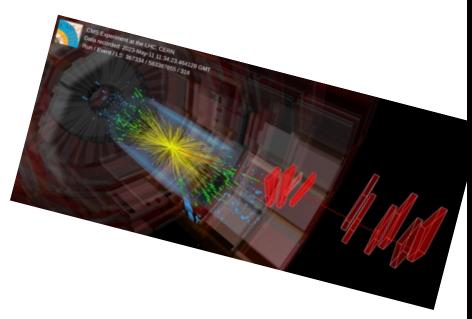
Florencia Canelli CHIPP annual meeting June 15, 2023

Compilation of results from conference Summary talks at Moriond EW (M. Kado,) Moriond QCD (A. Rizzi) and LHCP (R. Hawkins)

its from d CMS

13 years of LHC physics

- LHC experiments continue to explore the new energy frontier
 - Discovery of a / the(?) Higgs boson
 - → A new precision measurement program
 - Deepening the study of the SM
 - → Increasing precision of many SM parameters
 - → Exploring QCD in new environments
 - Plethora of searches for **new physics**
 - The Standard Model reigns supreme
 - Many models/parameter space ruled out
 - But new ideas are developing
 - 3σ effects come and go (and come and go)



Everything everywhere all at once

- ATLAS and CMS have a clean and well calibrated dataset of \sim 140 fb⁻¹
 - Still numerous results from Run 2 expected
- Run 3 started on 5th July 2022
 - Significant upgrades for both machine and detectors (esp. triggers)
 - Expect ~250 fb⁻¹ for ATLAS/CMS, 25-30 fb⁻¹ for LHCb and 7 nb⁻¹ PbPb for ALICE
 - More than doubling the Run-2 dataset
 - Injector/LHC improvements (e.g. lumi-levelling)
 - New detector capabilities bring new possibilities
 - Starting to see first results from Run3 data
- HL-LHC upgrade is coming (Run-4 ++)
 - Operation from 2029-2041, ~3 ab-1
 - Major upgrades of ATLAS+CMS for Run-4
 - LHCb and ALICE scoping their phase2b upgrades for Run-5 (2035 onwards)

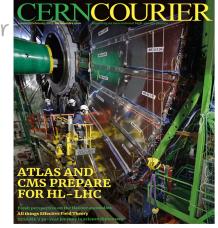




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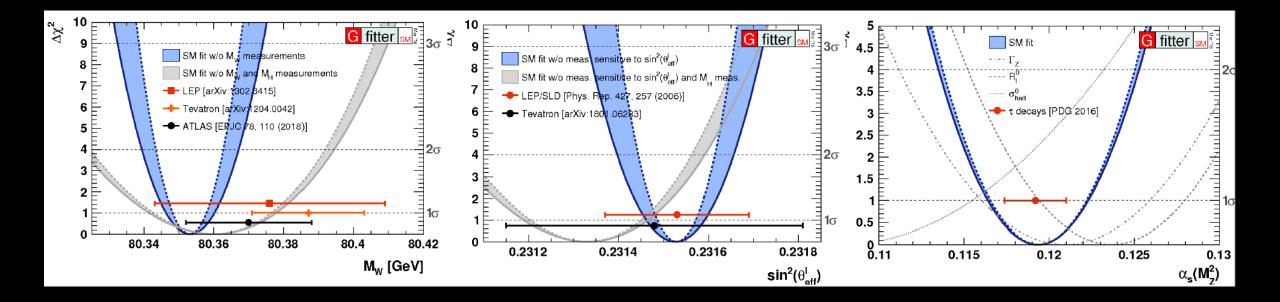




In this talk: Recent = Winter to LHCP No flavor results since our colleagues from LHCb are not here

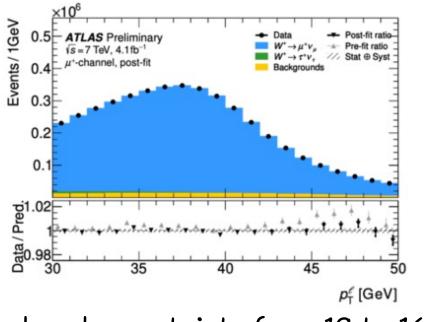
Challenges everywhere – data analysis, operations and construction

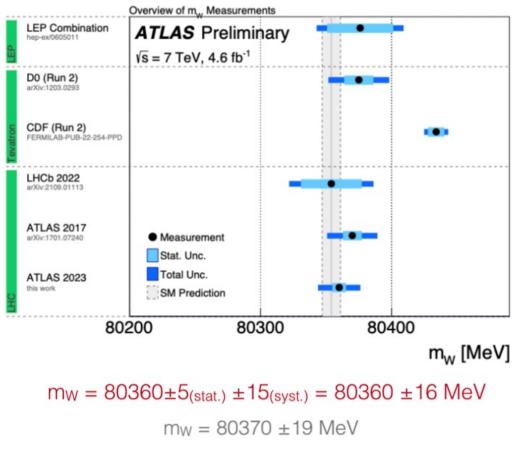
The precision frontier at LHC



W boson mass

Update of the ATLAS analysis with 7 TeV data New re-measurement includes several small Improvements mainly relies on profiling paradigm



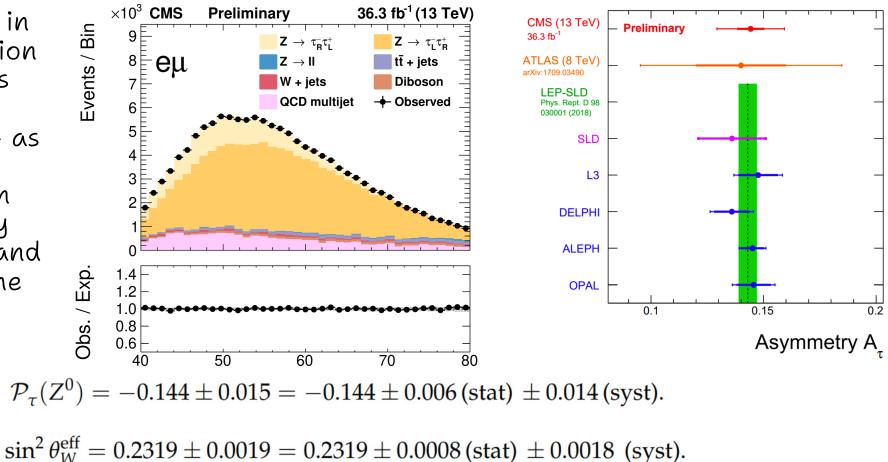


Reduced uncertainty from 19 to 16 GeV

Tension w/ CDF larger from 3.4 σ now 4 σ (Tension of CDF w/ the SM 7 σ)

Tau polarization

Measurement relies in measuring the fraction of tau helicity states using polarisation sensitive variables - as the polar emission angle of the t lepton and its sign are only very poorly known and cannot be used in the analysis

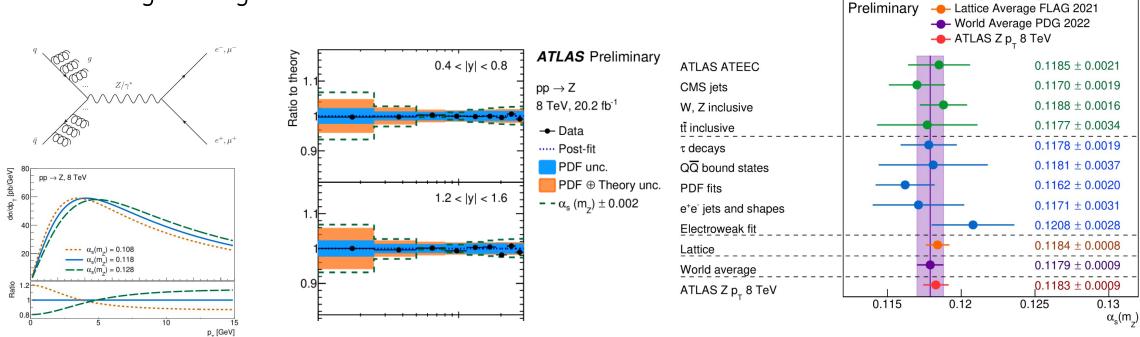


[LEP 1 and SLD at Z pole: 0.23152 ± 0.00016]

Determination of α_{s}

Measurement of the differential full-lepton phase space Z cross section!

Current **most precise measurement** Dominated by theory uncertainties



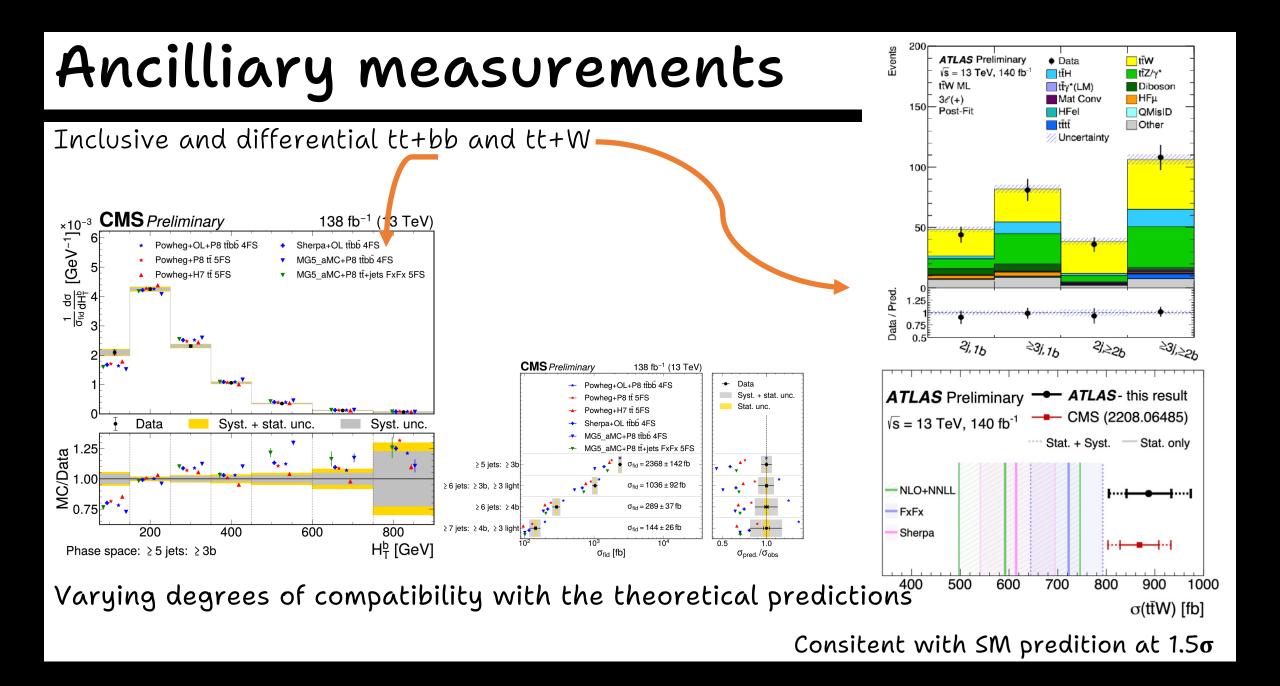
 $\alpha_{\rm S}(m_{\rm Z}) = 0.1183 \pm 0.0009$

Hadron Colliders

--- Category Averages PDG 2022

ATLAS

• New measurement from ZEUS from jet production $\alpha_{s}(M_{Z}^{2}) = 0.1138 \pm 0.0014$ (exp/fit)

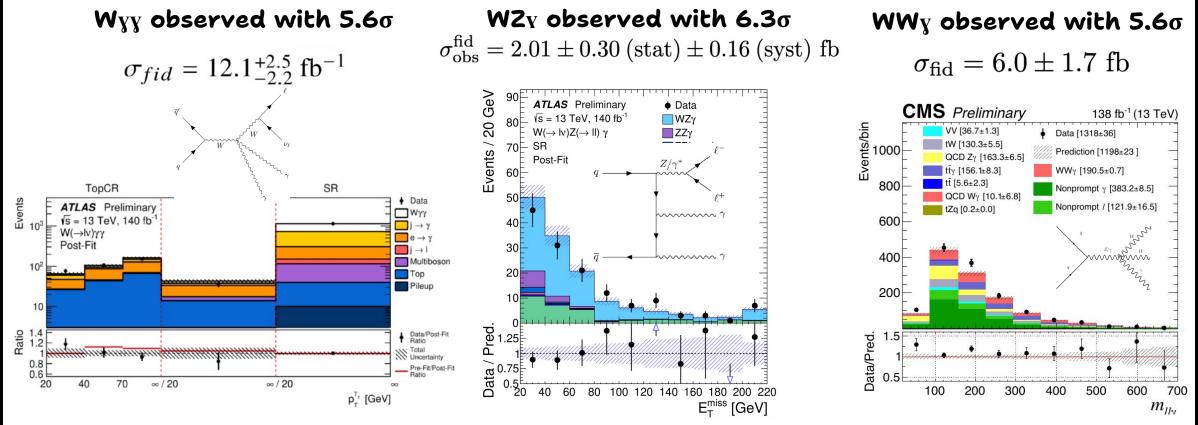


New production processes

New multibosons

Mature field with many inclusive and differential measurements

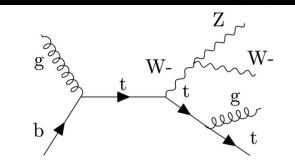
Investigate triple and quartic gauge couplings and more and more EFT limits



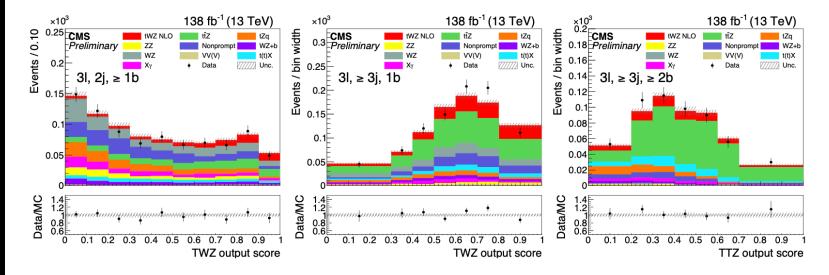
Stat. dominated, main syst. from non-prompt photons/ leptons

New top + multibosons

Evidence of tWZ production



in multileptons channels

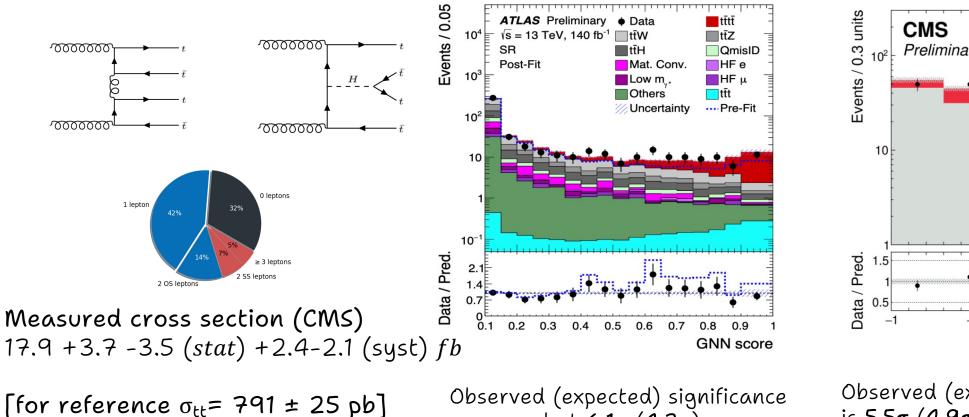


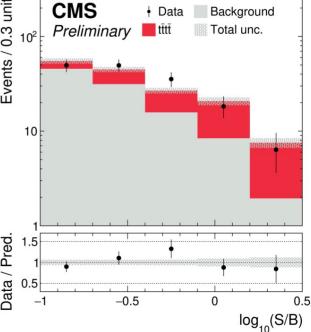
Measured cross section 0.37 ± 0.05 (stat) ± 0.10 (syst) pb

Observes a signal with 3.5σ significance (expected 1.3σ)

New multitops

(Independent) Observation by ATLAS and CMS of 4 top production! ٠





138 fb⁻¹ (13 TeV)

measured at 6.1σ (4.3σ)

Observed (expected) significance is **5.5σ** (**4.9σ**)

Searches for rare decays

In old particles

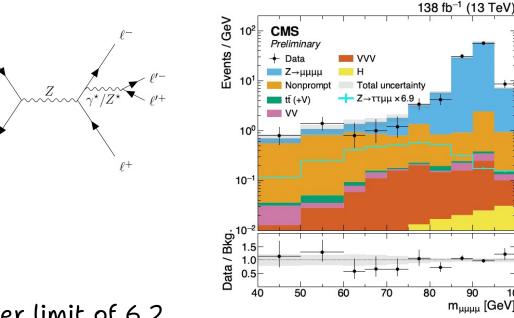
First ever searches for these decays

90

 $m_{\mu\mu\mu\mu}$ [GeV]

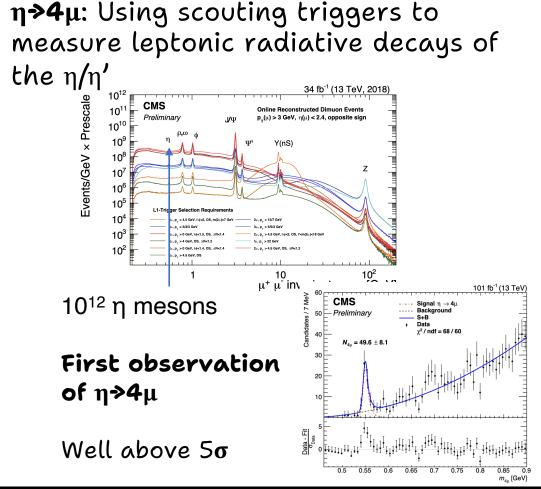
100

 $2 \rightarrow 2\mu 2\tau$: Using tau lepton decays to muons and neutrinos, events with two pairs of oppositely charged muons



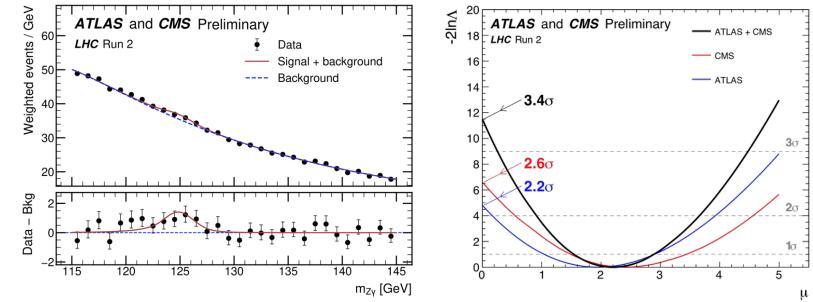
Upper limit of 6.2

Excludes values above 6.9 times the SM expectation



In Higgs

- $H \Rightarrow Z\gamma$ decay studied by ATLAS+CMS (both published)
 - BR in SM is ~1.5 10⁻³, 0.3% per Z→ll flavor
- Existing analyses have now been combined at the likelihood level



- Evidence for a signal with 3.4σ significance (expected 1.6σ):
 - Observed signal cross section corresponds to 2.2±0.7 times the SM cross section
 - 1.9 σ compatibility with SM prediction

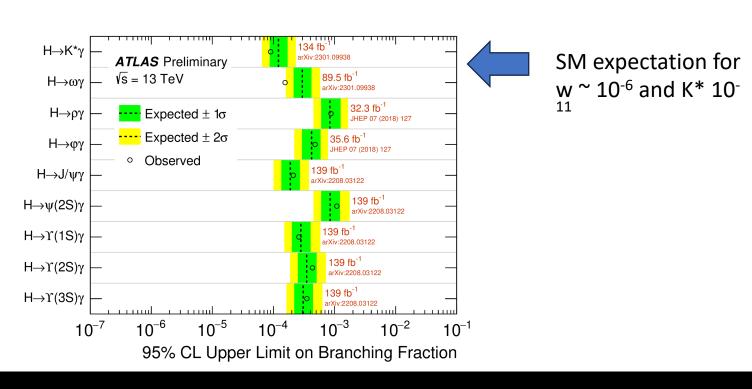
In Higgs

New searches for H (or Z) to meson + photon and new summary Can probe couplings of the **Higgs boson to light quarks** And can probe **charm and bottom couplings** when with Heavy quarkonia (J/ψ , ψ (25) and Y(nS) with n = 1, 2, 3,)

М

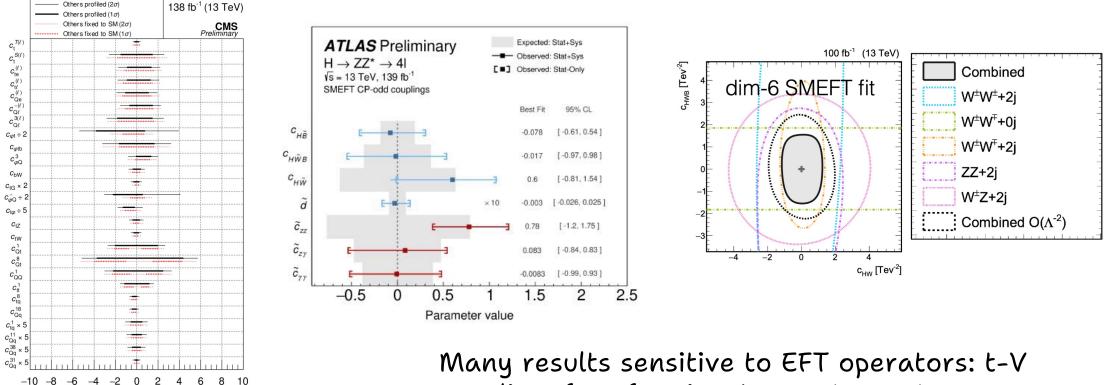
q

H(Z)



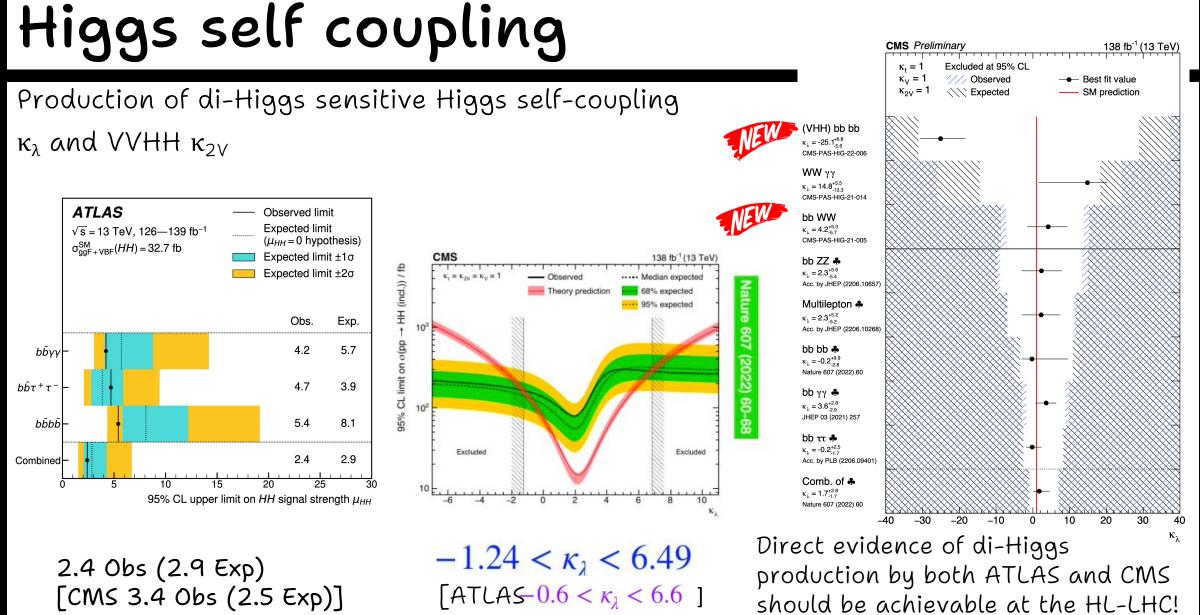
EFT instead of going model by model

EFT interpretation can be used to combine several processes and analysis and derive a single picture on the presence of new physics.



-8 -6 -4 -2 0 2 4 6 8 10Wilson coefficient / Λ^2 [TeV⁻²]

coupling, four fermions' operators, etc.



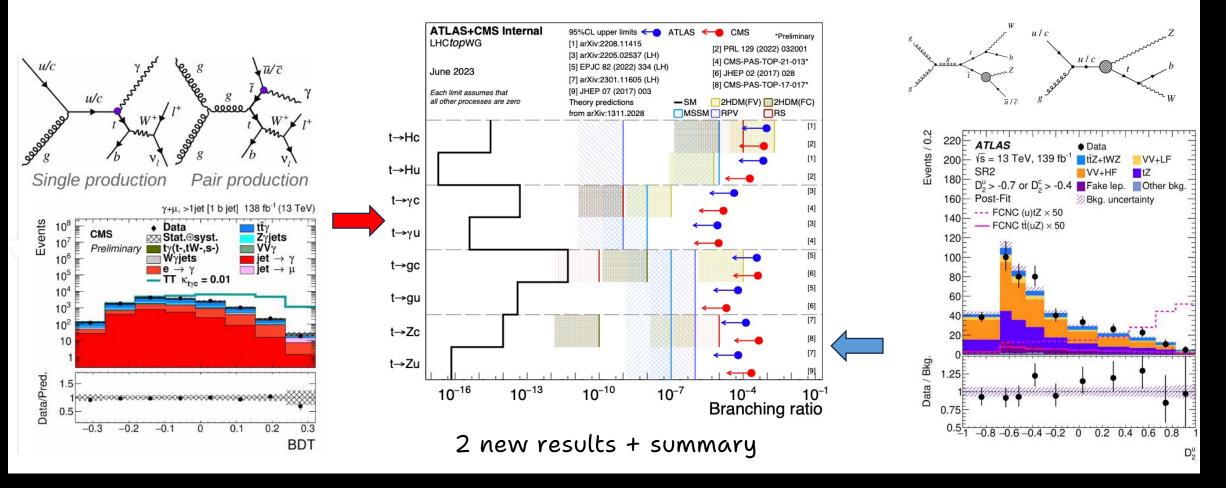
[CMS 3.4 Obs (2.5 Exp)]

[ATLAS- $0.6 < \kappa_{\lambda} < 6.6$]

Beyond what we know

New interactions

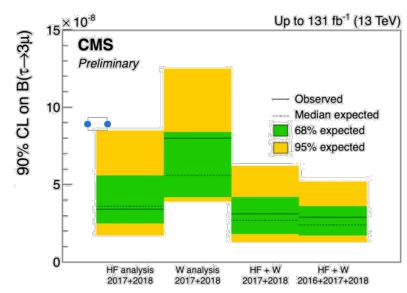
Top quark Flavor Changing Neutral Currents in SM heavily suppressed in decays with BFs < $O(10^{-12})$



Lepton Flavor Violation

Search for **τ→3μ**

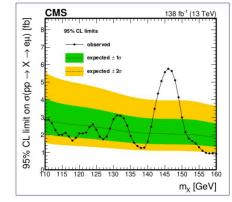
• Using taus from heavy flavor (low p_{T}) and W (high p_{T})



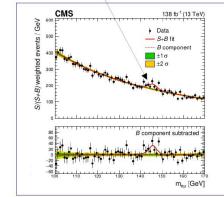
Limit $Br(\tau \rightarrow 3\mu) < 2.9 \ 10^{-8} at \ 90\% \ CL$

 Approaching 2.1 10⁻⁸ limit set by Belle

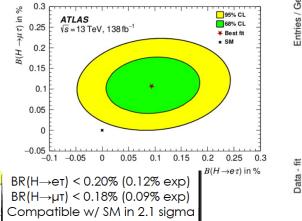
Search for **H→e**µ

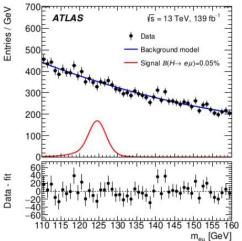


Result: Global (local) Significance of 2.8(3.8) o



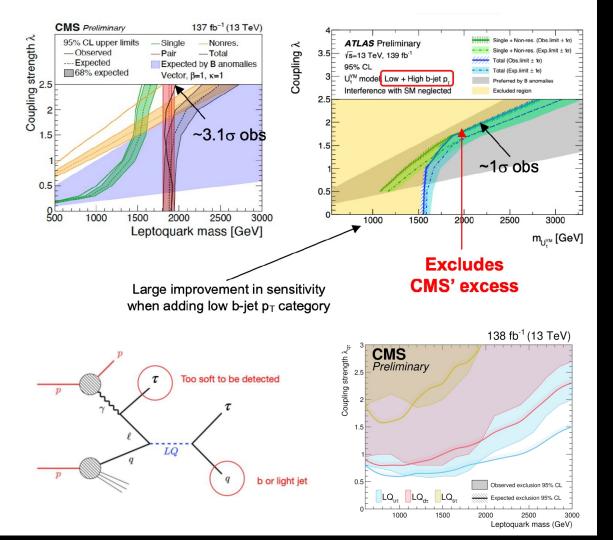
Search for $H \rightarrow \tau e$ and $H \rightarrow \tau \mu$





Lepton Flavor Universality Violation

- LFUV anomalies claimed by LHCb can be explained in several NP scenarios with particles coupling preferentially to first or second generation
- Broad program of searches for leptoquarks single and pair-production
- Increasing focus on non-resonant production to reach highest masses
- New searches:
 - LQ decaying to b and taus in single and and pair production (in s- and tchannels
 - LQ produced in lepton-quark collision (first time this mechanism is probed)
 - Z' search produced in association with b-jets (not shown)



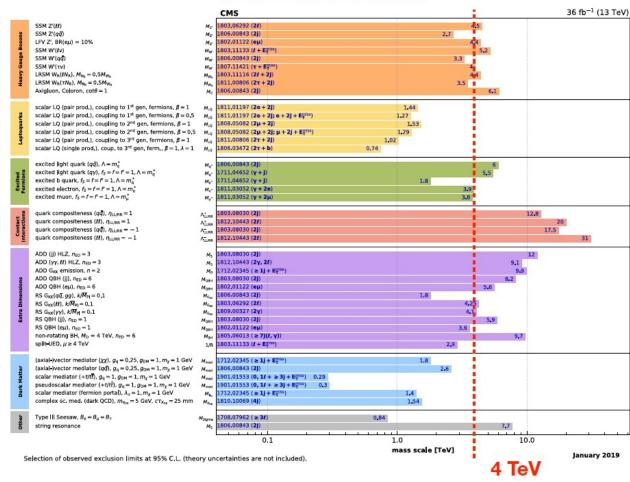
Numerous SUSY searches

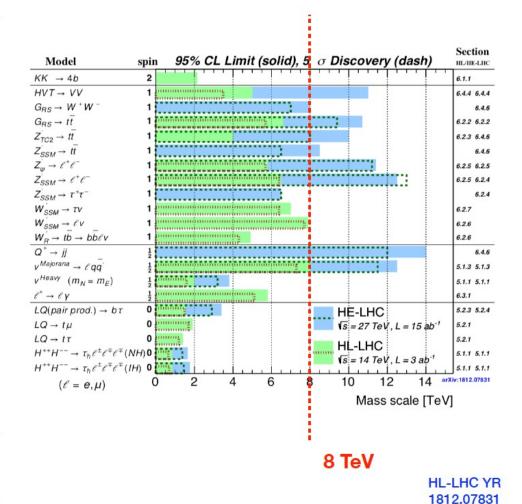
"Typical" SUSY searches: multiple SM objects, large MET More exploration: Challenging signatures (e.g. stealth SUSY sector) and previously uncovered corners • Compressed scenarios (small amount of visible energy) • Sleptons (extremely low cross sections) • Combine SUSY searches to be more powerful together

ATLAS SUSY Sea March 2022	arches* - 95% CL L	Lower Limits	ATLAS Preliminary $\sqrt{s} = 13 \text{ TeV}$ HL/HE-LHC SUSY Search			es = 111-110, jc u = 3utr ⁻¹ : 5r ds covery (55% C) HELHC, jc u = 3utr ⁻¹ : 5r ds covery (55% C)		Sinulation Freiminary			
Model	Signature f£dt	r (۱۵۰-۱) Mass limit	Reference	-	Model	e, µ, τ, γ	Jets	Masslimit	- Section (95% CLexclusion)		$\sqrt{s} = 14, 27 \text{ TeV}$ Section
$\bar{q}\bar{q}, \bar{q} \rightarrow q\bar{r}_{1}^{0}$	0 e, μ 2-6 jets E ^{miss} 139 mono-jet 1-3 jets E ^{miss} 139	39 ð [1x, 8x Degen] 1,0 1. 39 ð (8x Degen.] 0,9	5 m(k ²)>400 GeV 2010.14293 m(k)-m(k ²)=5 GeV 2102.10874	1	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q \tilde{q} \tilde{\chi}_{1}^{0}$	0	4 j ets	<i>B</i>	2.9 (3.2) ToV	m((7))-0	2.1.1
22. 2→0381	$0 e, \mu$ 2-6 jots E_T^{miss} 131	39 x Forbidden 1.15-	2.3 m(ℓ ²)=0 GeV 2010.14293 1.85 m(ℓ ²)=1000 GeV 2010.14293		$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q \tilde{q} \tilde{\chi}_{1}^{0}$	0	4 j ets	2	5.2 (5.7) TəV	m((\vec{r}_{1}^{0})=0	2.1.1
$\tilde{\mathcal{G}}$ $\tilde{\mathcal{R}}, \tilde{g} \rightarrow q\bar{q}W\tilde{x}_{1}^{0}$ $\tilde{\mathcal{R}}, \tilde{g} \rightarrow q\bar{q}(\ell)\tilde{x}_{1}^{0}$	1 е. µ 2-6 jats 131 се. µµ 2 jats E ^{rnico} 131		#2 m(k ²)>600 GeV 2101.01629 #2 m(k ²)>700 GeV CERN-EP-2022-014		$\tilde{g}_{\tilde{k}}, \tilde{g} \rightarrow t \tilde{k}_{1}^{0}$	0	Multiple	2	2.3 (2.5) TeV	m(\vec{x}_{i}^{0})=0	2.1.3
$\hat{g}\hat{g}, \hat{g} \rightarrow ggWZ\hat{g}_{1}^{0}$	$0 e, \mu$ 7-11 jets E_T^{retos} 131 SS e, μ 6 jets 131		1.97 m(¥1) <800 GeV 2008.0002 m(ŷ)-m(¥1)=200 GeV 1909.08457		NUHM2, $\hat{x} \rightarrow i \vec{x} \vec{x}$	0	Multiple Multiple/2/r	8	2.4 (2.6) TeV 5.5 (5.9) TeV	m(x ²)=500 GeV	2.1.3
$\xi = gg, g \rightarrow d\tilde{\chi}_1^0$	0-1 e, μ 3 b E ^{miss} 79.0 SS e, μ 6 jets 139	9.8 ž 39 ž 1.25	225 m(5)-200 GeV ATLAS-CONF-2018-041 m(g)-m(5)-m(5)-000 GeV 1909.08457	-		_		×		0	
$\tilde{b}_1 \tilde{b}_1$	0 e, µ 2 b E ^{mbo} 13	39 δ ₁ δ ₁ 0.68 1.255	mik ² ₁)<400 GeV 2101.12527 10 GeV<.2m(5, k ²)<20 GeV 2101.12527	-	$i_1 i_1, i_1 \rightarrow \delta i_1^0$ $\Im = i_1 i_1, i_1 \rightarrow \delta i_1^0$	0	Multiple/26 Multiple/26	71 71	1.4 (1.7) ToV 0.6 (0.85) ToV	$m(\tilde{t}_1')=0$ $\Delta m(\tilde{t}_1, \tilde{\lambda}_1') \sim m(t)$	2.1.2, 2.1.3 2.1.2
$b_1 \bar{b}_1, \bar{b}_1 \rightarrow b \bar{x}_2^0 \rightarrow b h \bar{x}_1^0$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	39 8, Forbidden 0.23-1.35	Δm(ξ ² ₂ , ξ ² ₁) = 130 GeV, m(ξ ² ₁) = 100 GeV Δm(ξ ² ₂ , ξ ² ₁) = 130 GeV, m(ξ ² ₁) = 100 GeV Δm(ξ ² ₂ , ξ ² ₁) = 130 GeV, m(ξ ² ₁) = 00 GeV 2103.08189		$\tilde{S}_{\tilde{I}_{1}\tilde{I}_{1}, \tilde{I}_{1} \rightarrow b\tilde{X}^{*}/t\tilde{X}_{1}^{0}, \tilde{X}_{2}^{0}}$	0	Multiple/26	7	3.16 (3.65) TeV		2.4.2
10000 111, 11→120	$0.1 e, \mu \ge 1$ jet E_T^{miss} 139	39 7, 1.25	m(t)_t1=10038V, m(t)=038V m(t)=106V m(t)=500 64V 2004.14060.2012.03799	-	$\hat{X}_{1}^{+}\hat{X}_{1}^{-}, \hat{X}_{1}^{+} \rightarrow W^{*}\hat{X}_{1}^{0}$	2 e. µ	0-1 jets	χ [*]	0.66 (0.84) TeV	m((²⁰)=0	2.2.1
$\vec{h}_{1}\vec{l}_{1}, \vec{h}_{1} \rightarrow Wb\hat{\ell}_{1}^{\prime\prime}$ $\vec{h}_{1}\vec{l}_{1}, \vec{h}_{1} \rightarrow t_{1}bv, t_{1} \rightarrow \tau \vec{G}$	1-2 T 2 jets/1 b ET 13	39 Ti Forbidden 1.4	m(r)=800 GeV 2108.07665		$\mathcal{L} = \mathcal{L} = \mathcal{L}^{\dagger} \mathcal{K}_{2}^{0} \text{ via } WZ$	3 e, µ	D-1 jets	$\bar{X}_1^* / \bar{X}_2^*$	0.92 (1.15) TeV	m(\vec{r}_{1}^{2})=0	2.2.2
$\tilde{z}_{\mu} \stackrel{\text{def}}{=} \tilde{h} \tilde{t}_{1}, \tilde{h} \rightarrow c \tilde{t}_{1}^{0} / i \tilde{c}, \tilde{c} \rightarrow c \tilde{t}_{1}^{0}$	0 c,μ 2 c E ^{miss} 36. 0 c,μ mono-jet E ^{miss} 139	39 Ž ₁ 0.55	m(\tilde{t}_{1}^{0})=0 GeV 1805.01649 m(\tilde{t}_{1} , \tilde{t}_{2}^{0})=m(\tilde{t}_{1})=5 GeV 2102.10874		Ling X ⁺ ₁ X ⁰ ₂ via Wk, Wh→tvbb	1 e, µ	2-3 jets/2/	$\hat{\chi}_{i}^{s} \hat{\chi}_{i}^{s}$	1.08 (1.28) ToV	$m(\vec{\tau}_1^0) = 0$	2.2.3
$\hat{t}_1\hat{t}_1, \hat{t}_1 \rightarrow t\hat{\ell}_2^0, \hat{k}_2^0 \rightarrow Z/h\hat{\ell}_1^0$ $\hat{t}_2\hat{t}_2, \hat{t}_2 \rightarrow \hat{t}_1 + Z$	$1-2 e, \mu$ $1-4 b E_T^{min}$ 130 $3 e, \mu$ $1 b E_T^{min}$ 131		m(\$\vec{k}_{1}^{0})=500 GeV 2006.05880 m(\$\vec{k}_{1}^{0})=360 GeV, m(f_{1})=m(\$\vec{k}_{1}^{0})=40 GeV 2006.05880		$G \in \tilde{X}_{1}^{*} \tilde{X}_{4}^{0} \rightarrow W^{a} \tilde{X}_{1}^{0} W^{a} \tilde{X}_{1}^{a}$	2 e. µ	-	$\bar{X}_{2}^{\pm}/\bar{X}_{4}^{4}$	0.9 TeV	m(\$ ² 1)=150, 250 GeV	2.2.4
$\hat{x}_{1}^{*}\hat{x}_{2}^{0}$ via WZ	$\begin{array}{llllllllllllllllllllllllllllllllllll$		m(t ²)=0, who-bino 2106.01676, 2108.07598 m(t ²)-m(t ²)=5 GeV, who-bino 1911.12606		$\begin{array}{c} \mathbf{g} & \hat{\mathcal{X}}_{1}^{+} \hat{\mathcal{X}}_{2}^{0} + \hat{\mathcal{X}}_{2}^{0} \hat{\mathcal{X}}_{1}^{0}, \hat{\mathcal{X}}_{2}^{0} \rightarrow Z \hat{\mathcal{X}}_{1}^{0}, \hat{\mathcal{X}}_{1}^{0} \rightarrow W \hat{\mathcal{X}}_{1}^{0} \\ & \hat{\mathcal{X}}_{1}^{+} \hat{\mathcal{X}}_{2}^{0} - \hat{\mathcal{X}}_{1}^{0} \hat{\mathcal{X}}_{1}^{0} \rightarrow Z \hat{\mathcal{X}}_{1}^{0}, \hat{\mathcal{X}}_{1}^{0} \rightarrow W \hat{\mathcal{X}}_{1}^{0} \end{array}$		1 jot 1 jot	$\widehat{X}_{1}^{a}/\widehat{X}_{1}^{a}$ $\widehat{\nabla}^{a}/\widehat{\nabla}^{a}$	0.25 (0.36) TeV	m(\hat{X}_{1}^{0})=15GeV	2.2.5.1
$\hat{x}_1^{\pm} \hat{x}_1^{\mp}$ via WW $\hat{x}_1^{\pm} \hat{x}_2^{0}$ via Wh	$2 e, \mu$ E_T^{miss} 139 Multiple $\ell/jets$ E_T^{miss} 139		m(P ¹ ₁)=0, Web-bino 1908.08215 m(P ¹ ₁)=70 GeV, Web-bino 2004.10894, 2108.07586		$\begin{array}{c} \tilde{\chi}_{1}^{*}\tilde{\chi}_{2}^{0}+\tilde{\chi}_{2}^{0}\tilde{\chi}_{1}^{0},\tilde{\chi}_{2}^{0}\rightarrow Z\tilde{\chi}_{1}^{0},\tilde{\chi}_{1}^{a}\rightarrow W\tilde{\chi}_{1}^{0}\\ \tilde{\chi}_{1}^{a}\tilde{\chi}_{2}^{a}-\tilde{\chi}_{2}^{a}\tilde{\chi}_{1}^{a},\tilde{\chi}_{1}^{a}\rightarrow W\tilde{\chi}_{1}^{0}\end{array}$	2 v. p 2 v	1 jat	x ₁ /x ₂	0.42 (0.55) TeV 0.21 (0.35) TeV	m(\hat{Y}_{1}^{0})=15GeV	2.2.5.1
$\sum_{\substack{i=1\\i j \in I}} \frac{\hat{\chi}_{1}^{*} \hat{\chi}_{1}^{*}}{\hat{\tau}_{i}} \frac{v \ln \tilde{\ell}_{L}/\hat{\tau}}{\tau + \tau \hat{\ell}_{1}^{0}}$	$2 e, \mu$ E_T^{min} 139 2τ E_T^{min} 139	39 \hat{x}_{i}^{\dagger} 1.0	$m(\tilde{c},\tilde{c})=0.5(m(\tilde{c}_1^+)+m(\tilde{c}_1^0))$ $m(\tilde{c}_1^0)=0$ 1911.06660		$\mathbf{\tilde{x}} \boldsymbol{\mathcal{X}}_{\mathcal{X}_{1}}^{*}, \boldsymbol{\mathcal{X}}_{1}^{*} \boldsymbol{\mathcal{X}}_{1}^{*}, \boldsymbol{\mathcal{X}}_{1}^{*} \boldsymbol{\mathcal{X}}_{1}^{*}$	0.000		x2	1.000	$\Delta m(\tilde{t}_2^0, \tilde{\lambda}_1^0) = 5 \text{ GeV}$	
$\tilde{l}_{L,R}\tilde{l}_{L,R}, \tilde{l} \rightarrow l\tilde{\chi}_1^0$	$2 e_{\mu}$ 0 jets $E_{\text{future}}^{\text{trains}}$ 139 cc. $\mu\mu$ \geq 1 jet $E_{\text{future}}^{\text{trains}}$ 139	39 7 0.7	m(l ²)-m(l ²)=0 1908.08215 m(l ²)-m(l ²)=0 GaV 1911.12506		λ [±] ₁ X ⁰ ₄ via same-sign WW	2 e, µ	٥	Wino	0.86 (1.08) TeV		2.4.2
$BR, R \rightarrow hG/ZG$	$\begin{array}{ccc} 0 \ e, \mu & \geq 3 \ b & E_{This}^{mins} & 36.5 \\ 4 \ e, \mu & 0 \ jets & E_{This}^{mins} & 135 \end{array}$	39 <i>n</i> 0.55	$\begin{array}{c c} BR(K_1^0 \to AG) = 1 & 1806.04030 \\ BR(K_1^0 \to 2G) = 1 & 2103.11694 \\ BR(K_1^0 \to 2G) = 1 & 2100.7266 \end{array}$		$\tilde{\tau}_{L,R}\tilde{\tau}_{L,R}, \tilde{\tau} \rightarrow \pi \tilde{\tau}_{1}^{0}$	2+	5	*	0.53 (0.73) TeV 0.47 (0.65) TeV	m(\vec{v}_{1}^{0})=0	2.3.1
				-		$2r, \tau(c, \mu)$ $2r, \tau(c, \mu)$	-	F F	0.81 (1.15) TeV	$m(\tilde{x}_{1}^{0})=0, m(\tilde{x}_{1})=m(\tilde{x}_{2})$ $m(\tilde{x}_{1}^{0})=0, m(\tilde{x}_{1})=m(\tilde{x}_{2})$	2.3.2 2.3.4
Direct $\tilde{x}_{1}^{\dagger} \tilde{x}_{1}^{-}$ prod., long-lived \tilde{x}_{1}^{\pm}	Disapp. trk 1 jet E ^{miss} 139	λ [*] ₁ 0.21	Pure Wino 2201.02472 Pure higgsino 2201.02472		$\hat{X}_{1}^{*}\hat{X}_{1}^{*}, \hat{X}_{1}^{*}\hat{X}_{1}^{*}$, long-lived \hat{X}_{1}^{*}	Disapp. trk.	1 jot	$\tilde{X}_{1}^{\delta} = [r(\tilde{X}_{1}^{\delta}) - \text{tns}]$	0.8 (1.1) ToV	Wino-like \tilde{X}_1^4	4.1.1
Stable ∂ R-hadron B G R-hadron B G R-hadron, ∂→qy ²	pixel dE/dx E_T^{mix} 139 pixel dE/dx E_T^{mix} 139	39 g [r(g) =10 ns]	2.05 CERN-EP-2022-029 22 m(F)=100 GeV CERN-EP-2022-029		$\hat{x}_1^* \hat{x}_1^*, \hat{x}_1^* \hat{x}_1^*, \text{ long-lived } \hat{x}_1^*$ $\hat{x}_1^* \hat{x}_1^*, \hat{x}_1^* \hat{x}_1^*, \text{ long-lived } \hat{x}_1^*$	Disapp. trk.	1 jot	$\hat{X}_1^{\dagger} = [r(\hat{X}_1^{\dagger}) - \ln 5]$ $\hat{X}_1^{\dagger} = [r(\hat{X}_1^{\dagger}) - \ln 5]$	0.6 (0.75) ToV	Higgsino-like \hat{X}_1^*	4.1.1
G B 11, 2→10	Displ. lep E ^{fmins} 139 pixel dE/dx E ^{mins} 139	7 0.34	$\pi(\tilde{t}) = 0.1 \text{ ms}$ $\pi(\tilde{t}) = 0.1 \text{ ms}$ $\pi(\tilde{t}) = 0.1 \text{ ms}$ $\pi(\tilde{t}) = 10 \text{ ms}$ CLFIP4-EP-3022-029		MSSM, Electroweak DM	Disapp. trk.	1 jet	DN mass	0.88 (0.9) TəV	Winc-like DM	4.1.3
$\hat{\chi}^{\dagger}_{1}\hat{\chi}^{\dagger}_{1}\hat{\chi}^{0}_{1}, \hat{\chi}^{\dagger}_{1} \rightarrow \mathbb{Z} t \rightarrow t t t$	3 e.µ 13		Pure Wino 2011:10543	- 1	MSSM, Electroweak DN	Disapp. trk.	1 jet	DM mass	2.0 (2.1) TeV	Wino-like DM	4.1.3
$\hat{X}_{1}^{\dagger}\hat{X}_{1}^{\dagger}\hat{X}_{1}^{\dagger}\hat{X}_{2}^{0} \rightarrow WW/Z\ell\ell\ell\ell\nu\nu$ $\hat{X}_{1}^{\dagger}\hat{X}_{1}^{\dagger}\hat{X}_{2}^{0} \rightarrow WW/Z\ell\ell\ell\ell\nu\nu$ $\hat{\chi}_{2}^{0}, \hat{\chi} \rightarrow qq\hat{\chi}_{1}^{0}, \hat{\chi}_{1}^{0} \rightarrow qqq$	4 e,μ 0 jets E ^{mins} 138 4-5 large jets 36.1	39 $\hat{X}_{\pm}^{\pm} / \hat{X}_{\pm}^{0} = (\lambda_{12} \neq 0, I_{124} \neq 0)$ 0.95 1.55	m(¹)=200 GeV 2103.11684 1.9 Large J [*] ₁ , 1804.05568	1	MSSM, Electroweak DM	Disapp. trk. Disapp. trk.	1 jet 1 jet	DM mass	0.29 (0.3) TeV 0.55 (0.6) TeV	Higgsino-like DM Higgsino-like DM	4.1.3 4.1.3
$i \vec{x}_i, \vec{x} \rightarrow q q q$ $i \vec{x}_i, \vec{t} \rightarrow t \vec{X}_1^0, \vec{X}_1^0 \rightarrow t b s$ $i \vec{x}_i, \vec{t} \rightarrow b \vec{X}_1^1, \vec{X}_1^1 \rightarrow b b s$	Multiple 36. ≥ 46 138	3.1 7 [H ₃₅₀ =2e-4, 1e-2] 0.55 1.05	m(f1)=200 GeV bino-like ATLAS-CONF-2018-003 m(f1)=200 GeV 2010.01015	-	g α MSSM, Electroweak DM ≵ R-hadron, ≵→ggξ ⁴	0	Multiple	2 [r(P) =0.1 - 3 ns]	3.4 TeV	m(x ⁰)=100 GeV	4.1.3
$\vec{\alpha}_{i}$ $\vec{i}_{1}\vec{i}_{1}, \vec{i}_{1} \rightarrow bs$ $\vec{i}_{1}\vec{i}_{1}, \vec{i}_{1} \rightarrow gf$	2 jets + 2 b 36. 2 e. µ 2 b 36.	3.7 ří (eg. ls) 0.42 0.61	BR(r),>tr/bs(l>20% 1710.07171 BR(r),>tr/bs(l>20% 1710.075544		ž R-hadron, ž→gg?	0	Multiple	$\hat{\mathbf{g}} = [\tau(\hat{\mathbf{g}}) = 0.1 - 10 \text{ ns}]$	2.8 TeV	mix p=ree dev	4.2.1
$\tilde{\chi}_1^* / \tilde{\chi}_2^0 / \tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow tbr, \tilde{\chi}_1^+ \rightarrow bbs$	1µ DV 13		BR(Fi→spi)=100%, coni(=1 Pure higgsino 2106.05609		GINS B $\mu \rightarrow \mu \tilde{G}$	displ. µ	-	μ̃	0.2 TeV	er =1000 mm	4.2.2
x1/x2/x1/x12=004/x1=600	tranih zoles in		21000000						1		arXiv:1812.07831
"Only a selection of the available m		10 ⁻¹ 1	Mass scale [TeV]					10 ⁻¹ 1	Mass scale [TeV]		arAiv:1012.07031
phénomena is shown. Many of the simplified models, c.f. refs. for the	e limits are based on assumptions made.										
			2 TeV						2 Tol		
			2 Iev						3 TeV	HL	-LHC YR
										18	12 07831

Numerous searches for exotica

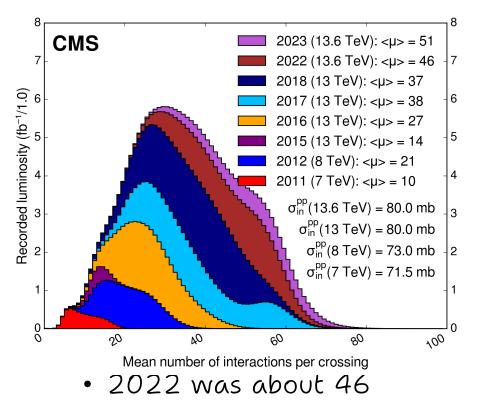
Overview of CMS EXO results



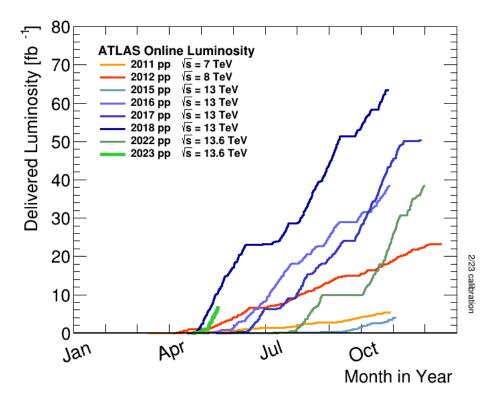


Run 3

Run 3 is underway

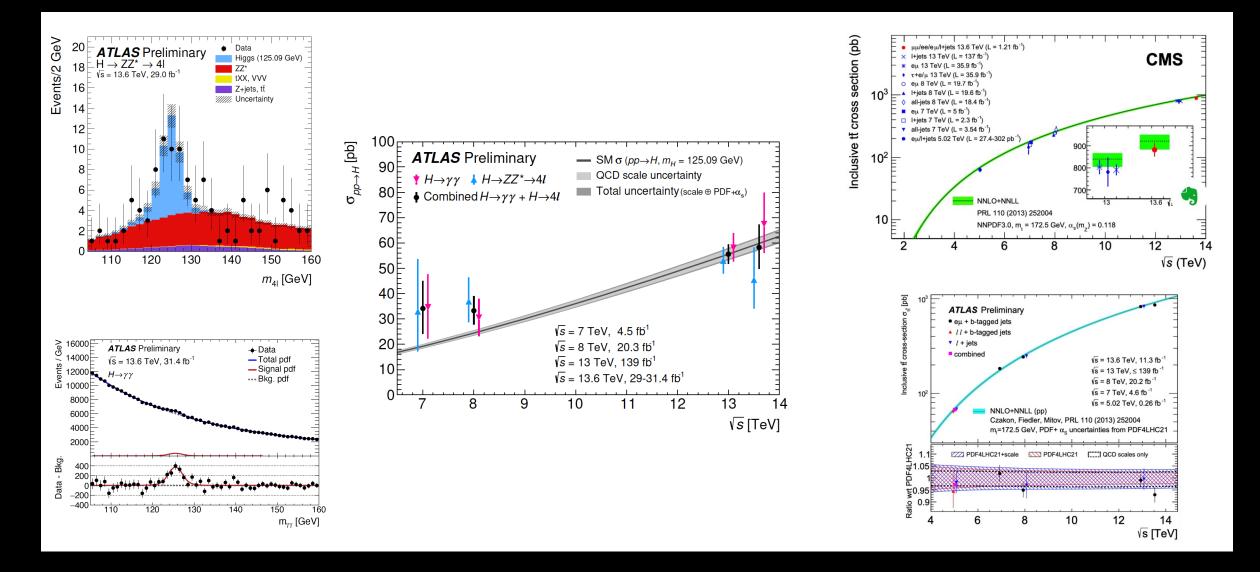


• 2023 is expected to be 60



The slope of delivered luminosity in 2023 is impressively steep, with an early start in the calendar year.

Results from Run 3: physics at 13.6 TeV

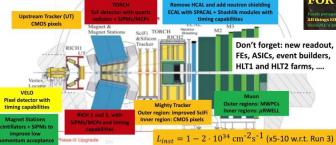


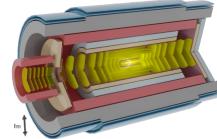
Run 4 and beyond

Detector upgrades for HL-LHC phase

- Upgrades for Run-3 now being commissioned
 - Trigger/rate capability, pre-Run4 upgrades
 - Challenging to commission/exploit for physics
- ATLAS+CMS phase 2 upgrades for Run4
 - New tracking detectors, timing layers, muons
 - CMS HGCal endcap 'digital' calorimeter
 - New state-of the art TDAQ/trigger systems
- LHCb and ALICE intermediate upgrades
 - E.g. RICH electronics; ITS3/FoCal
 - Phase2b upgrades for Run5-6
 - LHCb sub-ps precision timing everywhere, SciFitracker, SiPM-based RICH
 - ALICE3 with superconducting solenoid and all-silicon tracker
- Effort/cost like building new experiments ...
 - Ambitious programme for next decade(s)







Conclusions

- Somehow incomplete list of results from the past 6 months from CMS and ATLAS
 - Leaving flavour out (and LHCb! as explained)
 - Heavy ions results some of our community working in this area
- Increasing the precision of SM parameters and studies, deepening our understanding of the SM
 - Reaching new processes and decays
- New ideas and methods are improving are sharpening the exploration of SM and BM
 - Expanding the phase space
 - Improving uncertainties
- An exciting and intense few years ahead
 - Still lots to do with Run 2
 - Run 3 is her
 - Upgrades for Run 4 in progress