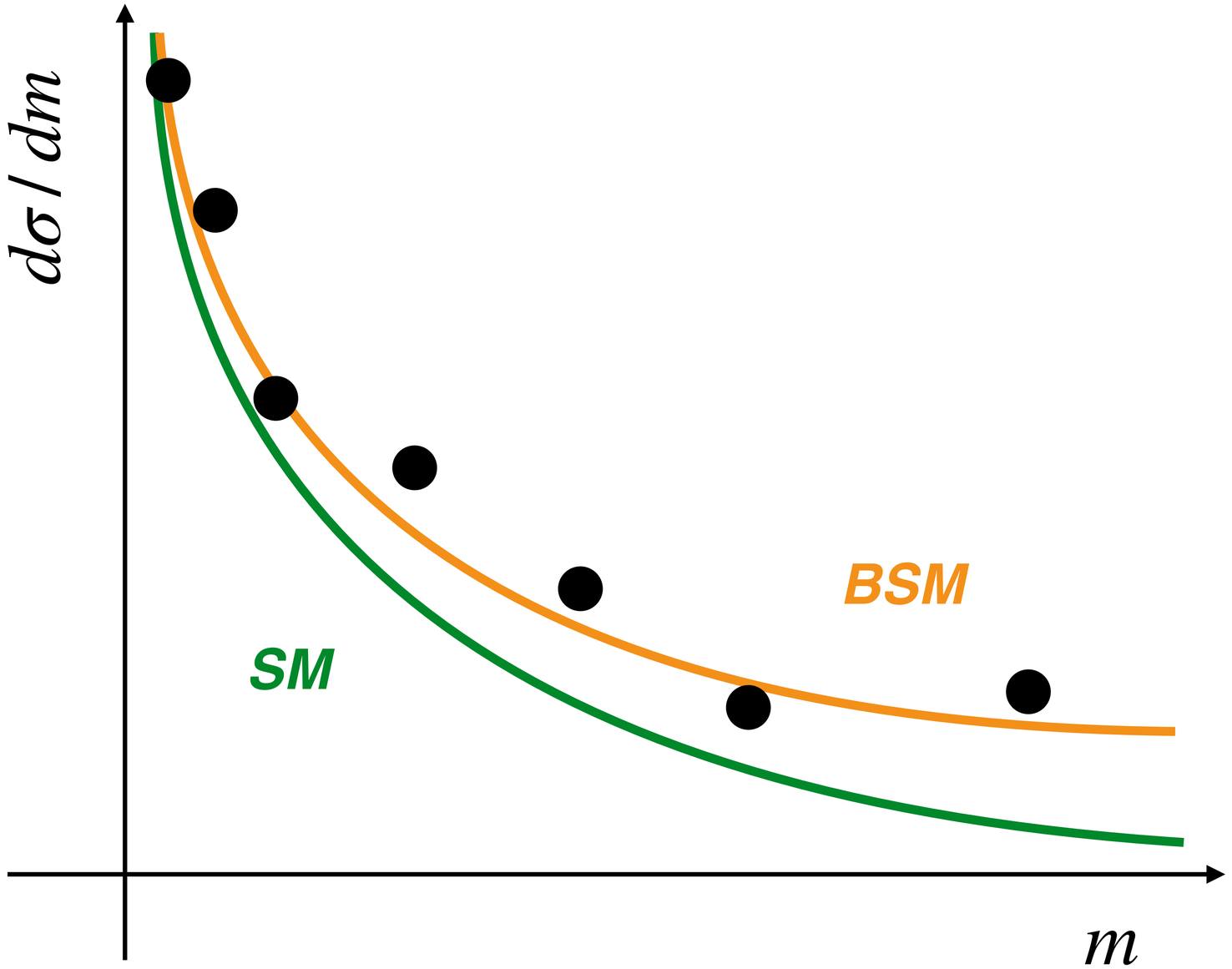
searches for lepton flavor violation and SUSY + tests of lepton universality

Chris Pollard, Warwick
o.b.o. ATLAS and CMS

we’re all looking forward to many plots like this

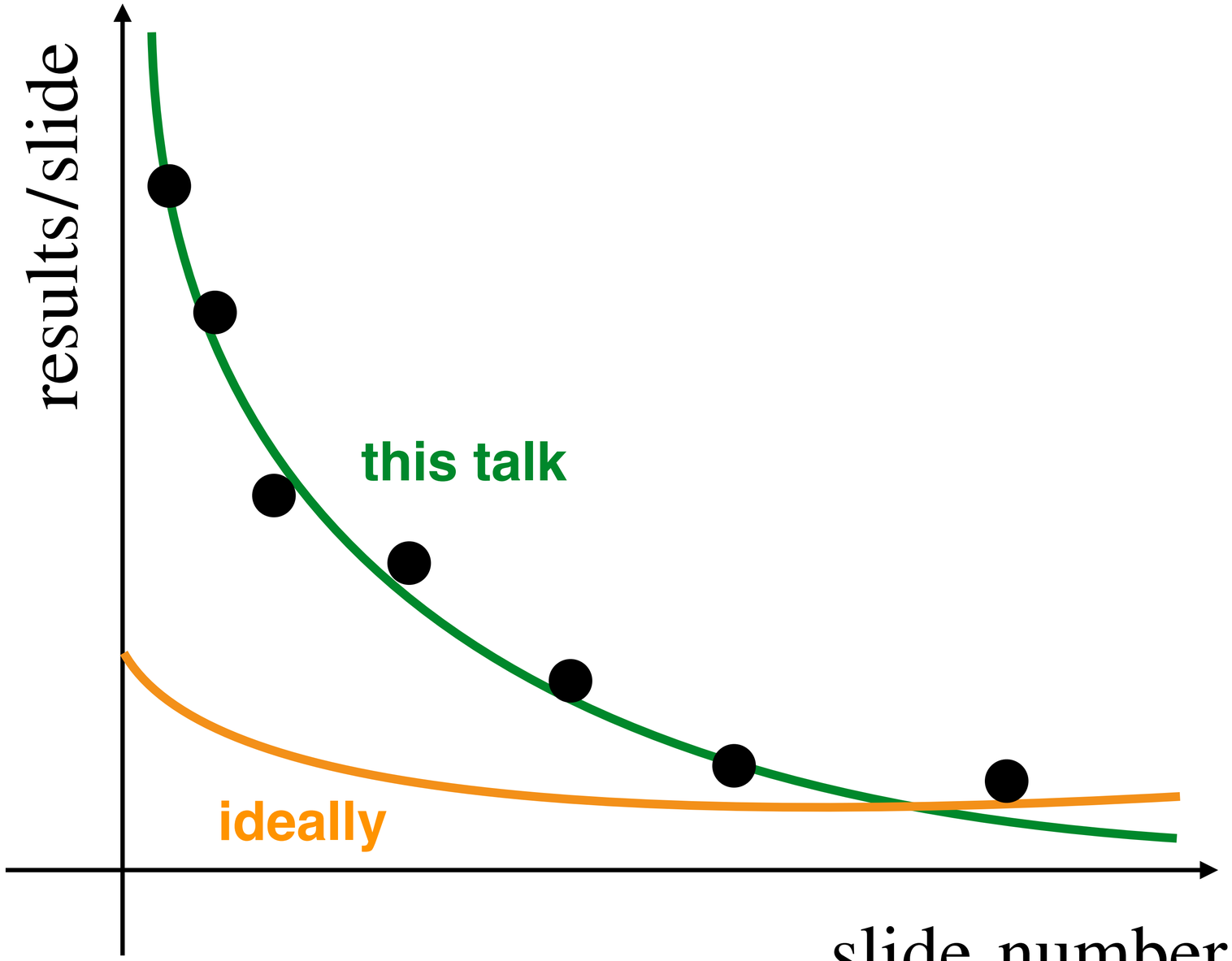


many nice results in the last year from the LHC on these topics!

there is just too much to cover: there will be a clear bias toward the newest results.

be sure to check out the public results websites:

ATLAS link
CMS link



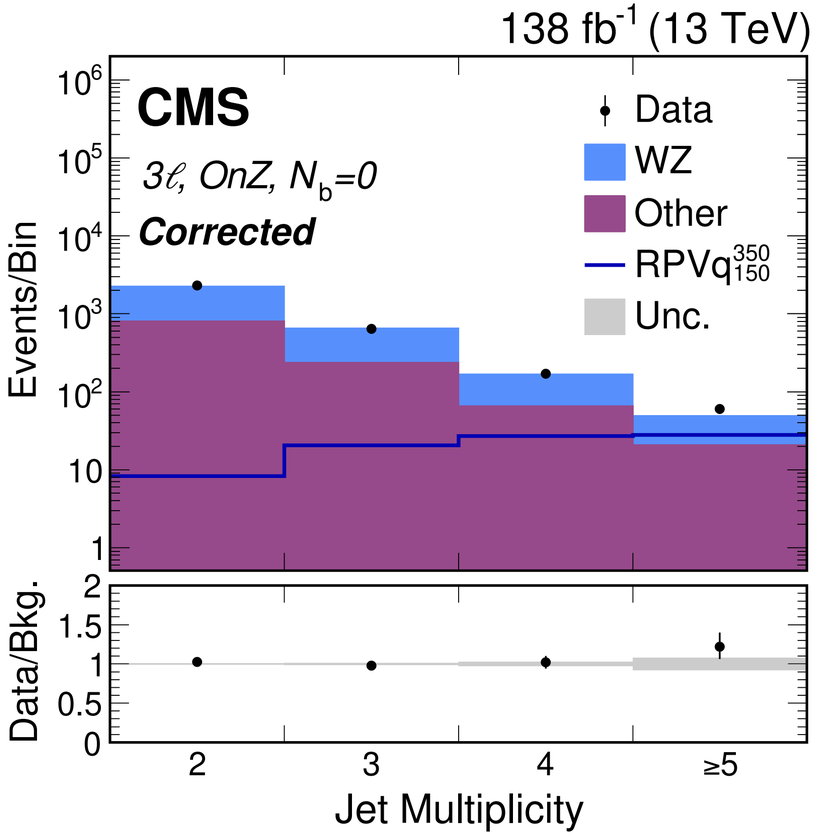
supersymmetry

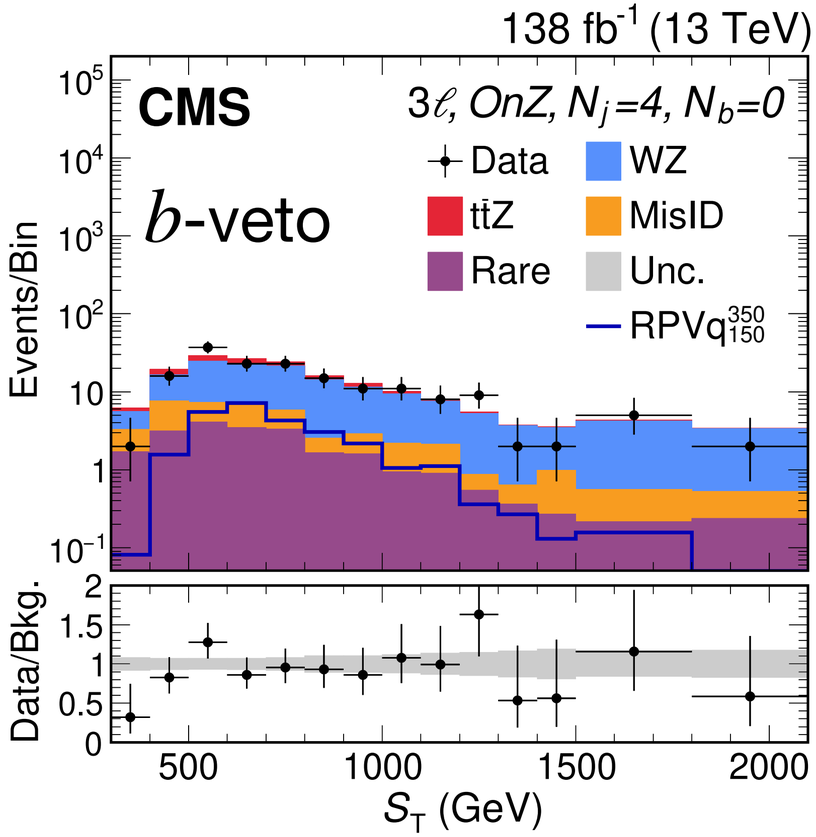
CMS new physics in jet scaling patterns

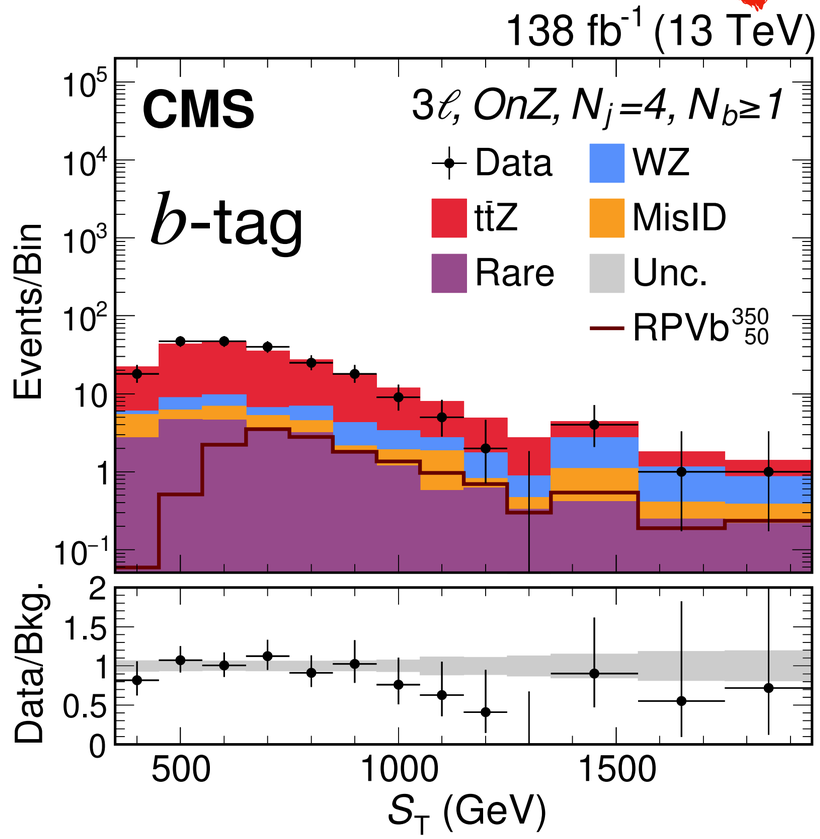
SUS-23-015

early March

search for relatively generic new physics
in multi-lepton + multi-jet events:
focus on jet multiplicity and S_T distributions





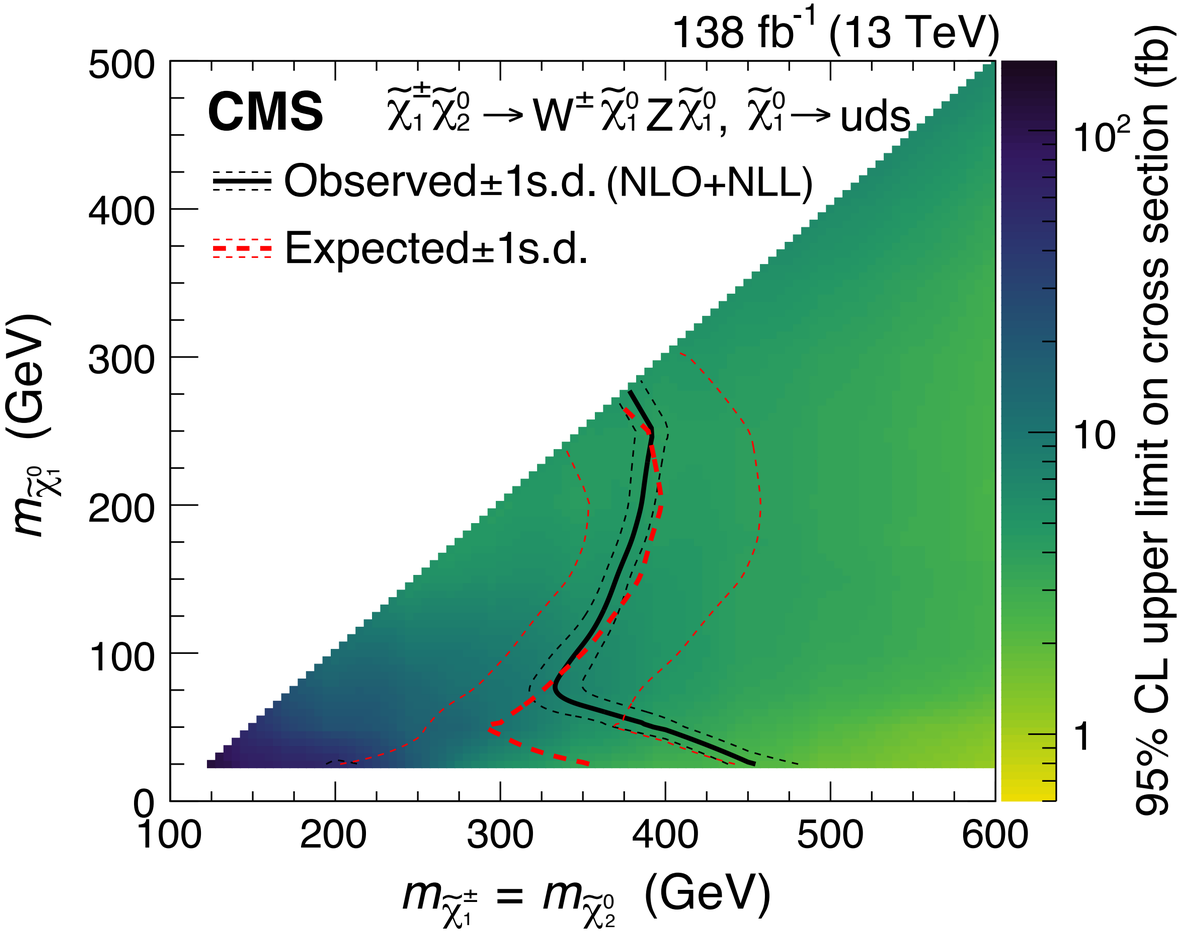


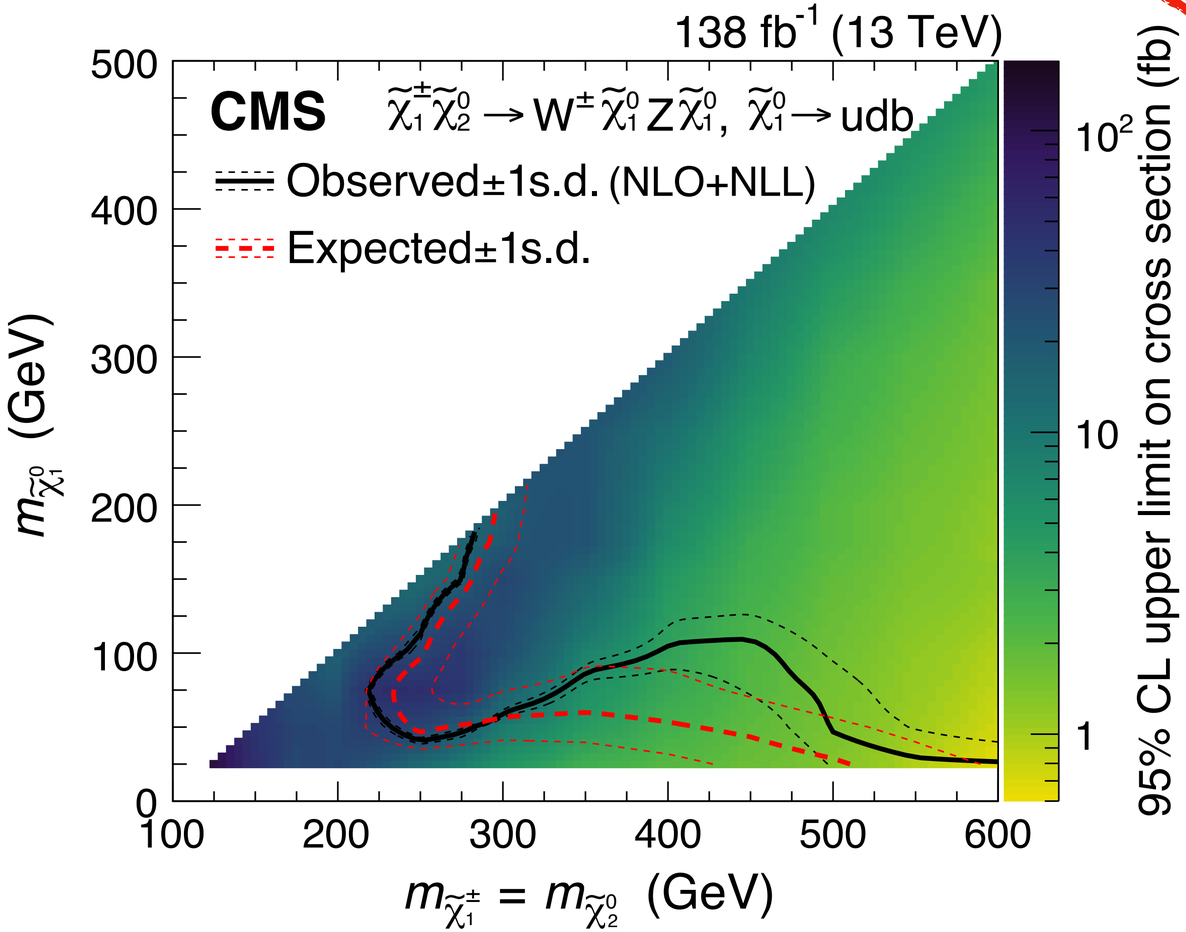
CMS new physics in jet scaling patterns

SUS-23-015

early March

interpreted in SUSY scenarios
→ first dedicated constraints of SUSY production
in the 3ℓ+jets final state.



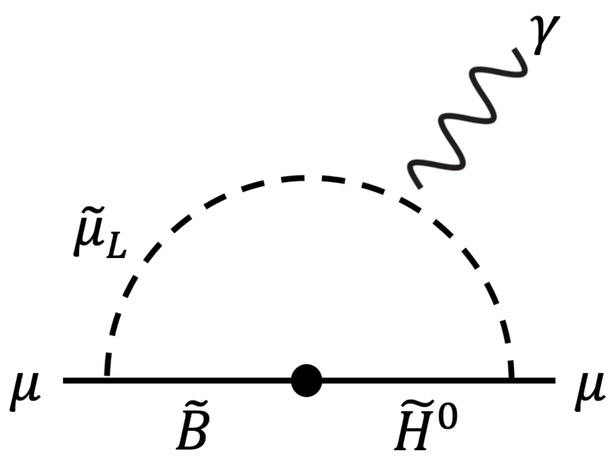


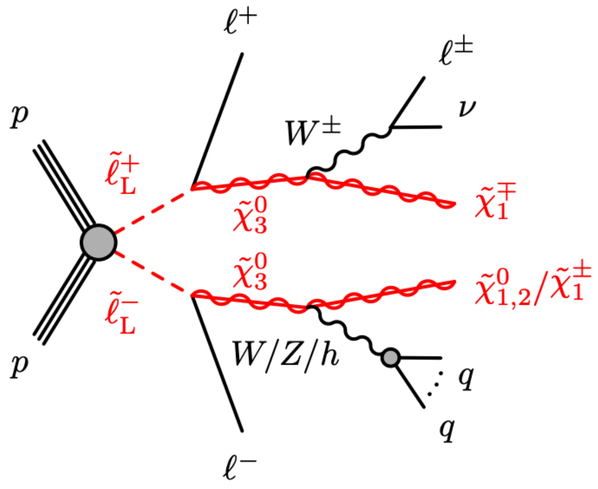
ATLAS search sleptons/sneutrino cascades

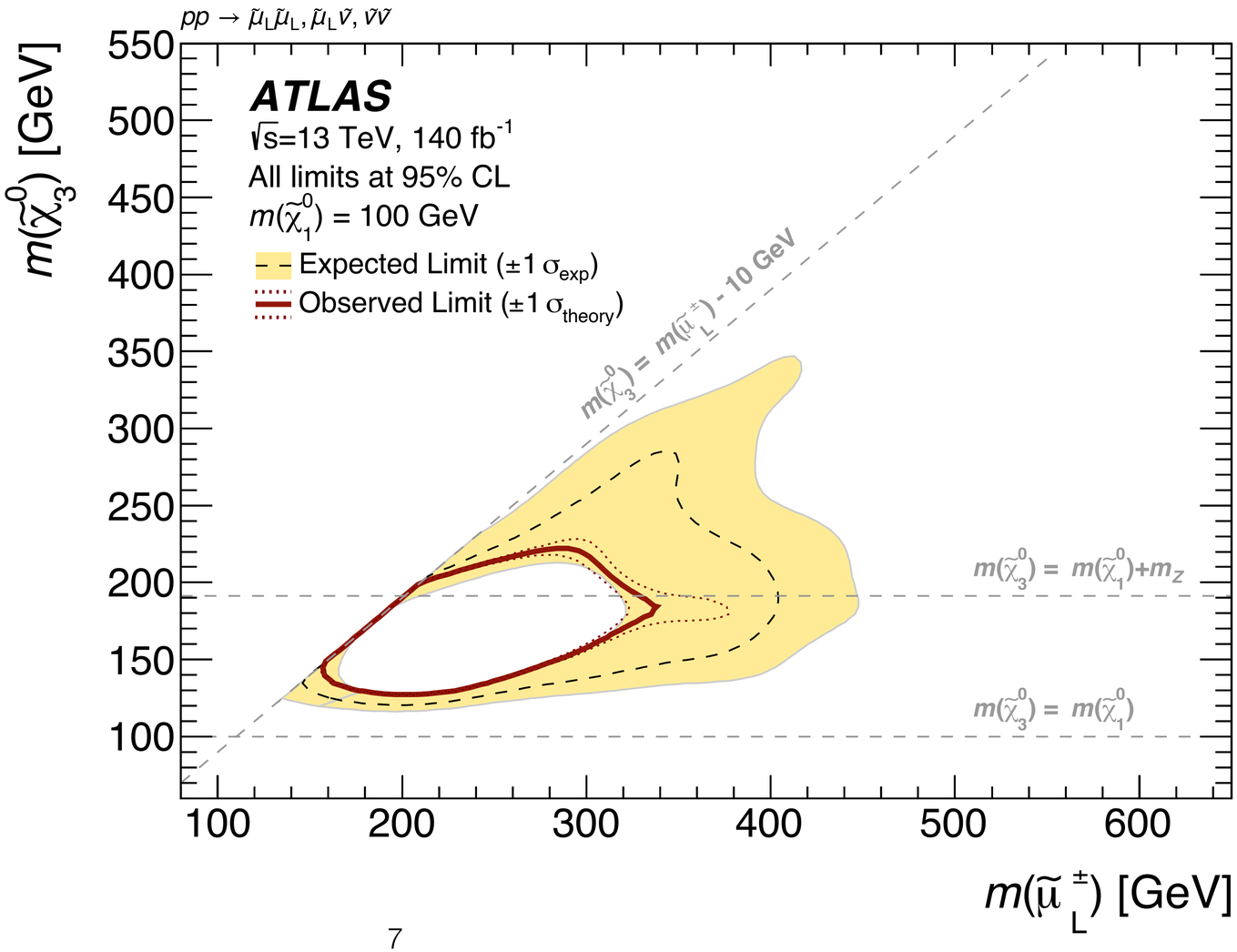
HMBS-2024-11

brand new

search targets $\tilde{\ell}, \tilde{B}, \tilde{H}^0$, which e.g. can contribute to μ anomalous magnetic moment







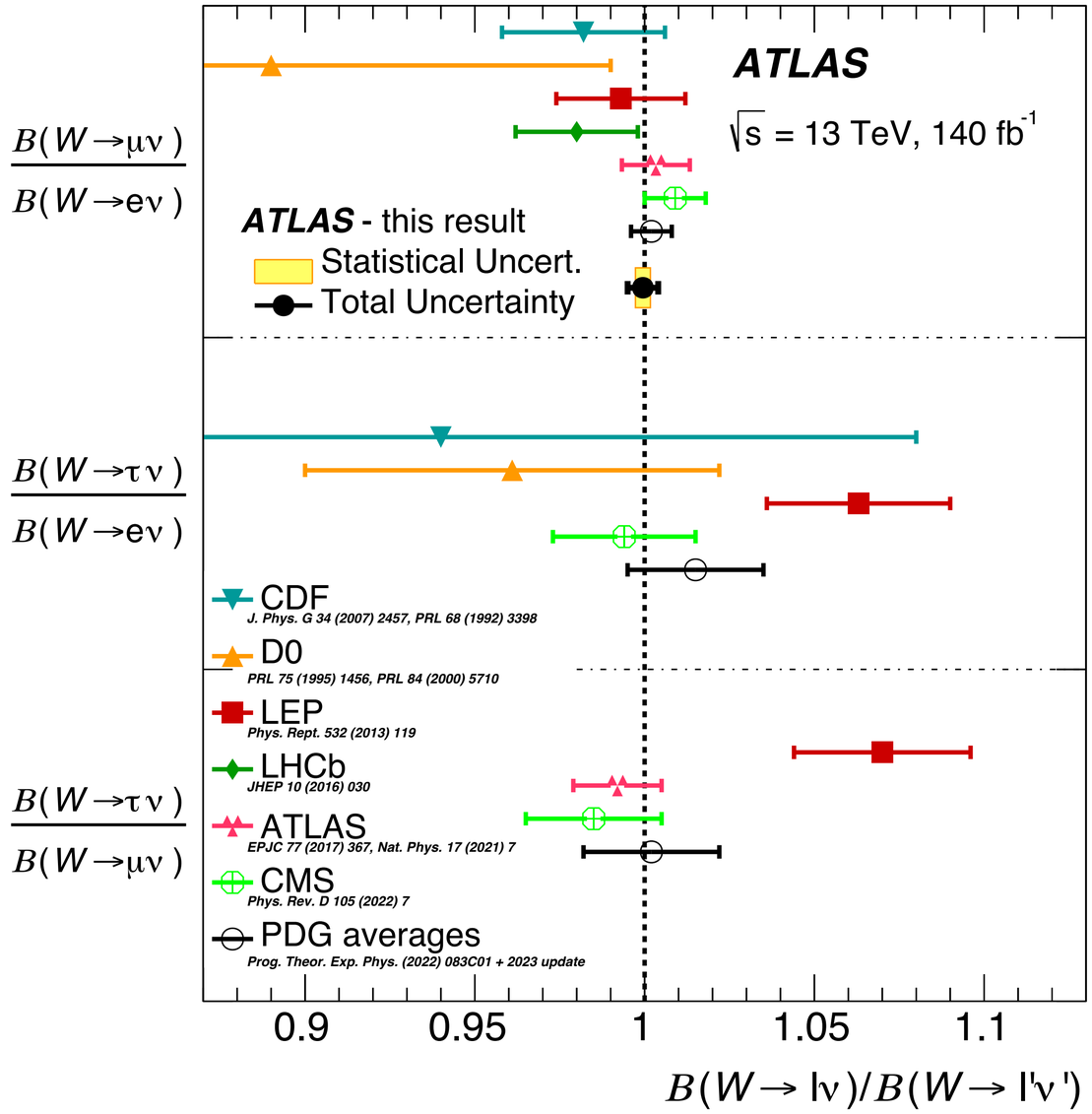
lepton flavor universality + violation

Eur. Phys. J. C 84 (2024) 993

the LHC has a history of strong tests of LFU

for the new measurement of $B(W \to \tau\nu)/B(W \to e\nu)$ in $t\bar{t}$ events:

see Federica's talk

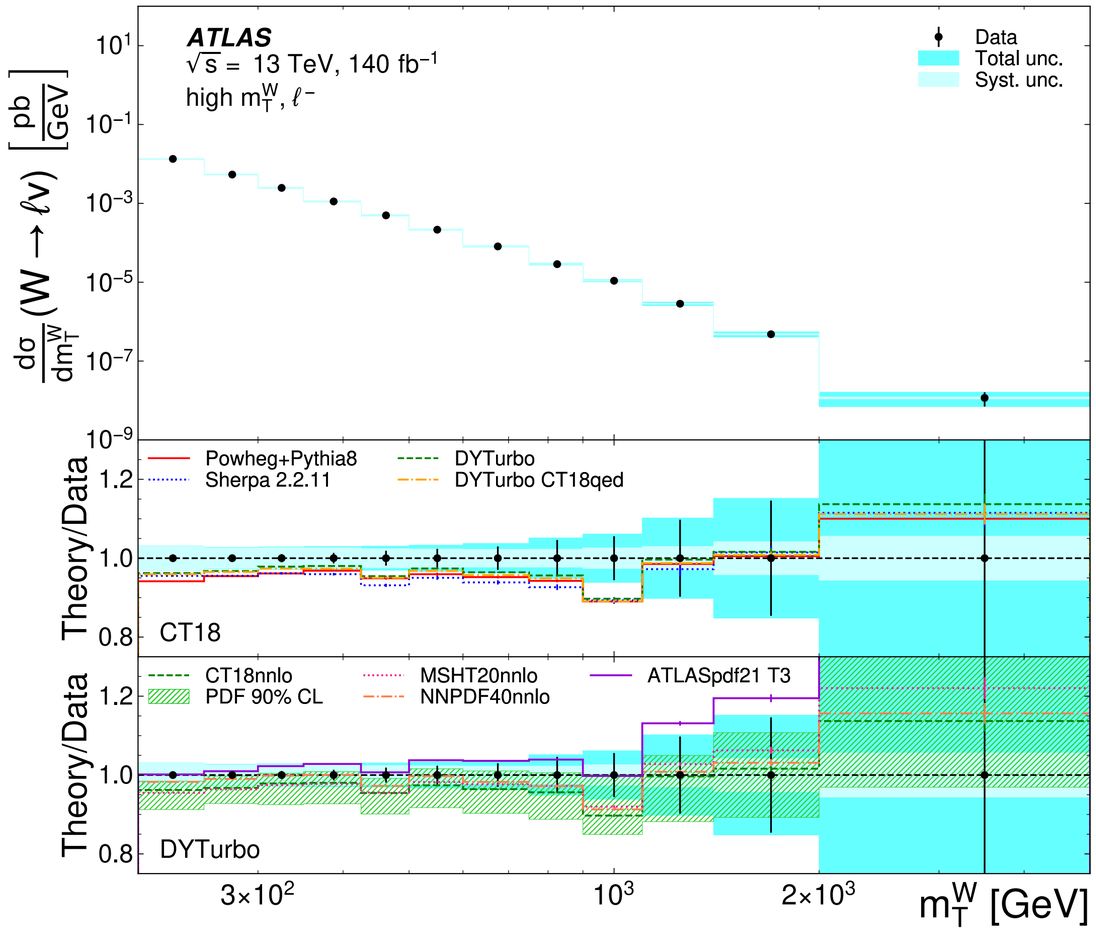


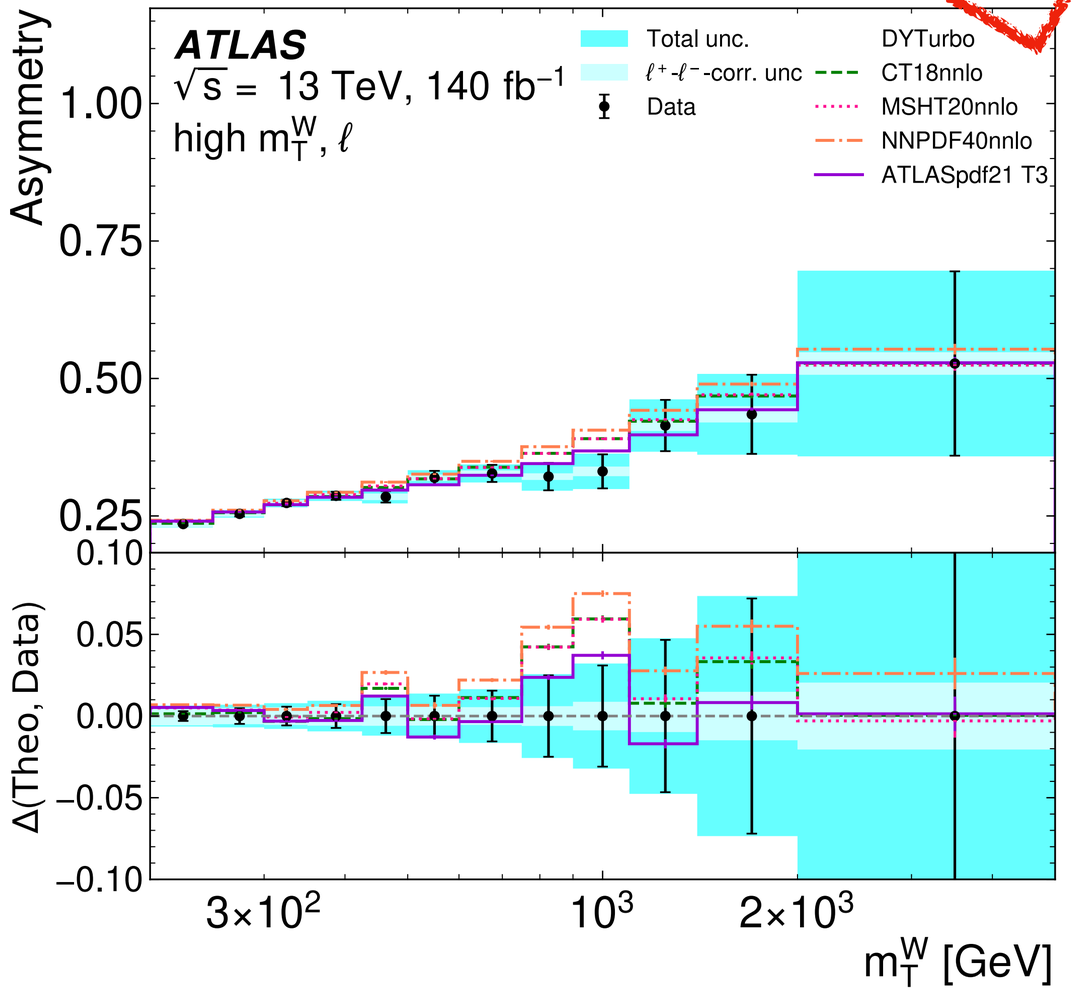
ATLAS measurement of high m_T production

STDM-2018-41

February

comprehensive unfolded measurement
split by lepton $|\eta|$, flavor, and charge



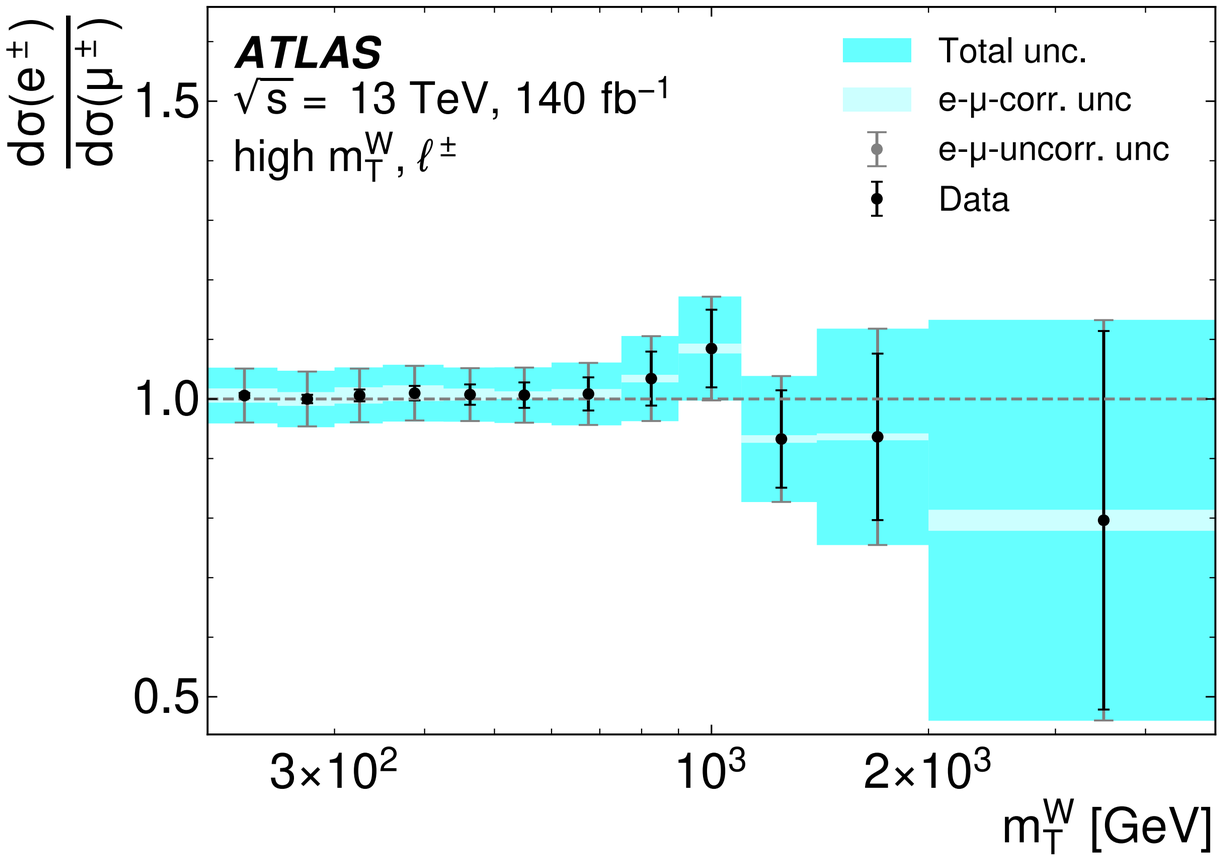


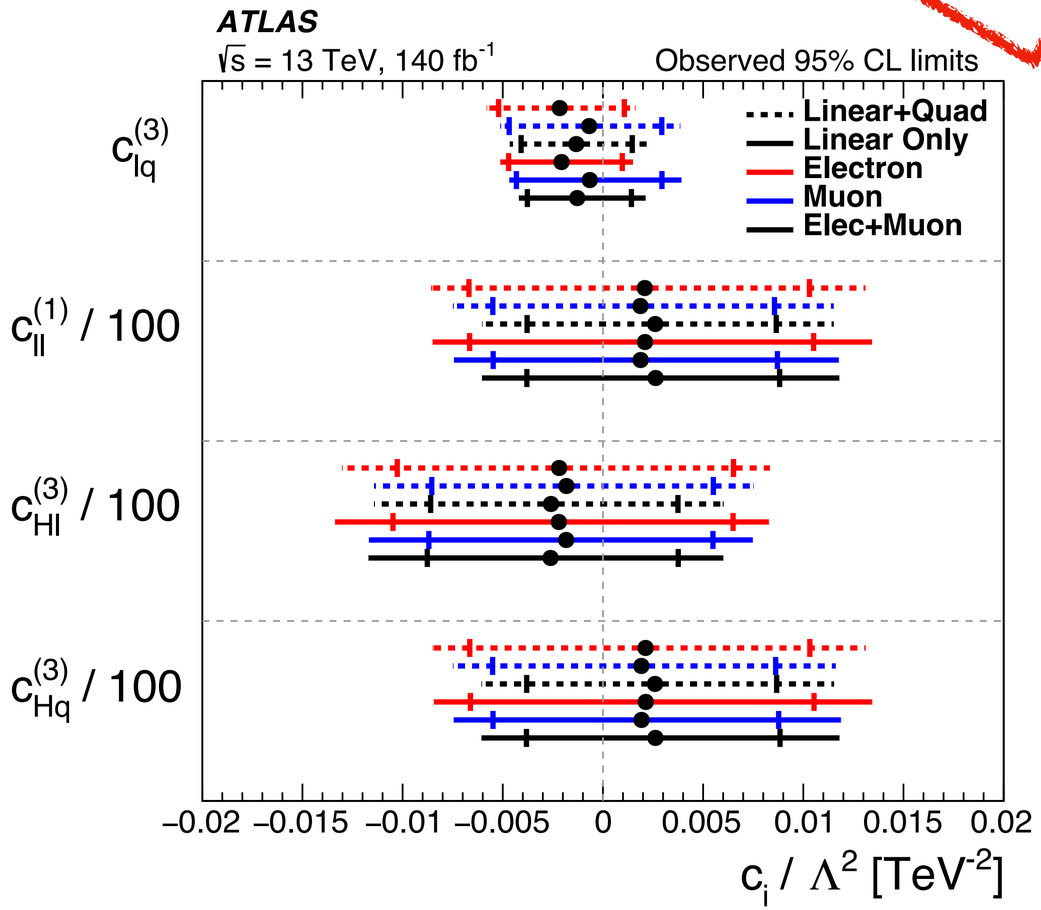
ATLAS measurement of high m_T production

STDM-2018-41

February

no sign of e/μ non-universality
→ new limits set on effective coupling coefficients
→ many unfolded differential distributions for interpretation



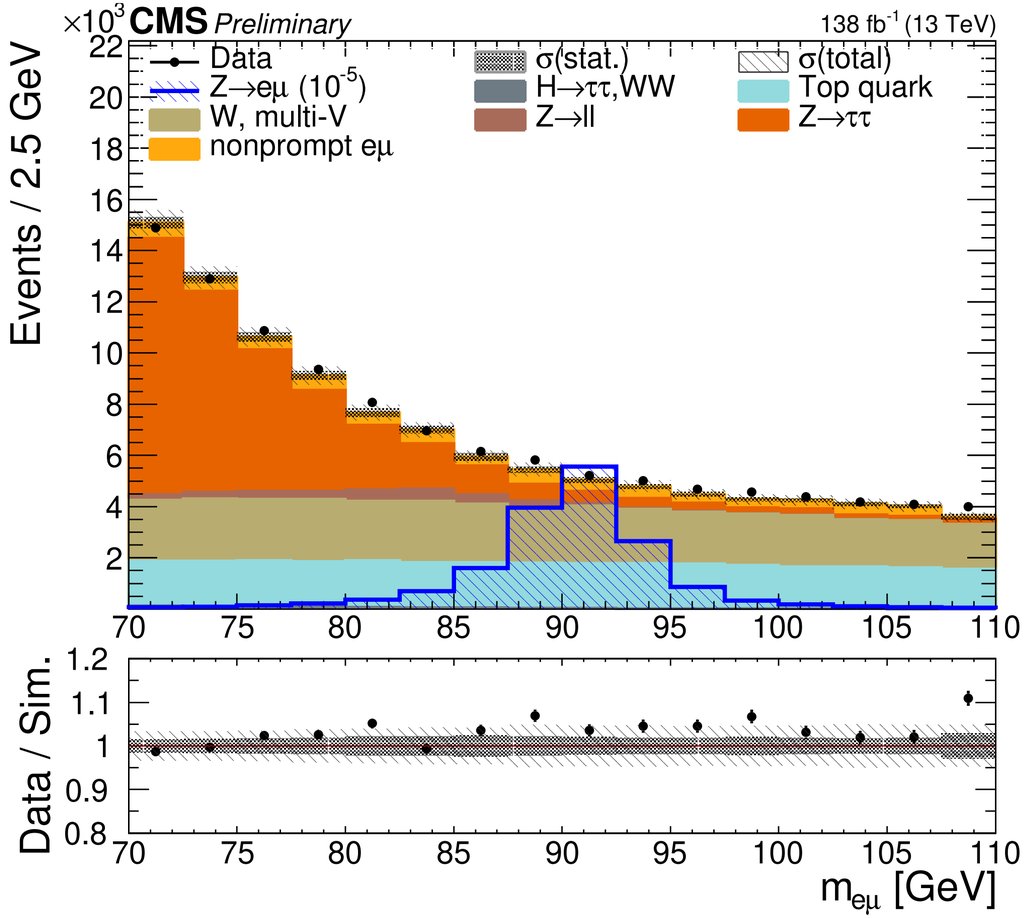


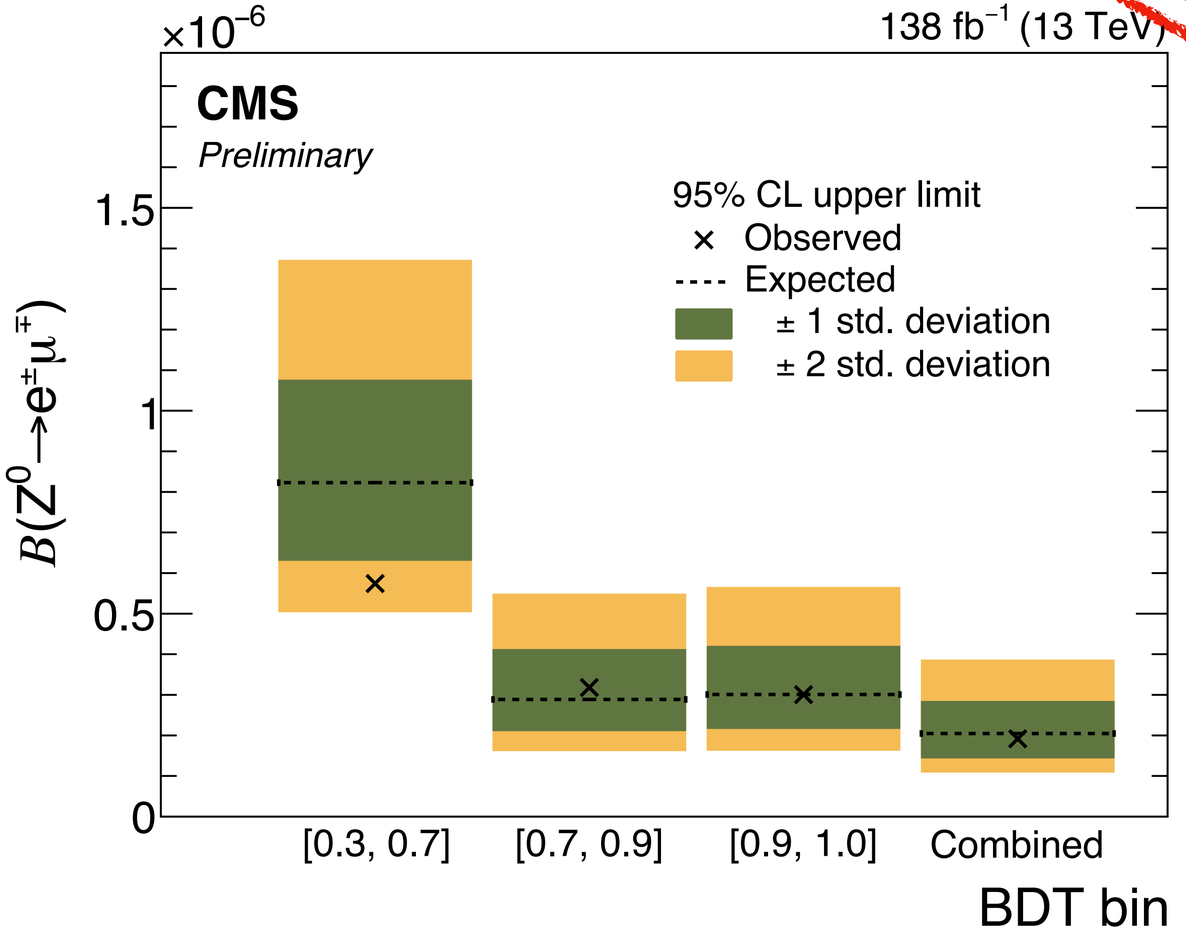
CMS search for LFV in Z and Z' decays

PAS-SMP-23-003

brand new

comprehensive search for LFV $Z/Z' \to \ell^+\ell'^-$
very tight limits $\mathcal{O}(10^{-7})$ on $Z \to e\mu$



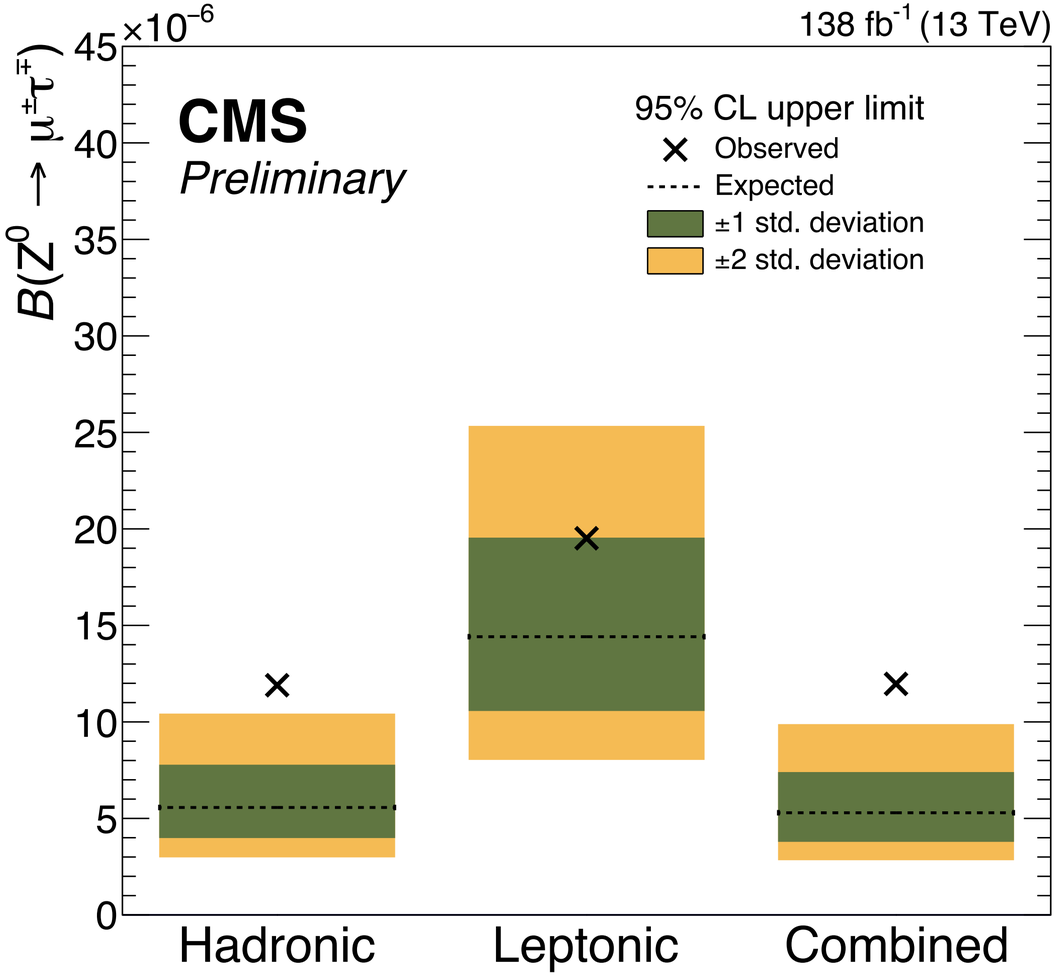


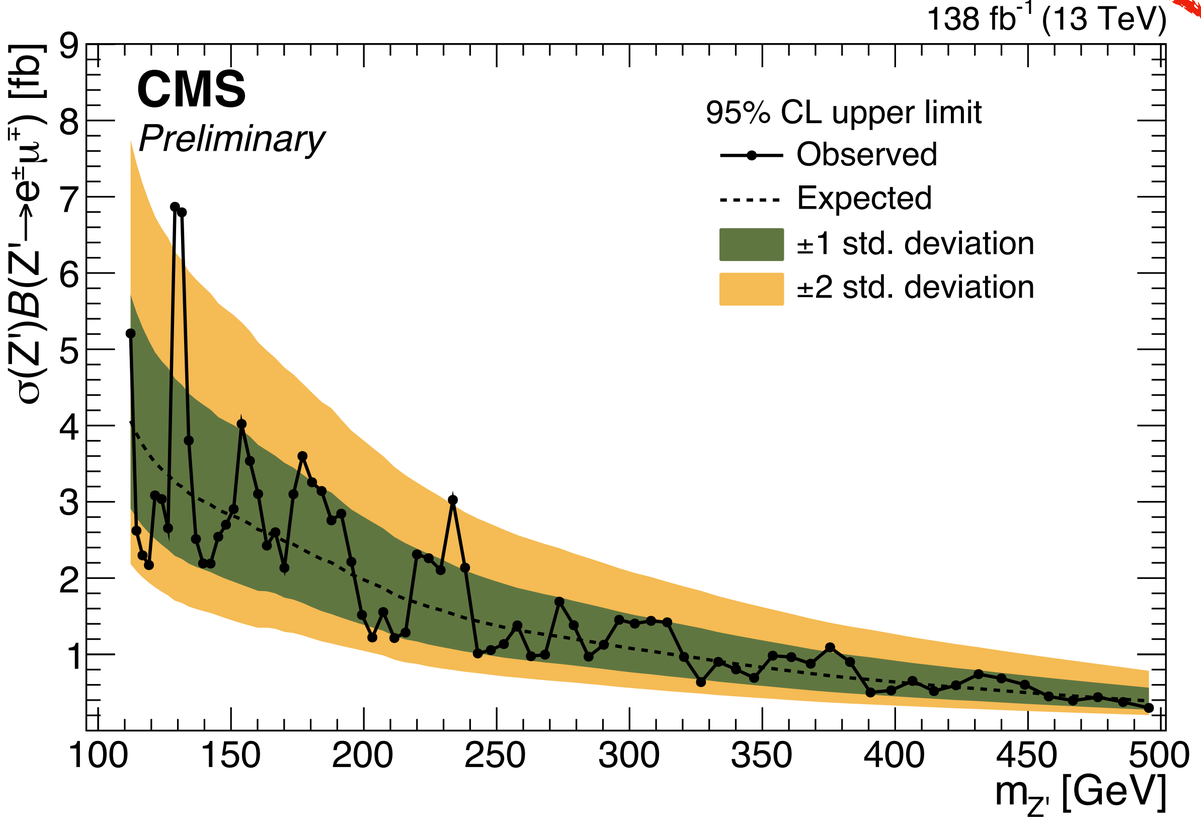
CMS search for LFV in Z and Z' decays

PAS-SMP-23-003

brand new

$B(Z \to \ell\tau)$ ruled out at the 10^{-6} level





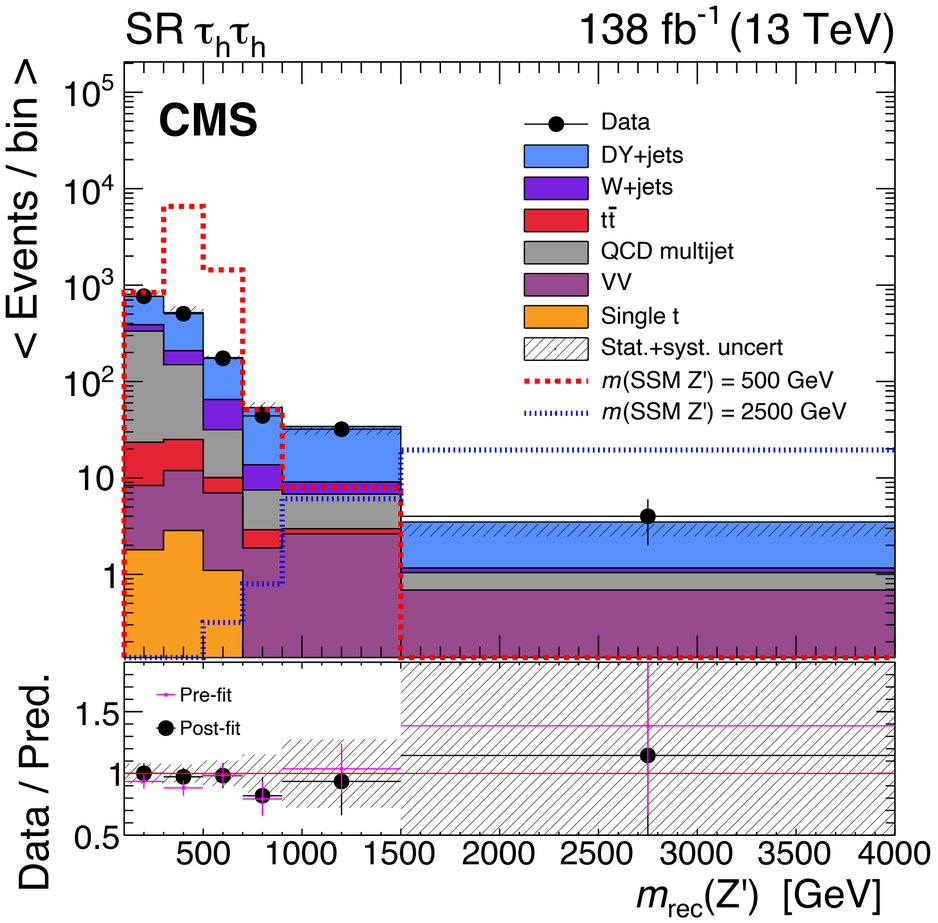
$\sigma \times B(Z' \to e\mu)$ constrained vs $m_{Z'}$

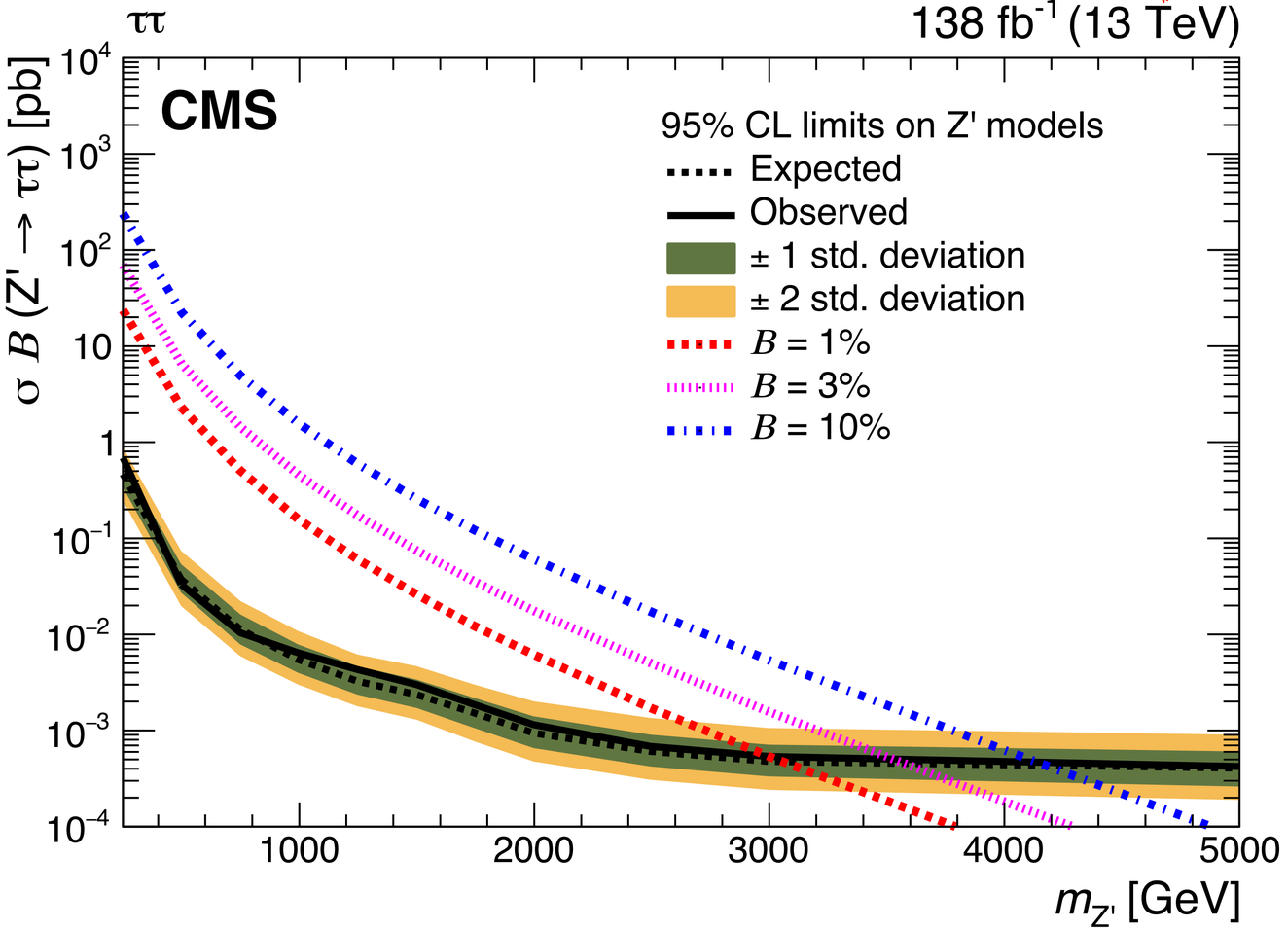
CMS search for $Z' \to \tau\tau$

EXO-21-016

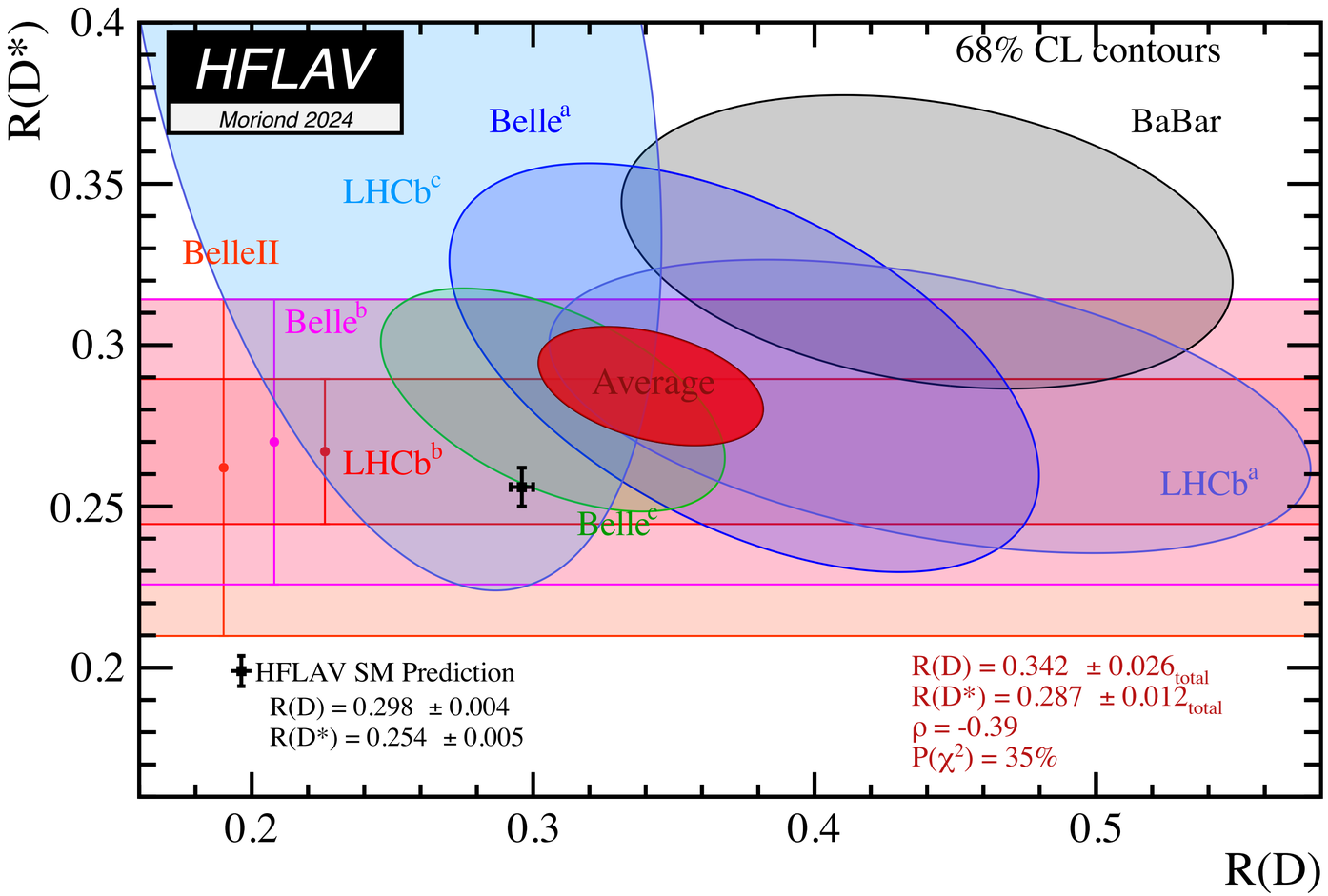
December

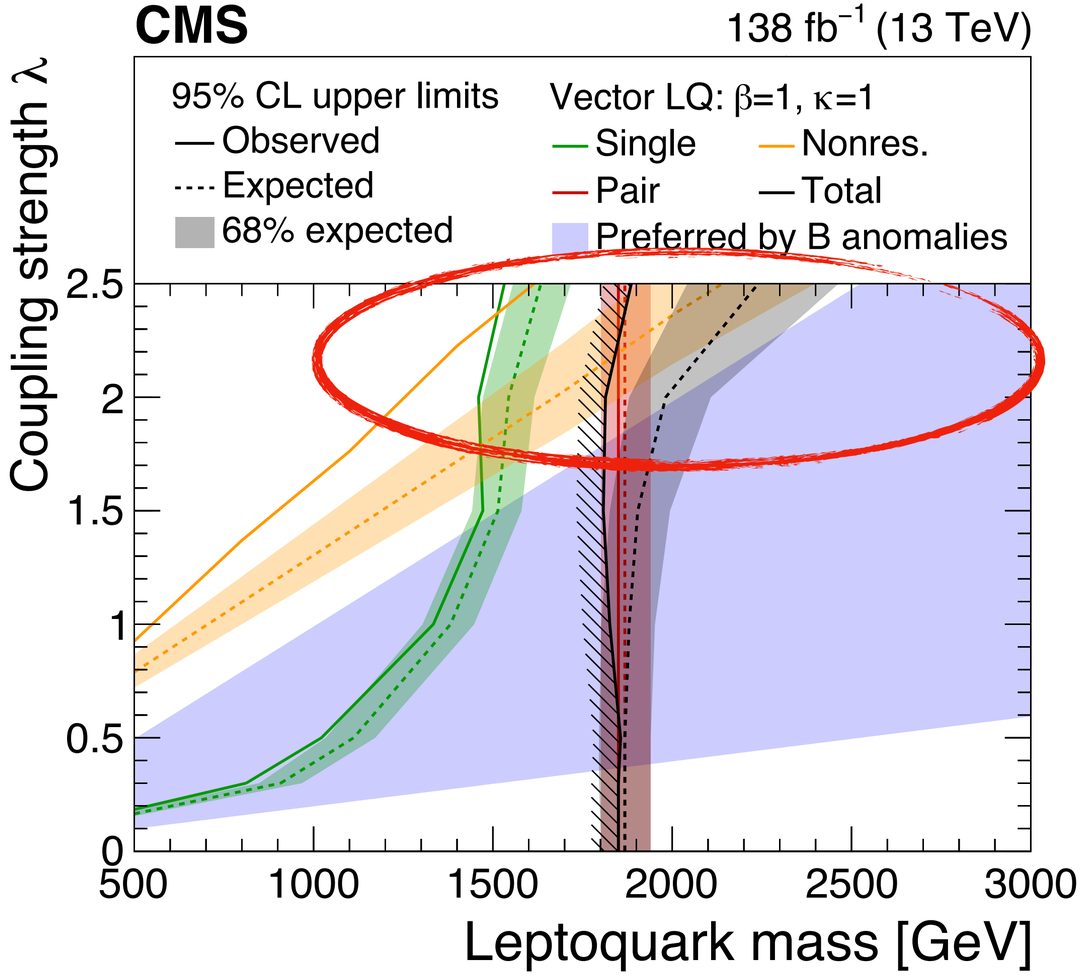
probes the high-mass $\tau\tau$ spectrum for resonances:
none in sight. :(





indications of non-SM $b \leftrightarrow \tau$ couplings?



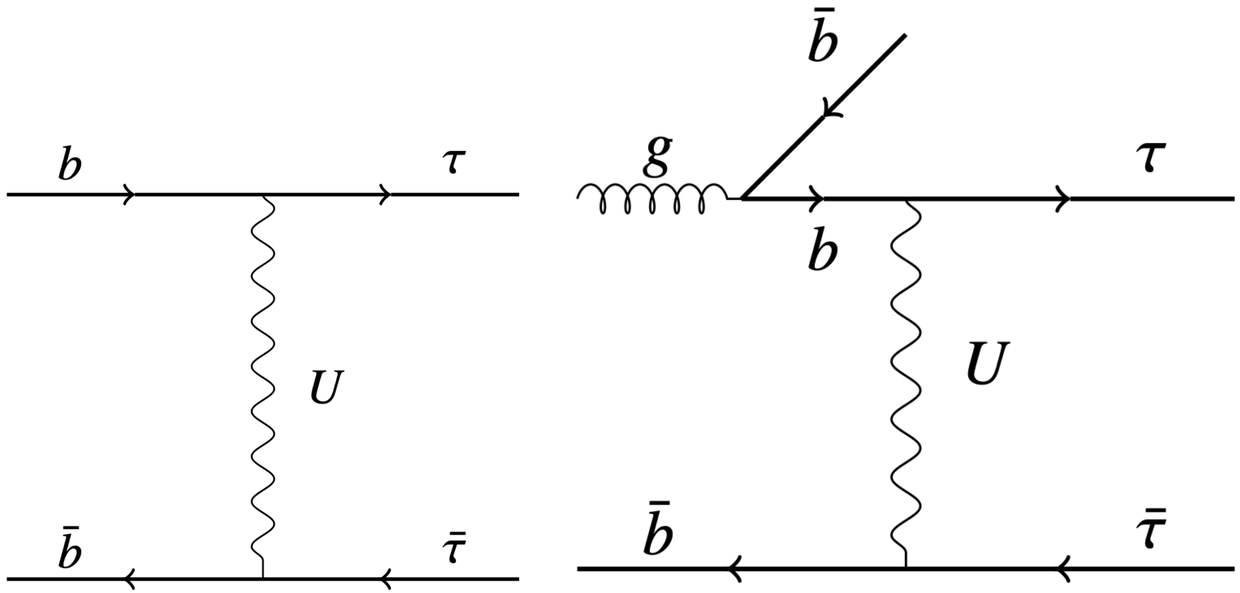


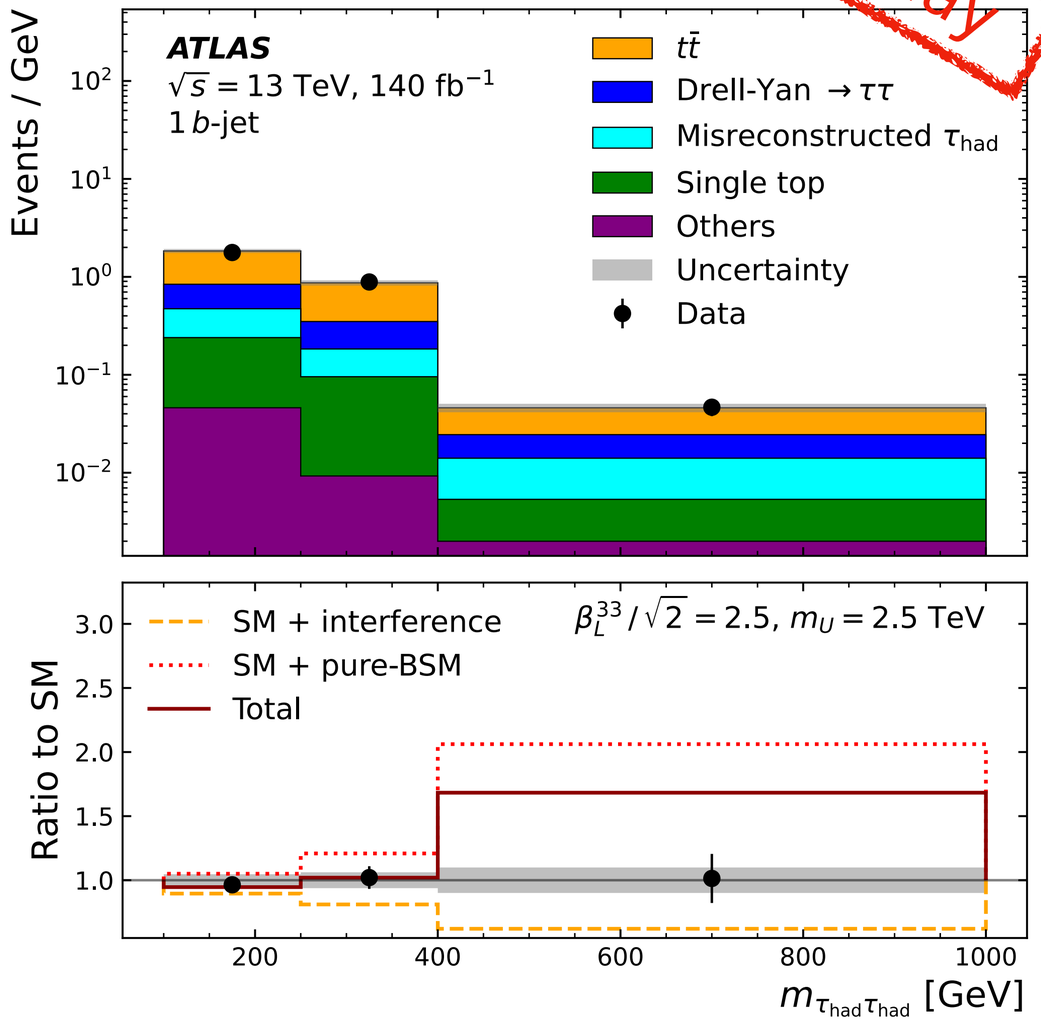
ATLAS analysis of high-mass $\tau\tau$ production

EXOT-2022-42

new today

search for high-mass, non-resonant indications of BSM particles coupling to 3rd generation fermions



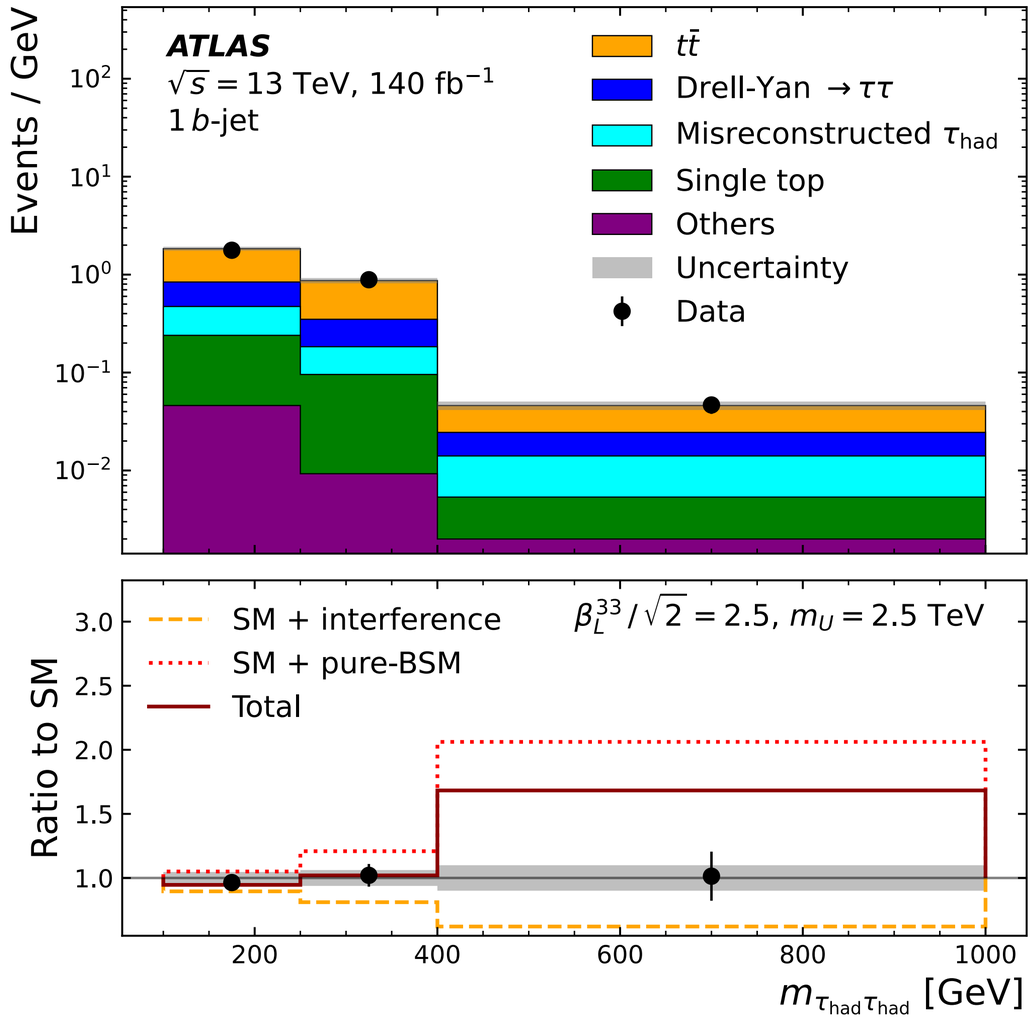


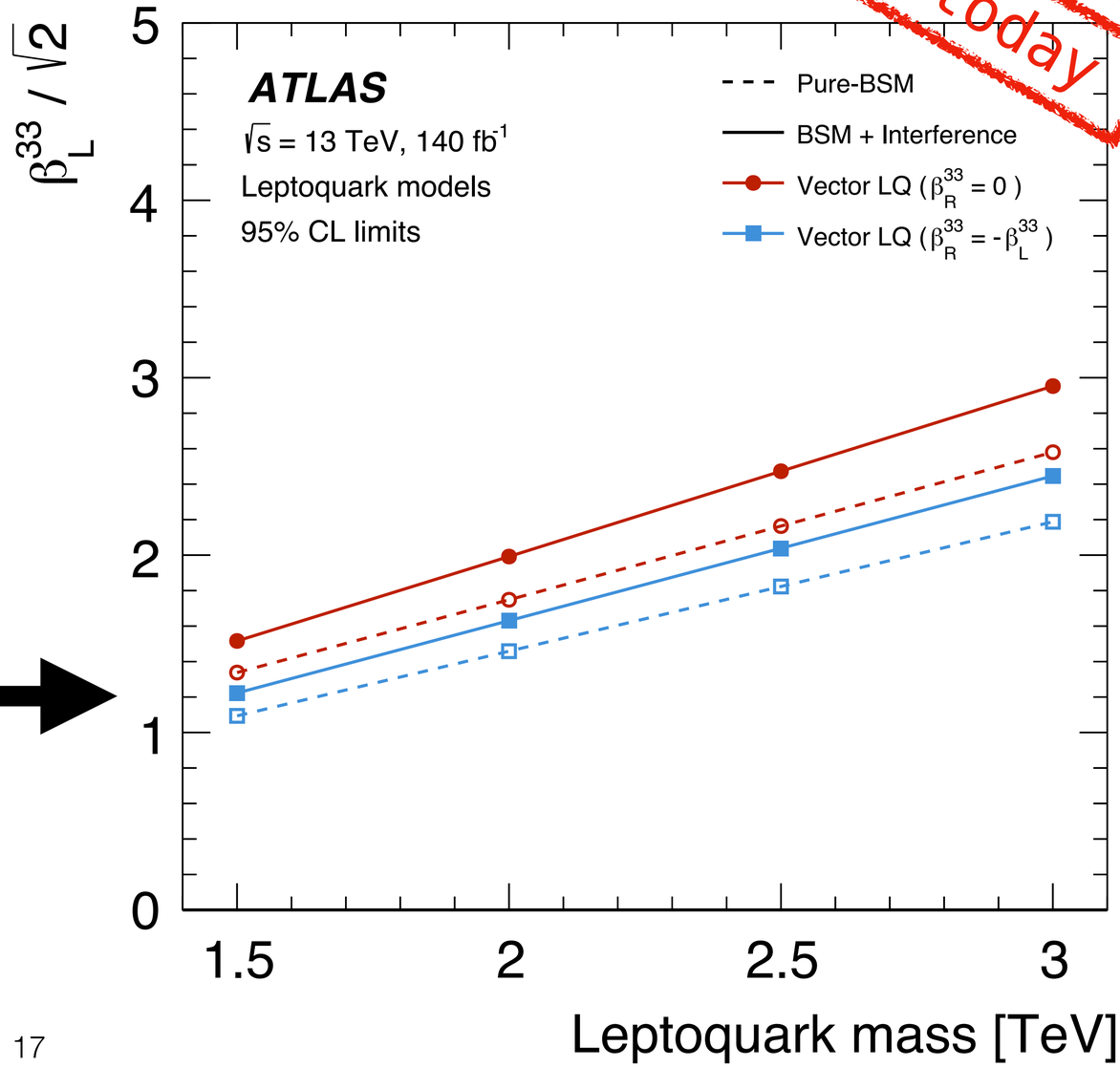
ATLAS analysis of high-mass $\tau\tau$ production

EXOT-2022-42

new today

careful treatment of interference:
up to 25% changes in constraints



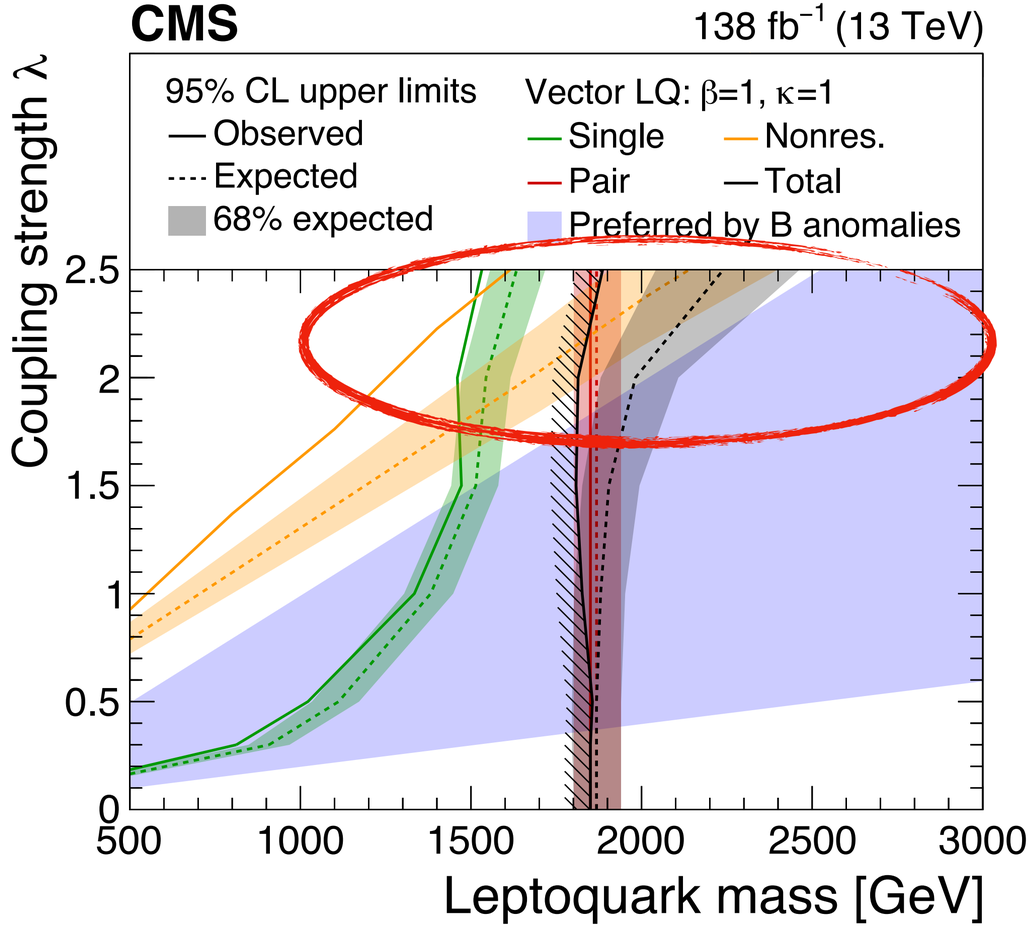


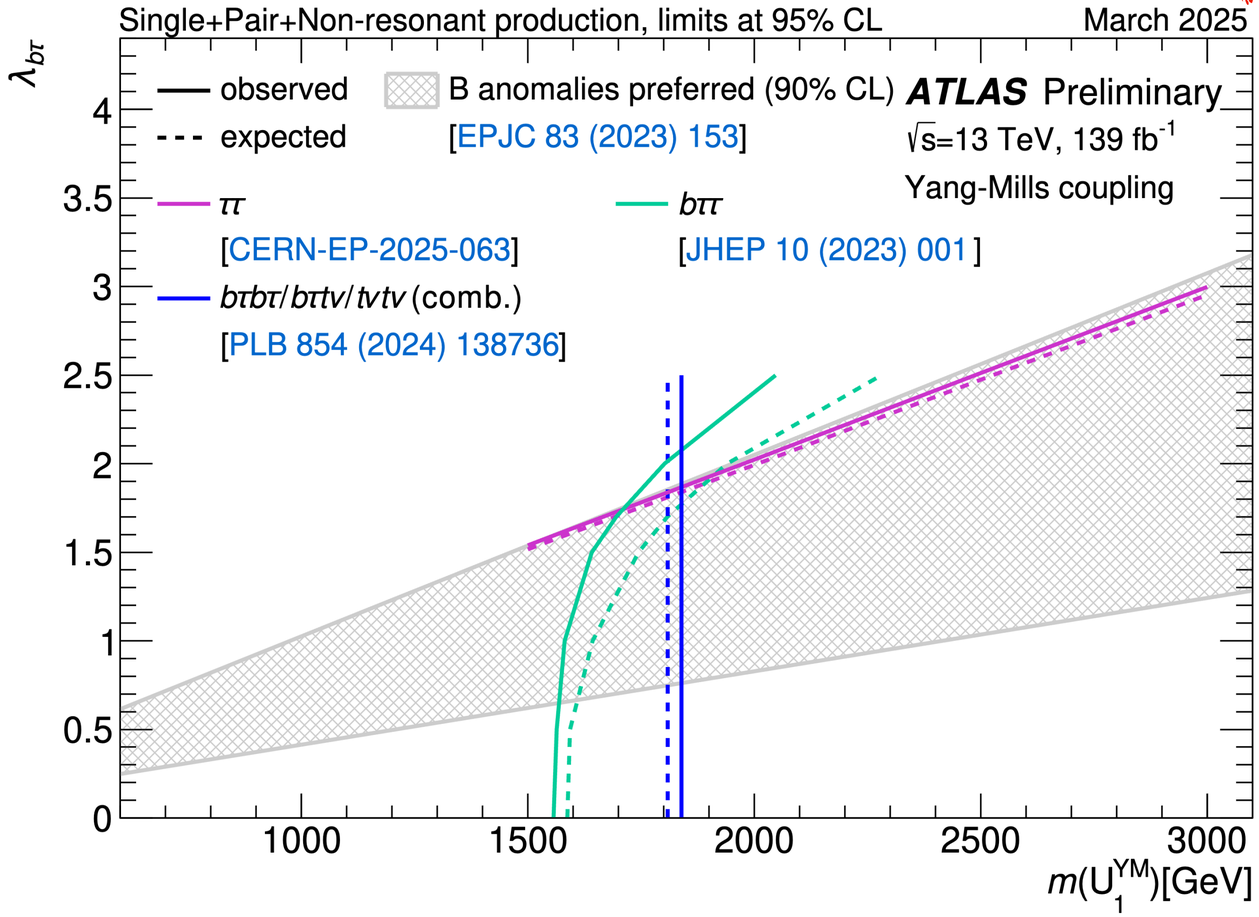
ATLAS analysis of high-mass $\tau\tau$ production

EXOT-2022-42

new today

no sign of excess reported by CMS
encroaching on phase space preferred by R_D/R_{D^*} anomalies.





ATLAS analysis of high-mass $\tau\tau$ production

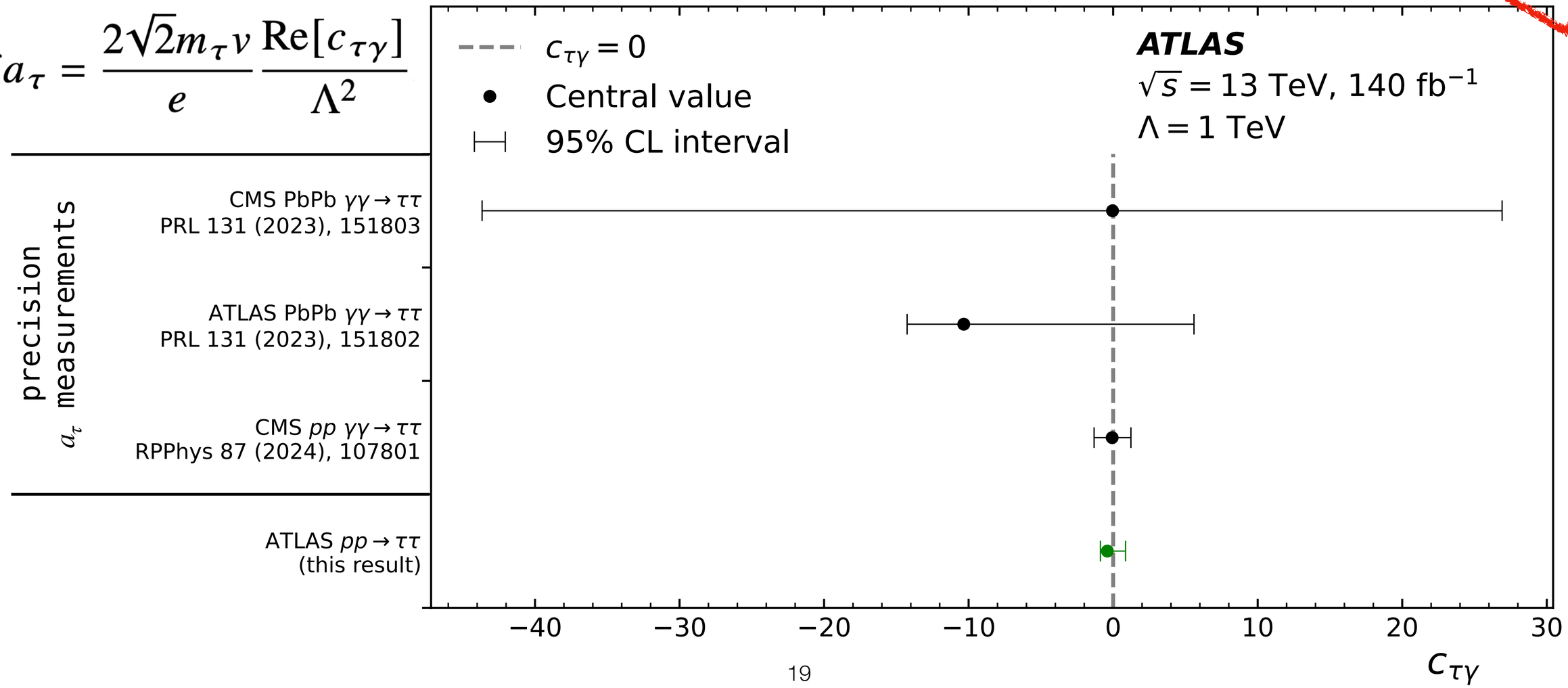
EXOT-2022-42

new today

constraints on new high-scale $\tau \leftrightarrow \gamma$ interactions:
tighter than existing a_τ measurements.

$$O_{\tau\gamma} = (\bar{l}\sigma^{\mu\nu}\tau)\sigma^i H(-s_W\sigma^i W^i_{\mu\nu} + c_W B_{\mu\nu})$$

$$\delta a_\tau = \frac{2\sqrt{2}m_\tau v}{e}\frac{\mathrm{Re}[c_{\tau\gamma}]}{\Lambda^2}$$

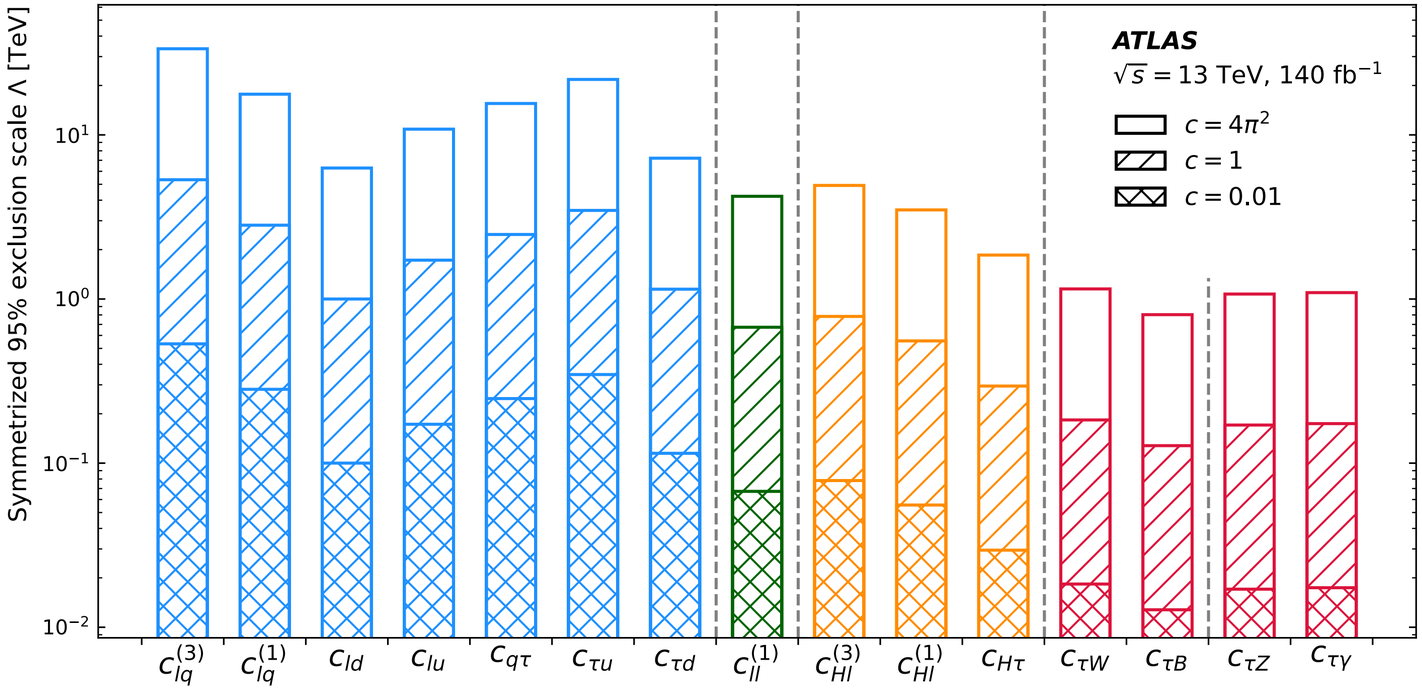


ATLAS analysis of high-mass $\tau\tau$ production

EXOT-2022-42

new today

interpreted as constraints on dim-6 EFT coefficients



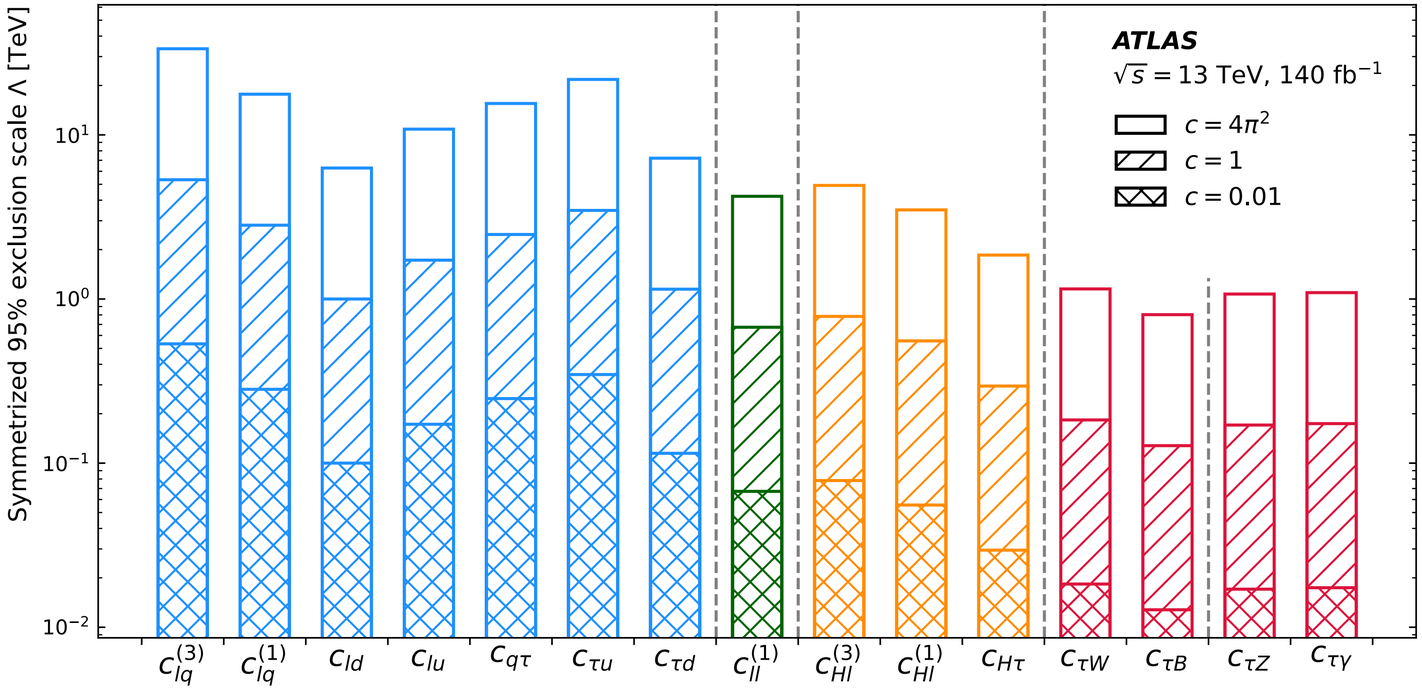
ATLAS analysis of high-mass $\tau\tau$ production

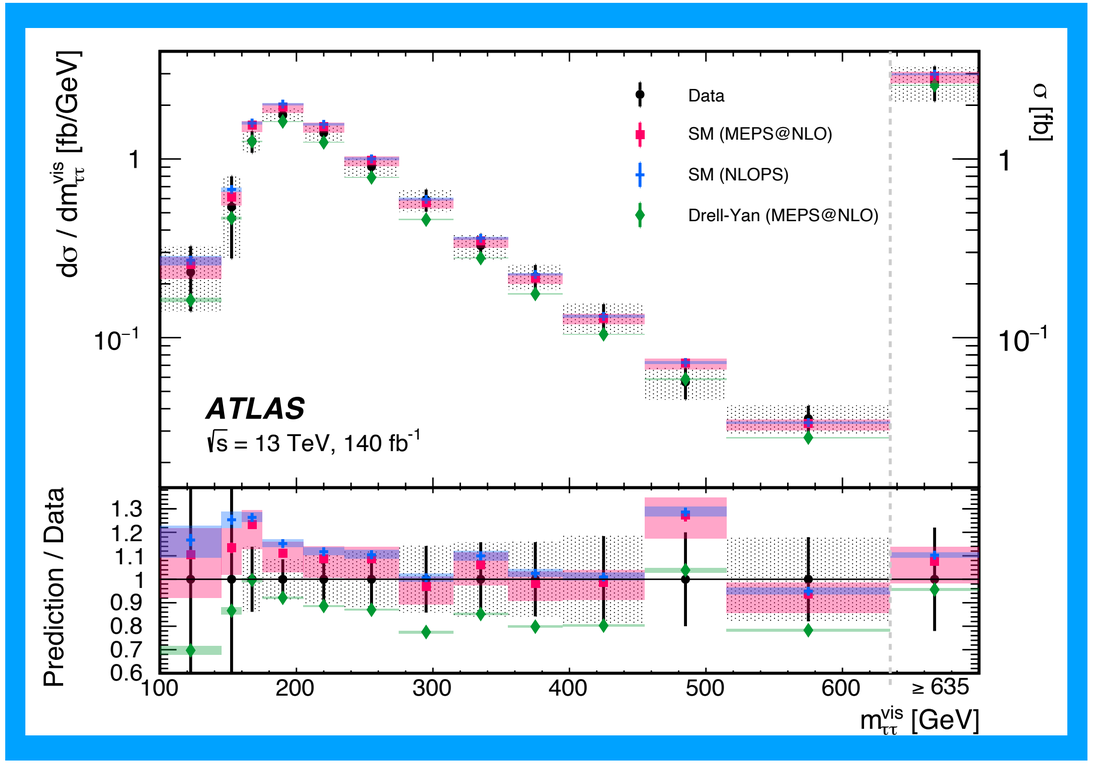
EXOT-2022-42

new today

interpreted as constraints on dim-6 EFT coefficients

unfolded cross-sections + SM backgrounds made available for your further interpretation!





thanks for your attention!

more related results in other presentations:

Izaak Neutelings (leptoquarks)
Alessandro Ruggiero (SUSY)
Federica Fabbri (top)
several in the flavor sessions

other new(-ish) highlights to be aware of:

ATLAS SUSY in VBF topologies SUSY-2023-26

ATLAS search for $cc + E_T^{miss}$ SUSY-2018-25

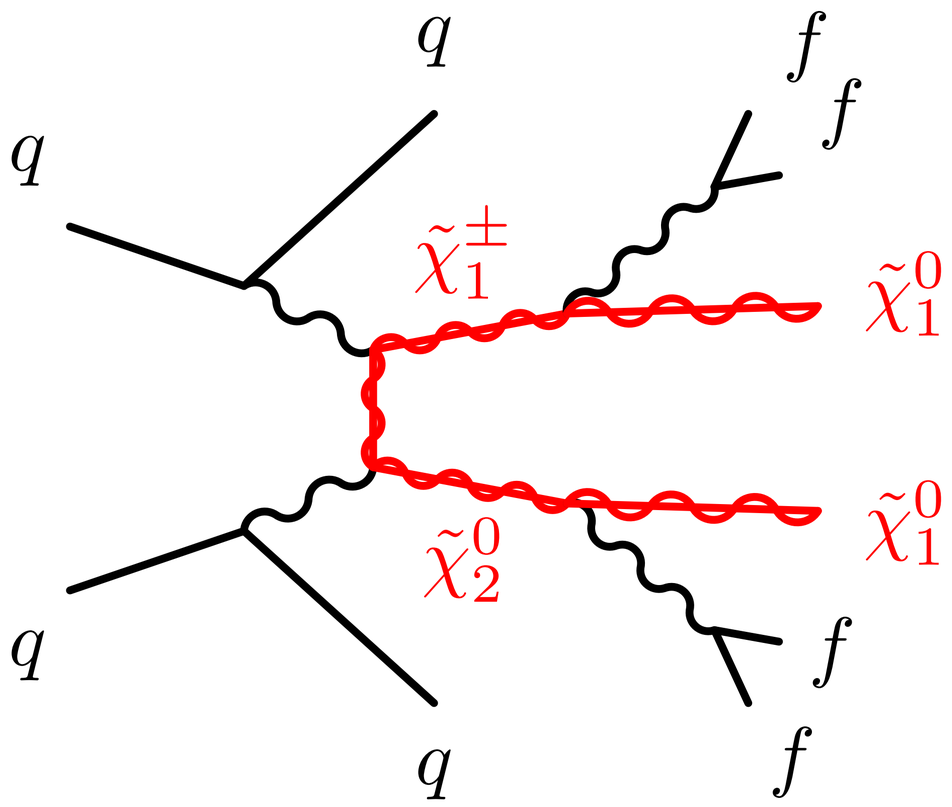
DM interpretation of $tc + E_T^{miss}$ link

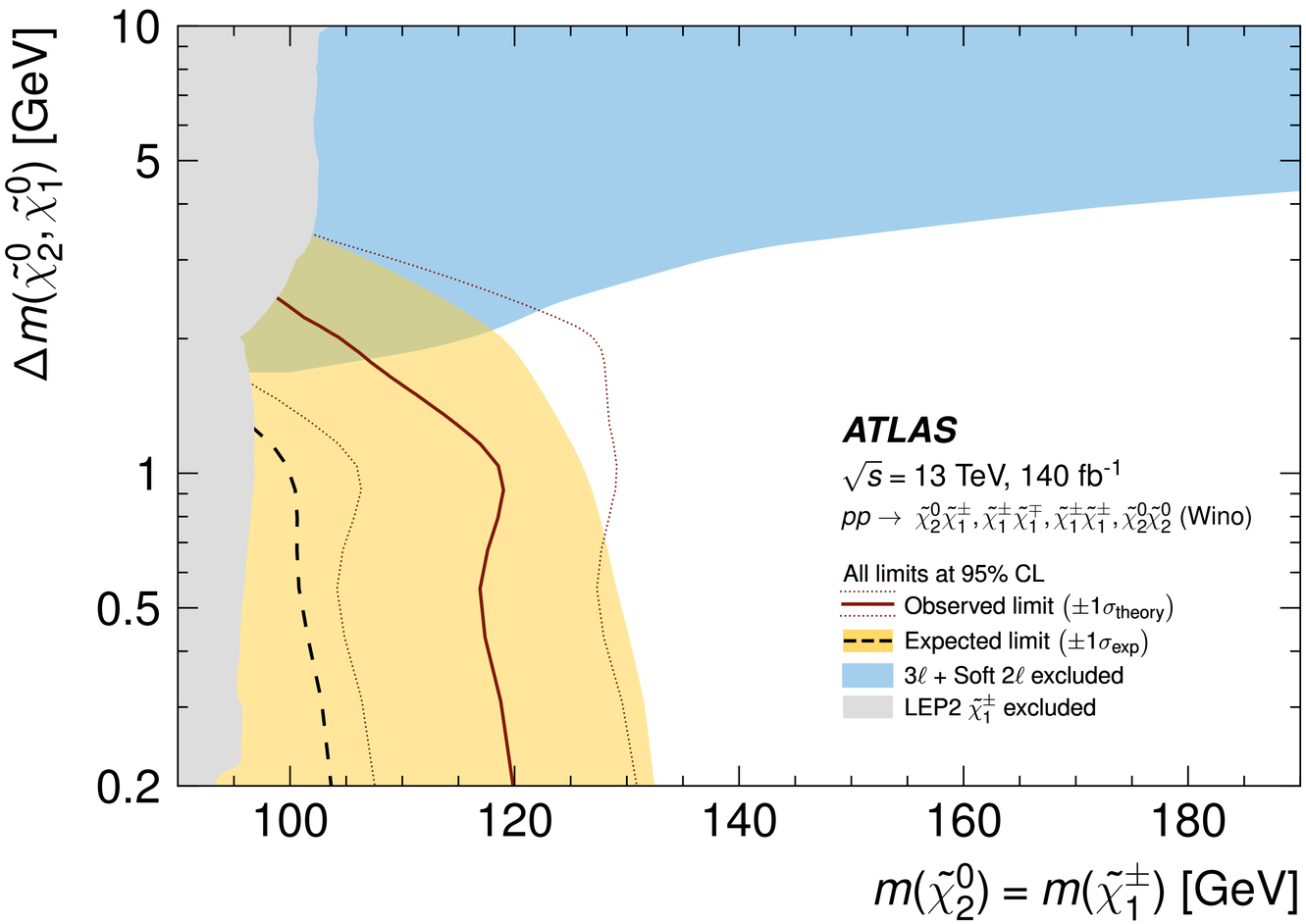
Backup

ATLAS search for SUSY in VBF topologies

SUSY-2023-26

VBF topologies particularly sensitive to
R-conserving SUSY scenarios with a
bino-like LSP ($\tilde{\chi}_1^0$) and
a compressed mass hierarchy.



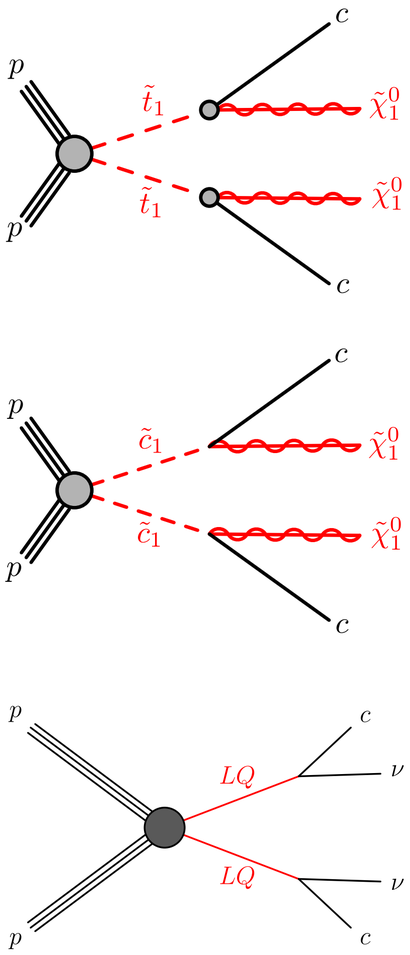


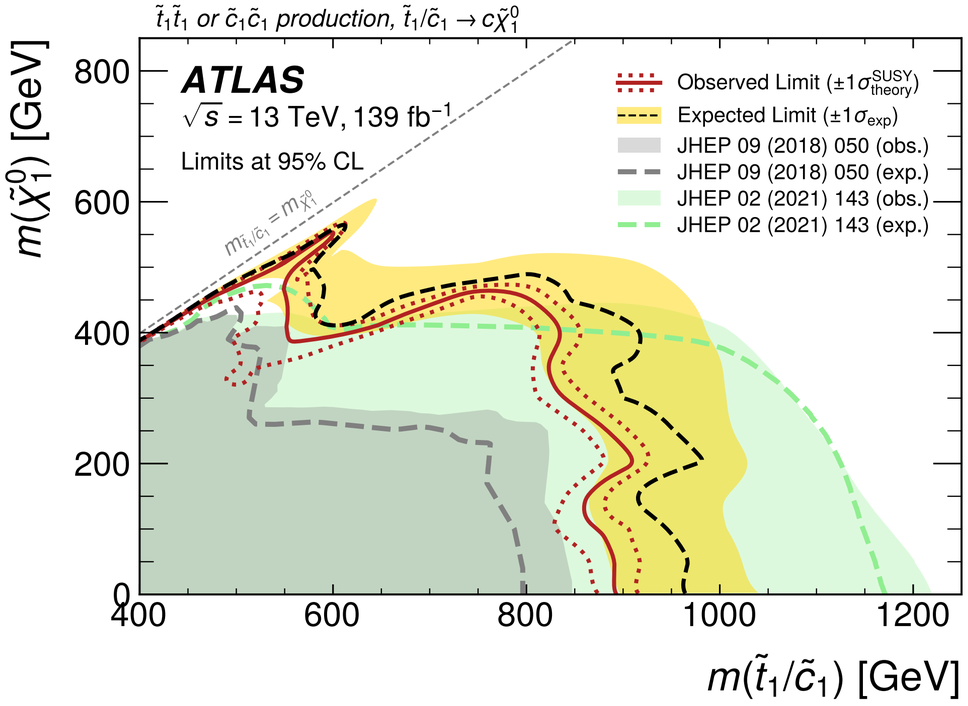
ATLAS search for $cc + E_T^{miss}$

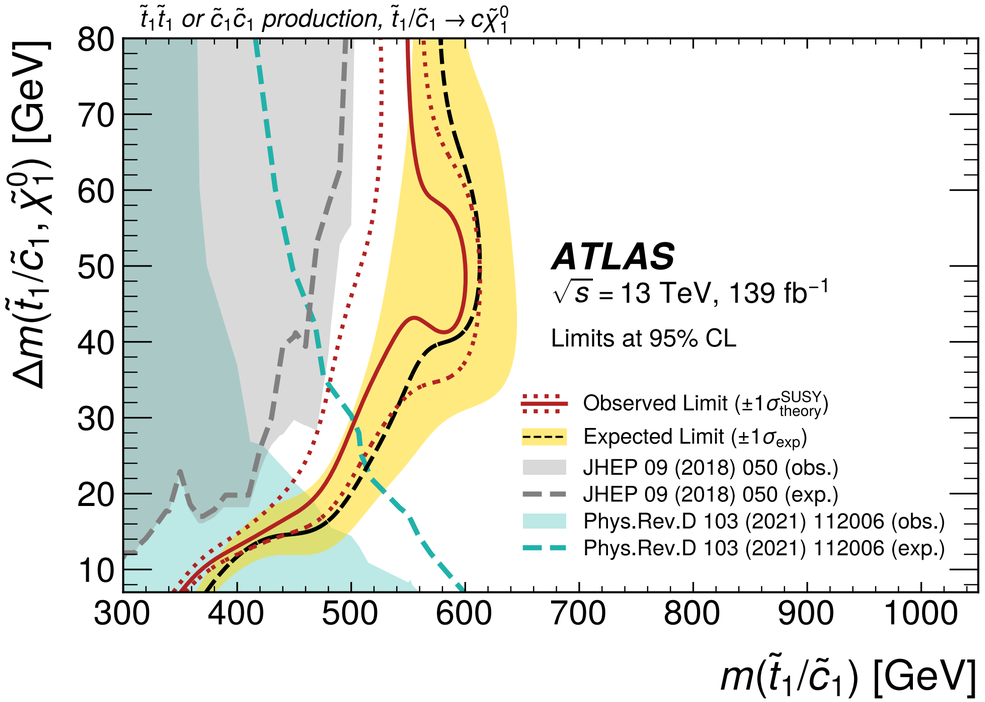
SUSY-2018-25

new dedicated flavor-tagging strategy implemented to identify charm jets

leads to limits on $\tilde{t}$ and $\tilde{c}$ production as well as $LQ \to c\nu$ decays (see Izaak's talk this afternoon)



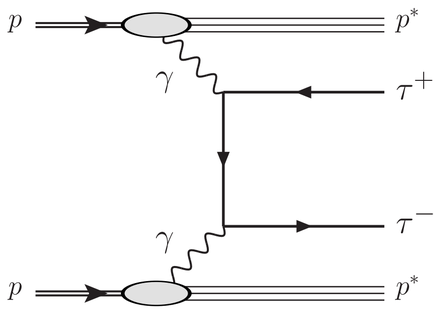


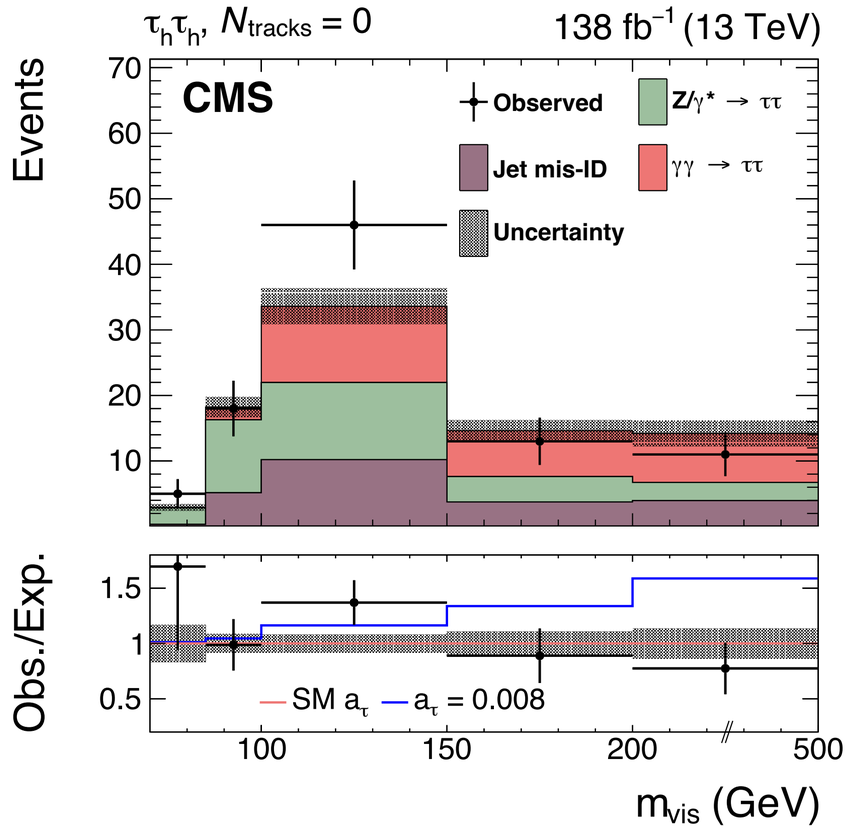


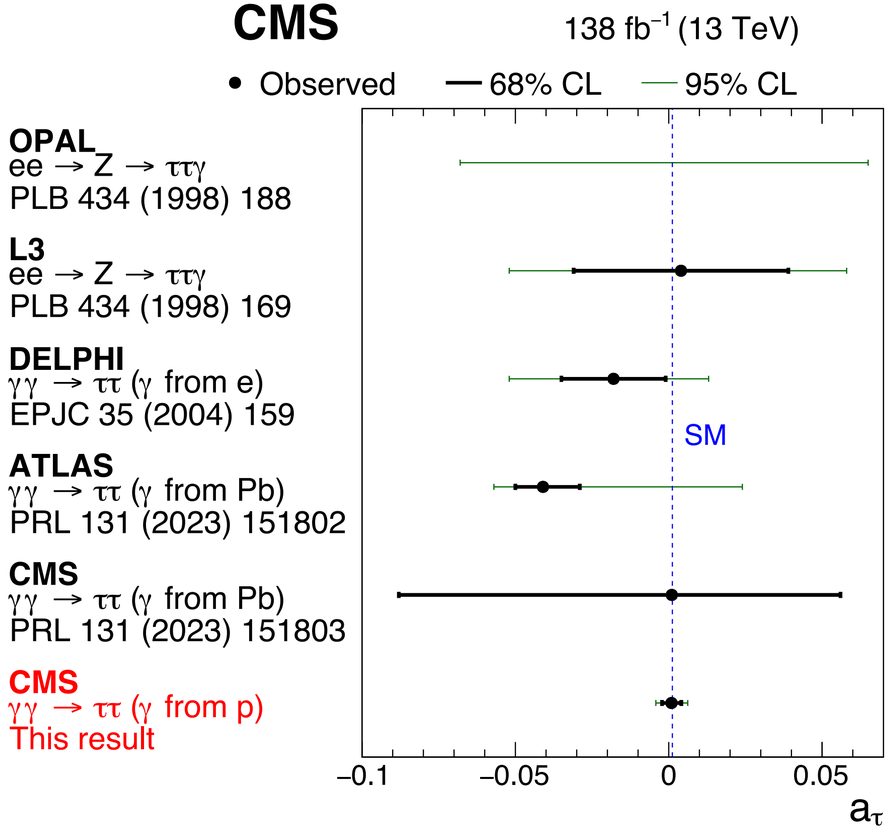
CMS observation of $pp\gamma\gamma \to pp\tau\tau$

CMS has observed the process $\gamma\gamma \to \tau\tau$ in pp collisions for the first time, which allows extraction of the anomalous EM moments of the τ-lepton with high precision

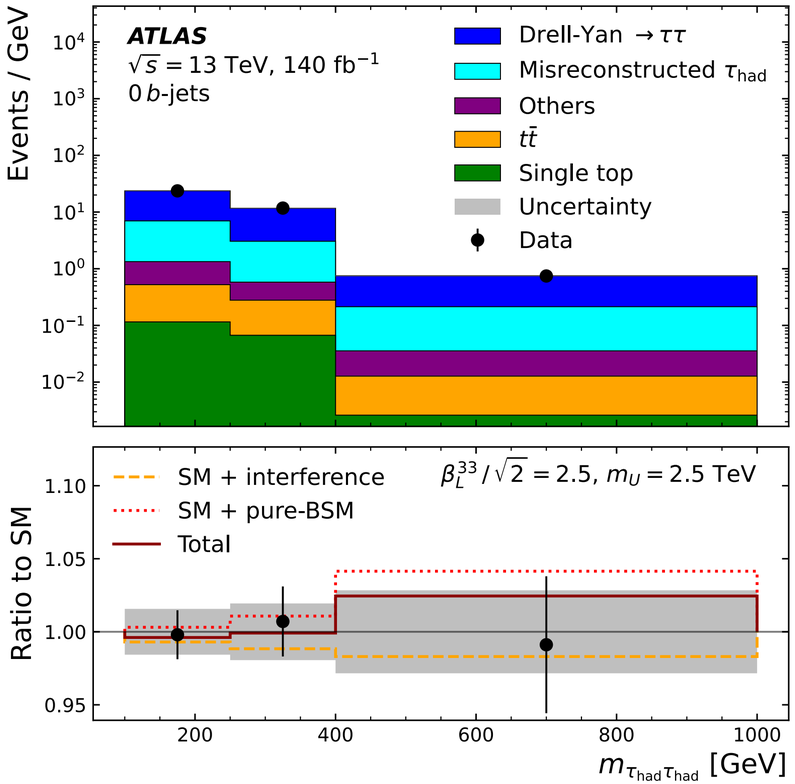
link

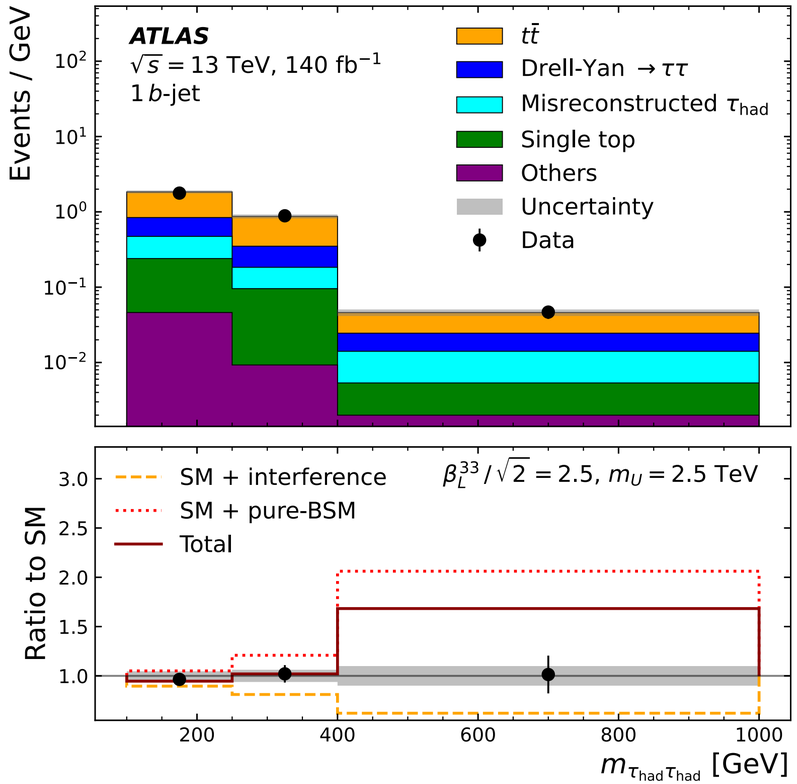


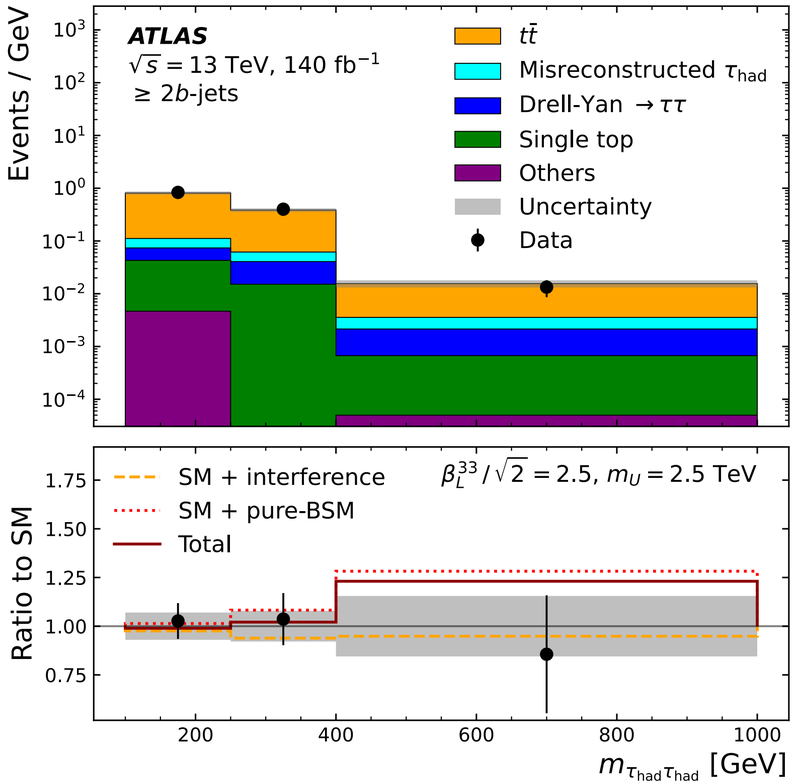




ATLAS analysis of high-mass $\tau\tau$ production

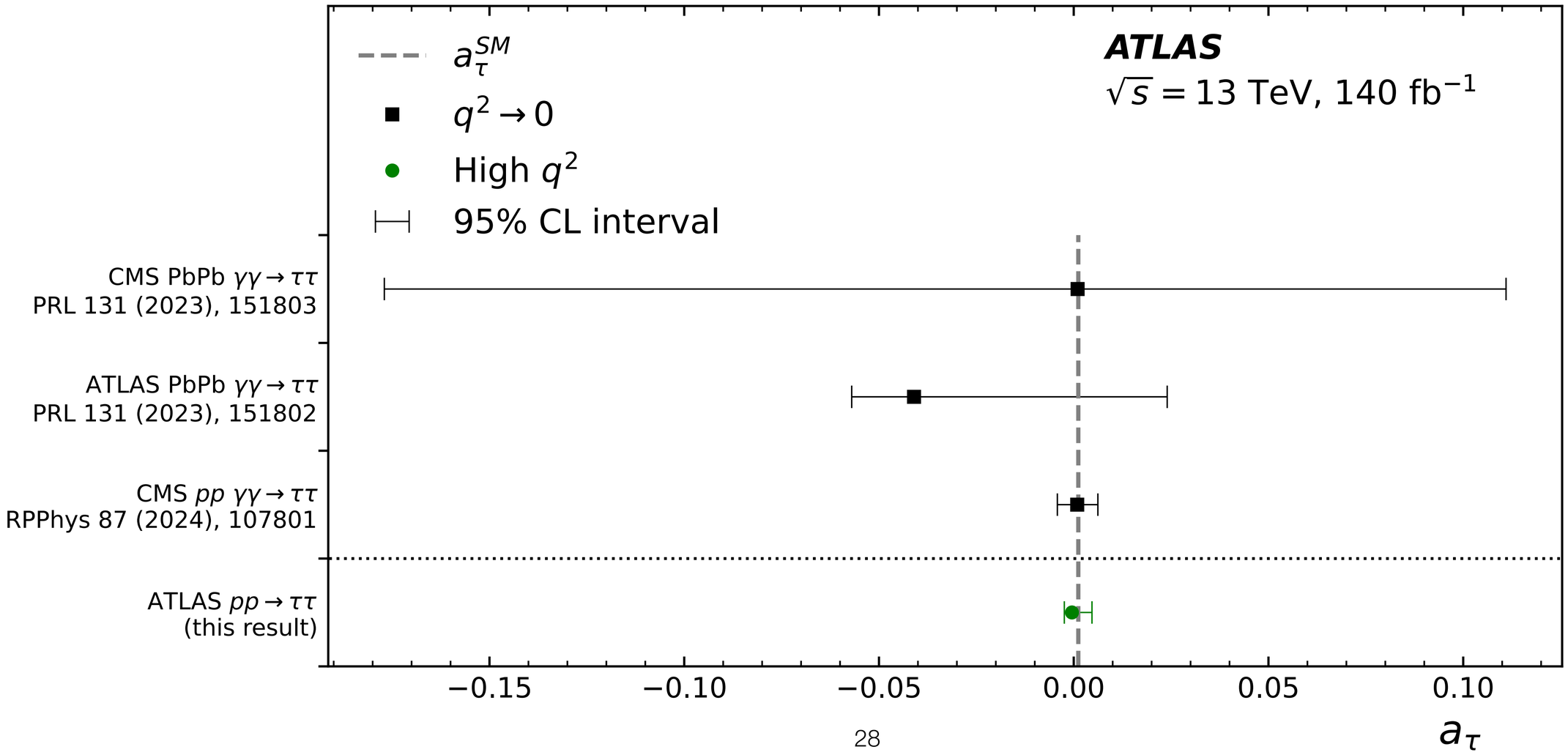




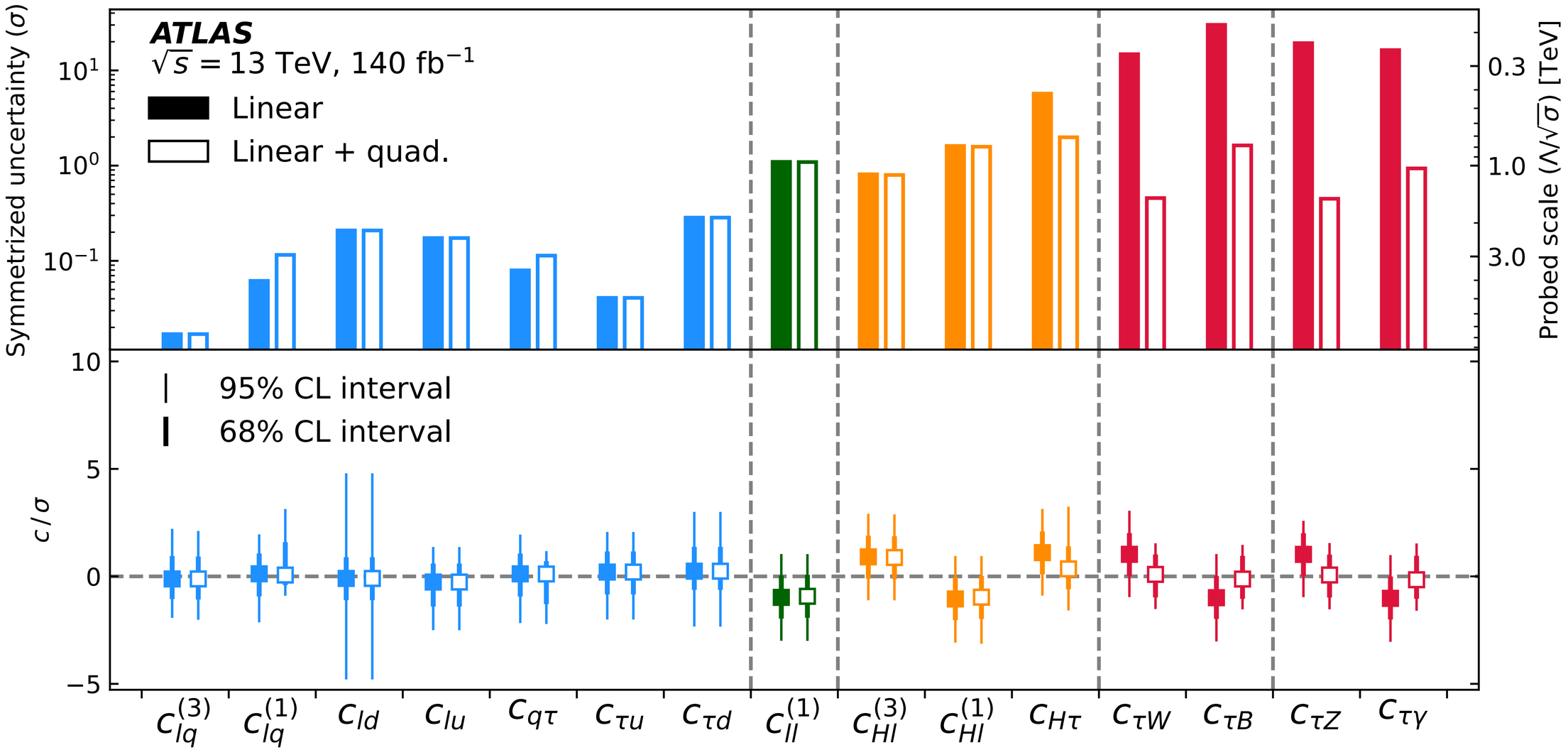


ATLAS analysis of high-mass $\tau\tau$ production

assuming no low-scale new physics,
can constrain high-scale contributions to a_τ



ATLAS analysis of high-mass $\tau\tau$ production



ATLAS analysis of high-mass $\tau\tau$ production

Coupling coefficient	Operator
$c_{lq}^{(3)}$	$(\bar{l}\sigma^i\gamma^\mu l)(\bar{q}\sigma^i\gamma^\mu q)$
$c_{lq}^{(1)}$	$(\bar{l}\gamma^\mu l)(\bar{q}\gamma^\mu q)$
c_{lu}	$(\bar{l}\gamma^\mu l)(\bar{u}\gamma^\mu u)$
c_{ld}	$(\bar{l}\gamma^\mu l)(\bar{d}\gamma^\mu d)$
$c_{q\tau}$	$(\bar{\tau}\gamma^\mu \tau)(\bar{q}\gamma^\mu q)$
$c_{\tau u}$	$(\bar{\tau}\gamma^\mu \tau)(\bar{u}\gamma^\mu u)$
$c_{\tau d}$	$(\bar{\tau}\gamma^\mu \tau)(\bar{d}\gamma^\mu d)$
c_{ll}	$(\bar{l}\gamma^\mu l)(\bar{l}\gamma^\mu l)$
$c_{Hl}^{(3)}$	$(H^\dagger i\overleftrightarrow{D}^i_\mu H)(\bar{l}\sigma^i\gamma^\mu l)$
$c_{Hl}^{(1)}$	$(H^\dagger i\overleftrightarrow{D}_\mu H)(\bar{l}\gamma^\mu l)$
$c_{H\tau}$	$(H^\dagger i\overleftrightarrow{D}_\mu H)(\bar{\tau}\gamma^\mu \tau)$
$c_{\tau W}$	$(\bar{l}\sigma^{\mu\nu}\tau)\sigma^i H W^i_{\mu\nu}$
$c_{\tau B}$	$(\bar{l}\sigma^{\mu\nu}\tau)H B_{\mu\nu}$
$c_{\tau Z}$	$(\bar{l}\sigma^{\mu\nu}\tau)\sigma^i H(c_W\sigma^i W^i_{\mu\nu} + s_W B_{\mu\nu})$
$c_{\tau\gamma}$	$(\bar{l}\sigma^{\mu\nu}\tau)\sigma^i H(-s_W\sigma^i W^i_{\mu\nu} + c_W B_{\mu\nu})$

ATLAS analysis of high-mass $\tau\tau$ production

EXOT-2022-42