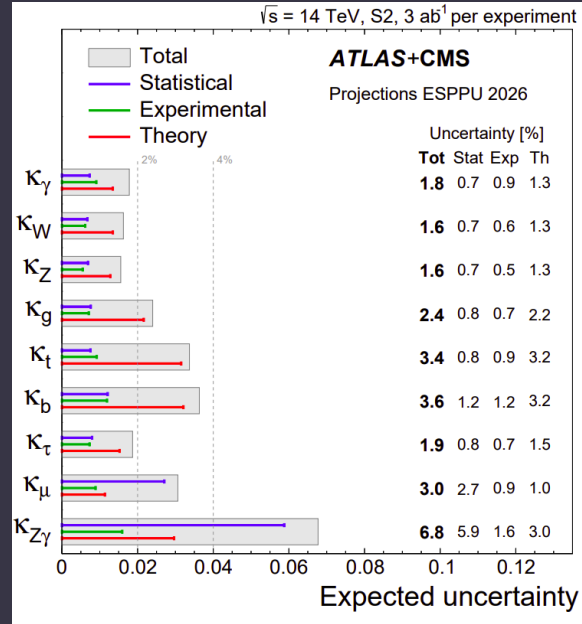
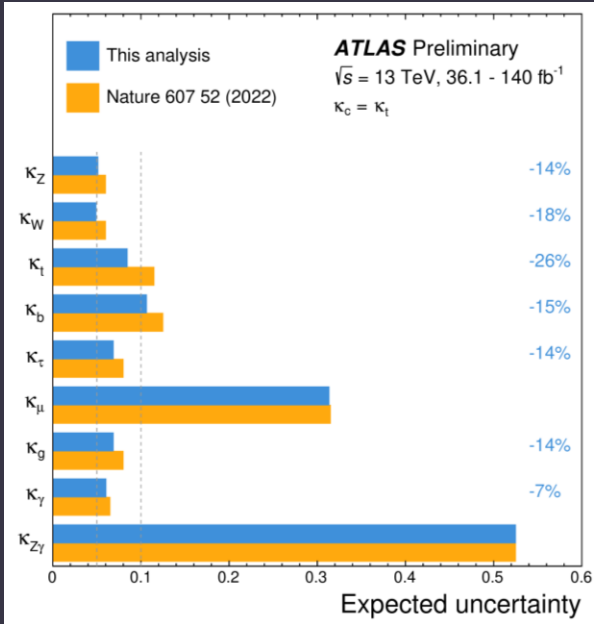
ATLAS [/HIGP-2024-34/](#) Oct 2025 | X->SH->bbgamgam, [Heavy Res](#), [Ext. Scalar](#), R2+3

MORE SUSY



NEW STOP RESULTS AND UNCONVENTIONAL SIOUXSIE REINTERPRETATION

OTHER NEW RESULTS: RPC->RPV REINTERPRETATION, EWINOS WITH PHOTONS+JETS+MET, RUN-3 SQUARKS+GLUINOS

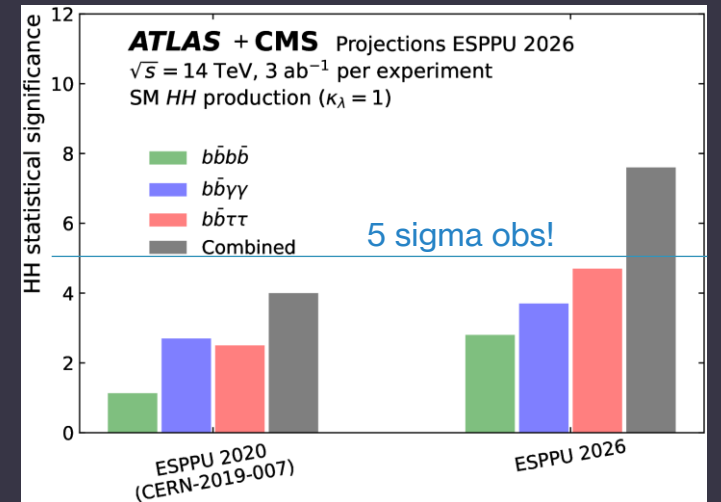
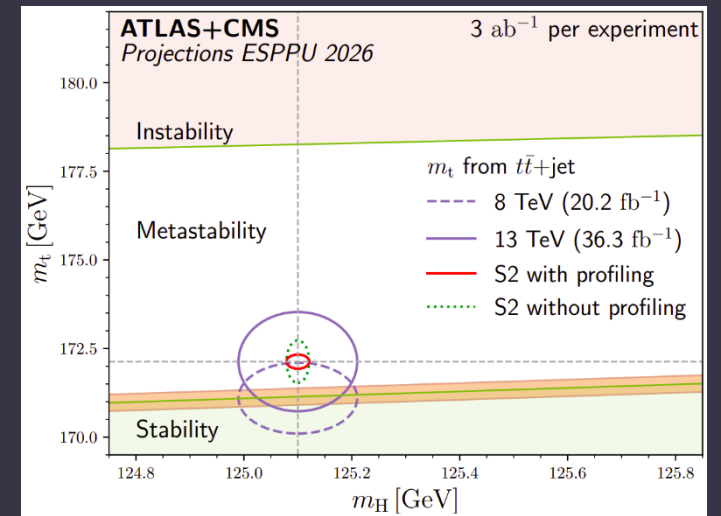


Higgs Yukawa precision big improvements

$M(t), M(h)$ precision to understand EW vacuum metastability

hh over 5σ observation threshold!

& highlighting how improvements with ML analysis/reco. techniques have rendered past projections obsolete!



HIGGS @ HL-LHC

HL-LHC, n., hh observer, SM ultra-investigator, BSM discoverer

BIG

data creator