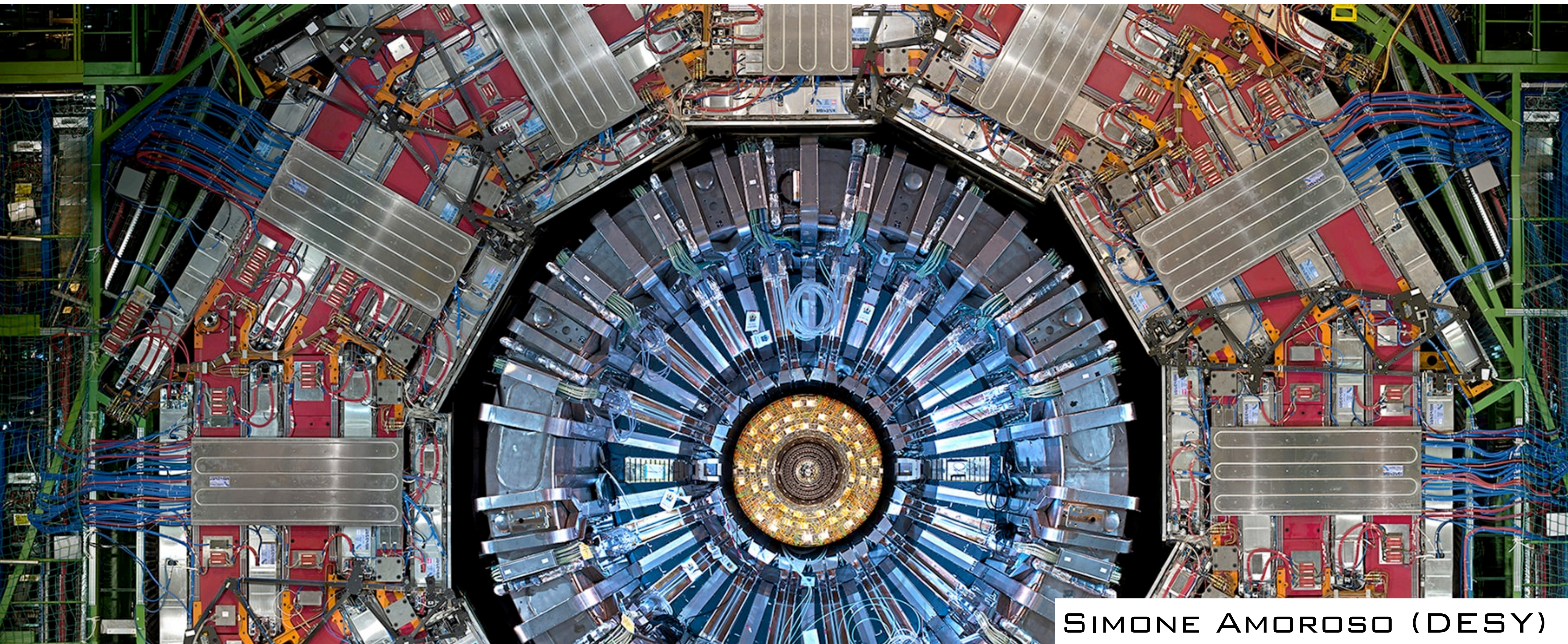
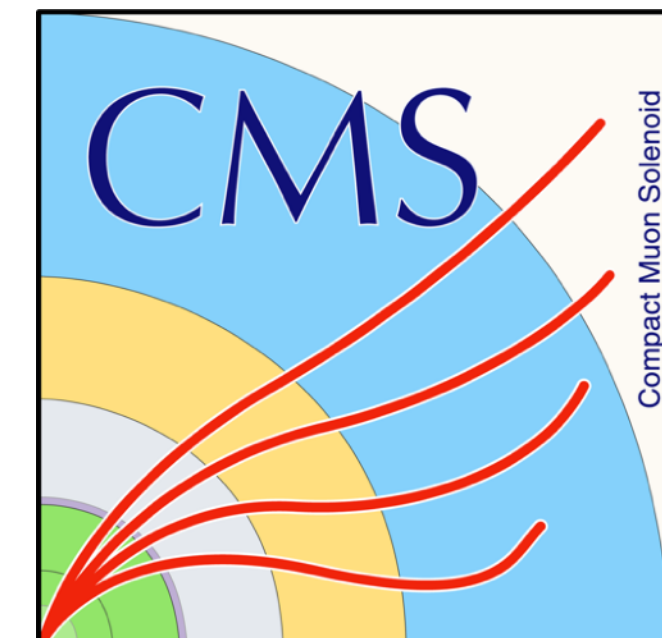




FROM THE PRECISION FRONTIER TO PHYSICS BEYOND THE STANDARD MODEL

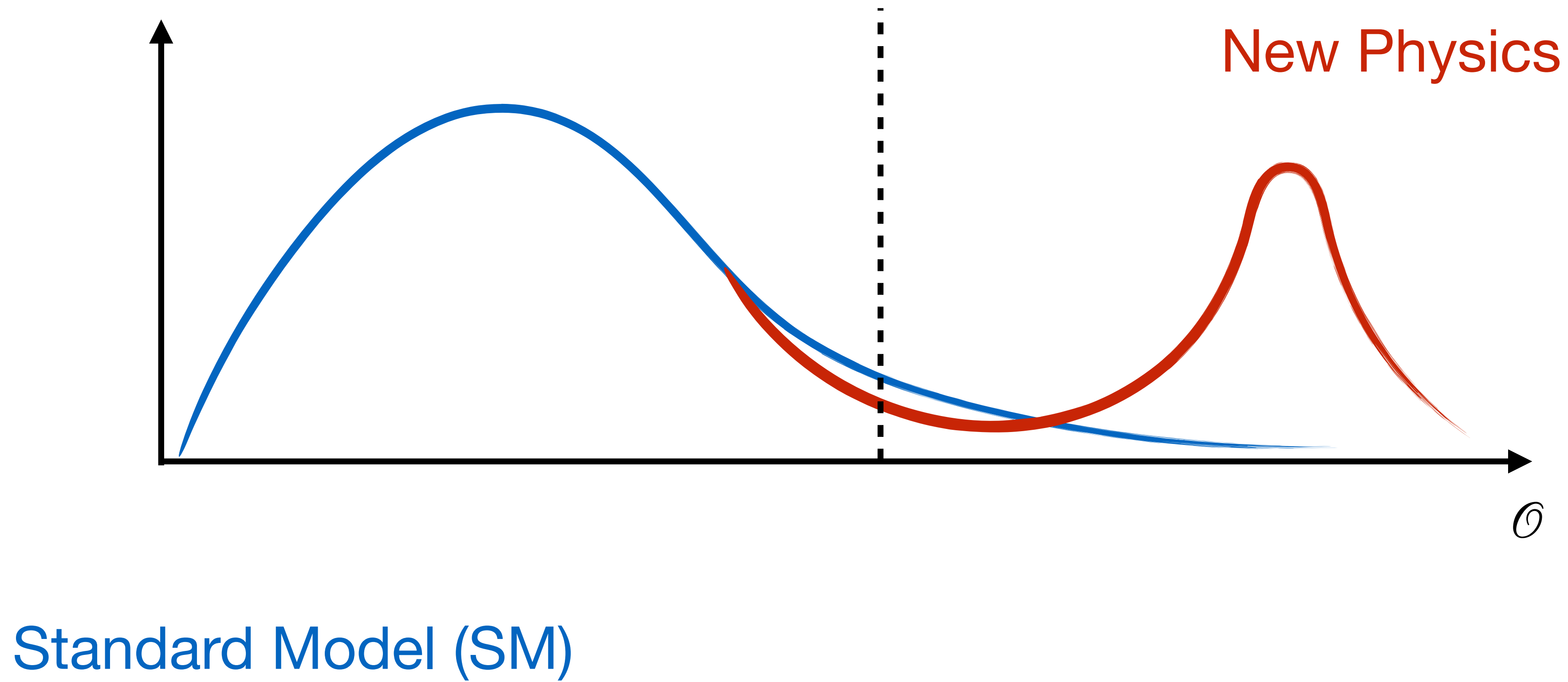
MU DAYS 2022

OCT. 21ST, 2022



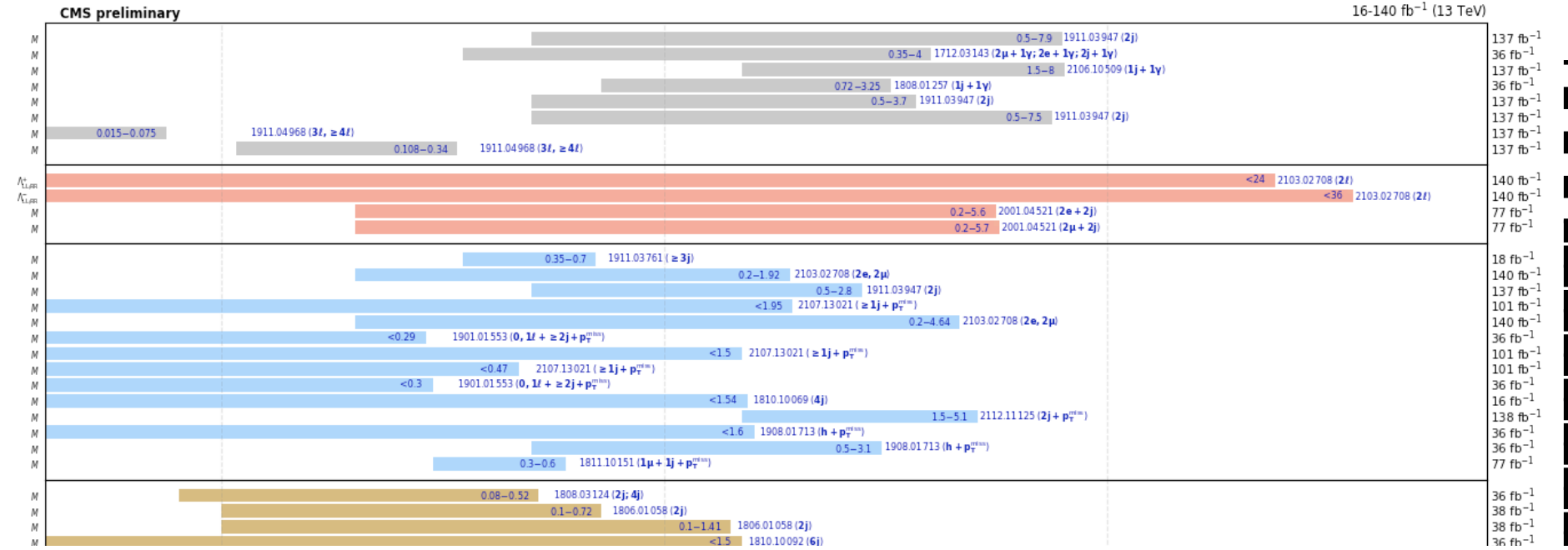
SIMONE AMOROSO (DESY)

PHYSICS AT THE LARGE HADRON COLLIDER



A DEDICATED SEARCH PROGRAM

Overview of CMS EXO results



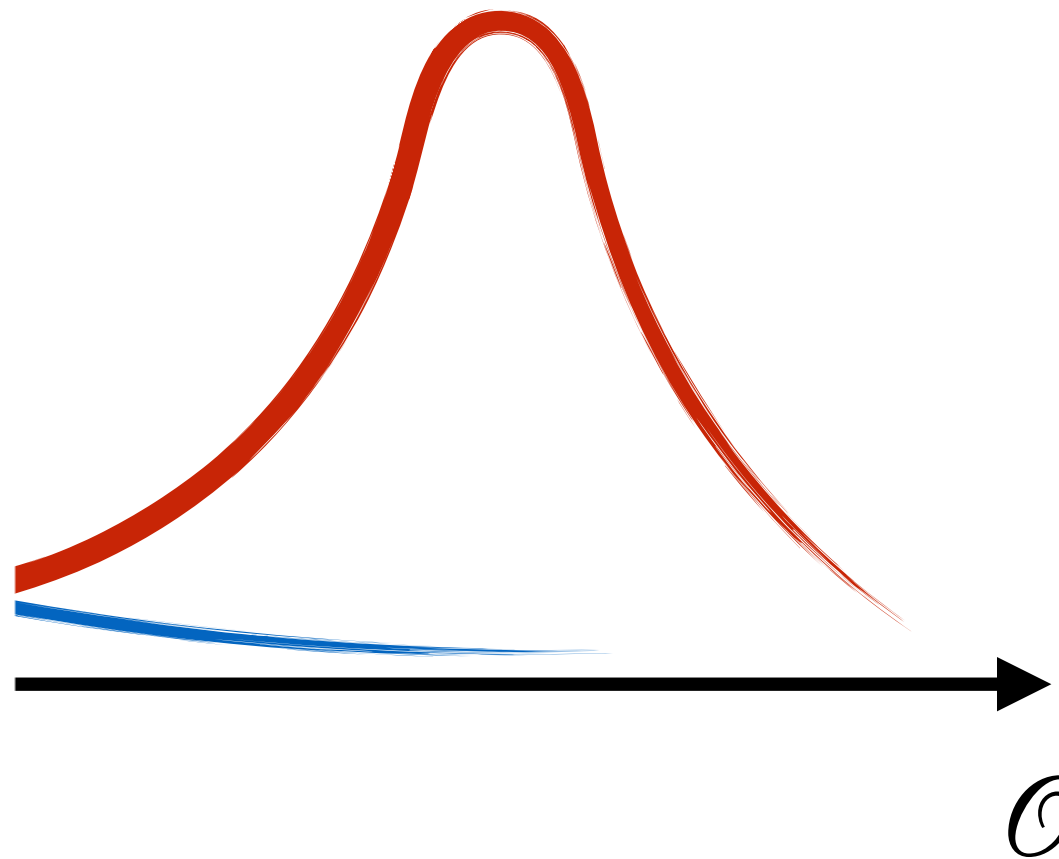
ATLAS SUSY Searches* - 95% CL Lower Limits
March 2022

Model	Signature	$\int \mathcal{L} dt$ [fb $^{-1}$]	Mass limit	Reference
Inclusive Searches	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{\chi}_1^0$	0 e, μ	2-6 jets	E_T^{miss} 139
	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0 e, μ	1-3 jets	E_T^{miss} 139
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	0 e, μ	2-6 jets	E_T^{miss} 139
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}W\tilde{\chi}_1^0$	1 e, μ	2-6 jets	E_T^{miss} 139
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}t\tilde{\chi}_1^0$	0 e, μ	7-11 jets	E_T^{miss} 139
3 rd gen. squarks direct production	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$	0 e, μ	2 b	E_T^{miss} 139
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$	0 e, μ	2 b	E_T^{miss} 139
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$	0 e, μ	2 b	E_T^{miss} 139
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$	0 e, μ	2 b	E_T^{miss} 139
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{\chi}_1^0$	0 e, μ	2 b	E_T^{miss} 139
EW direct	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	Multiple ℓ/jets	≥ 1 jet	E_T^{miss} 139
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WW	Multiple ℓ/jets	≥ 1 jet	E_T^{miss} 139
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	Multiple ℓ/jets	≥ 1 jet	E_T^{miss} 139
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	Multiple ℓ/jets	≥ 1 jet	E_T^{miss} 139
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	Multiple ℓ/jets	≥ 1 jet	E_T^{miss} 139
Long-lived particles	Direct $\tilde{\chi}_1^0\tilde{\chi}_1^0$ prod., long-lived $\tilde{\chi}_1^0$	Disapp. trk	1 jet	E_T^{miss} 139
	Stable \tilde{g} R-hadron	pixel dE/dx		E_T^{miss} 139
	Metastable \tilde{g} R-hadron, $\tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0$	pixel dE/dx		E_T^{miss} 139
	$\tilde{t}\tilde{t}, \tilde{t} \rightarrow t\tilde{G}$	Displ. lep		E_T^{miss} 139
	$\tilde{t}\tilde{t}, \tilde{t} \rightarrow t\tilde{G}$	pixel dE/dx		E_T^{miss} 139
RPV	$\tilde{\chi}_1^0\tilde{\chi}_1^0/\tilde{\chi}_1^0\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow \ell\ell\ell$	3 e, μ	0 jets	E_T^{miss} 139
	$\tilde{\chi}_1^0\tilde{\chi}_1^0/\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow WWZZ\ell\ell\nu\nu$	4 e, μ	0 jets	E_T^{miss} 139
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow q\tilde{q}q$	Multiple	$\geq 4b$	36.1
	$\tilde{t}\tilde{t}, \tilde{t} \rightarrow t\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow tbs$	Multiple	$\geq 4b$	36.1
	$\tilde{t}\tilde{t}, \tilde{t} \rightarrow t\tilde{\chi}_1^0, \tilde{\chi}_1^0 \rightarrow bbs$	Multiple	$\geq 4b$	36.1

*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.

1 TeV

ATLAS Preliminary
 $\sqrt{s} = 13$ TeV



► Extensive (~1000 results)

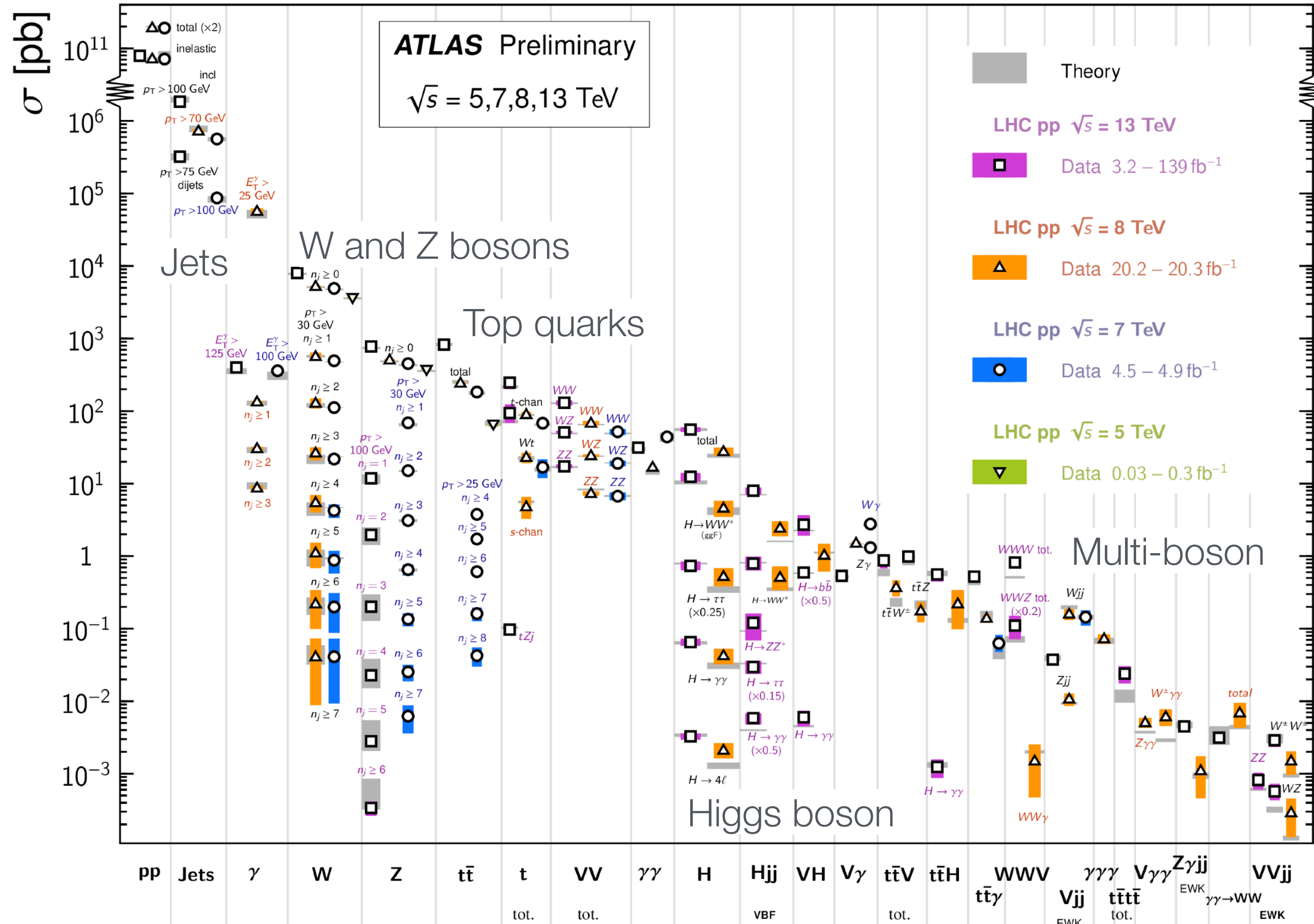
► Signature/model driven

► Fast → detector level

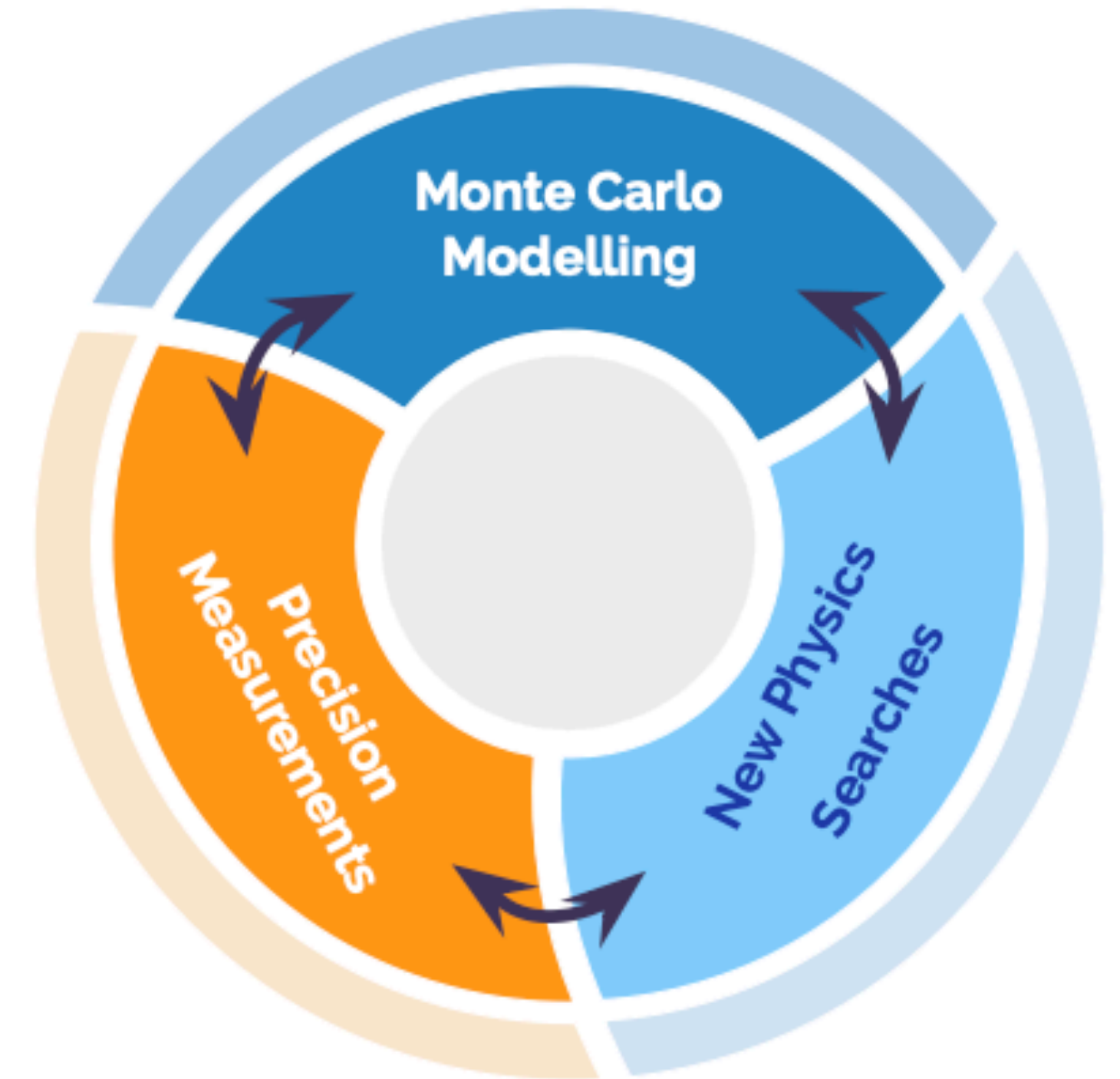
HOW DO STANDARD MODEL MEASUREMENTS DIFFER ?

Standard Model Production Cross Section Measurements

Status: February 2022



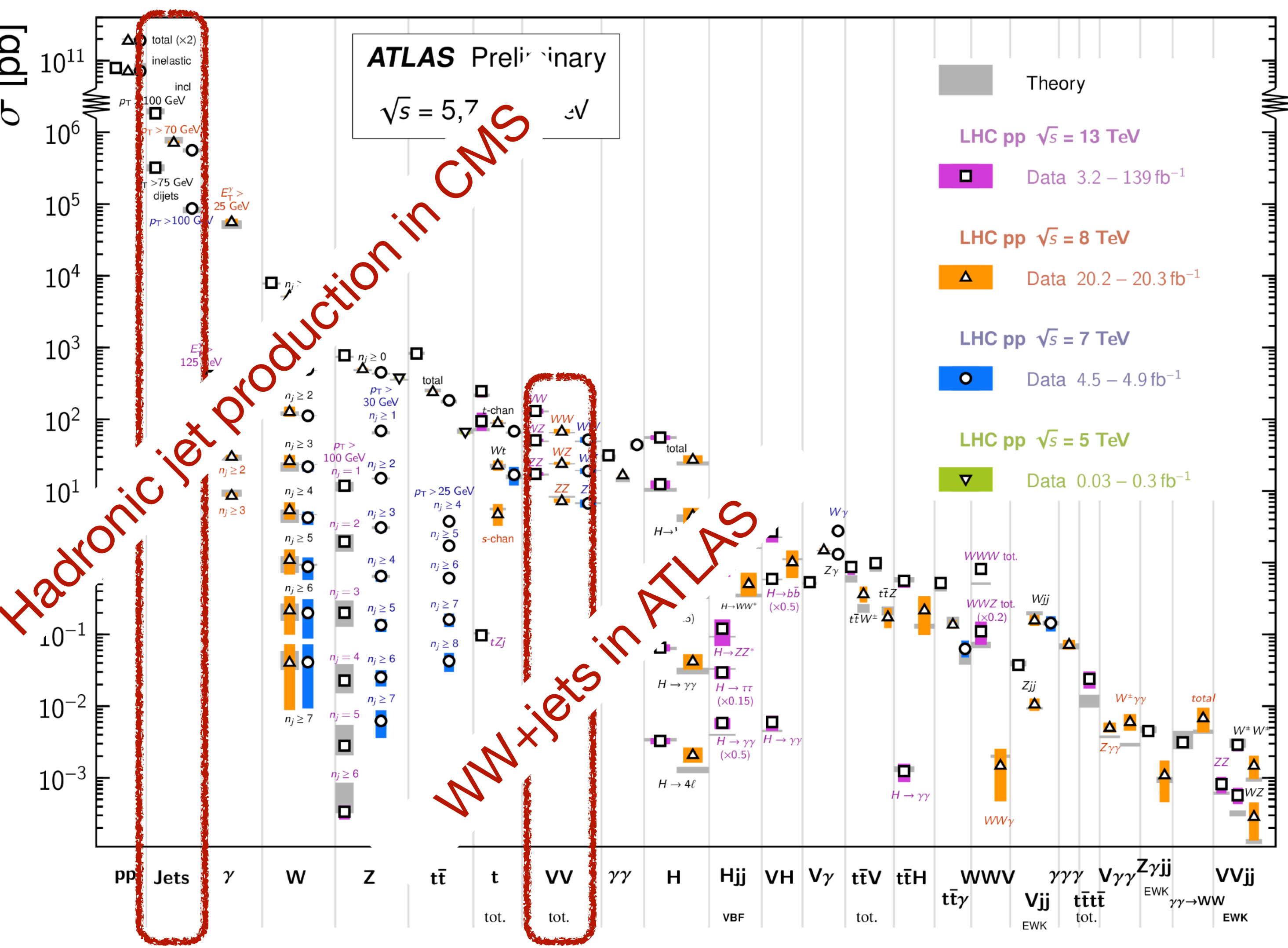
- ▶ SM process driven
- ▶ Detector-corrected
- ▶ Focus on precision/longevity



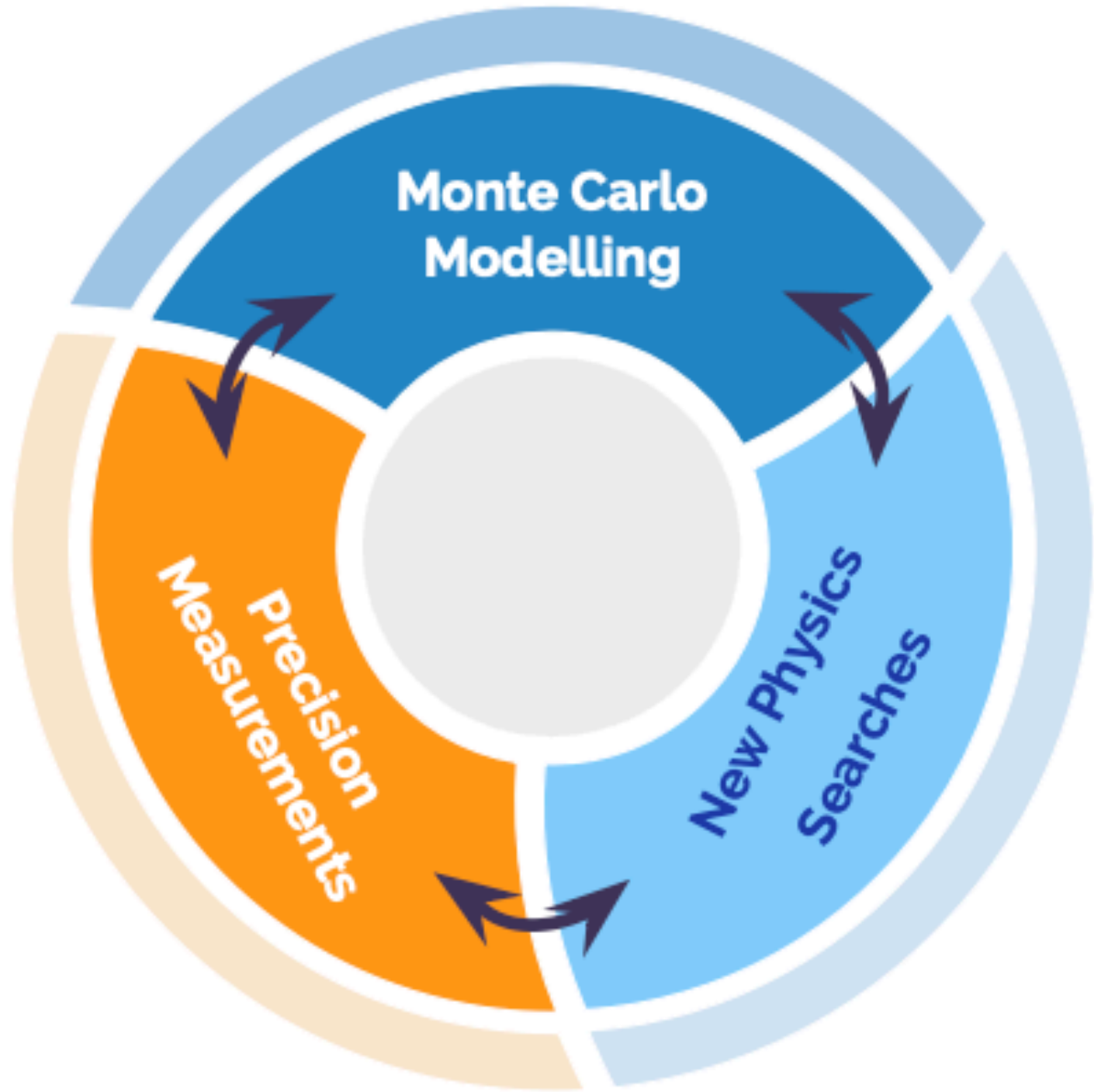
HOW DO STANDARD MODEL MEASUREMENTS DIFFER ?

Standard Model Production Cross Section Measurements

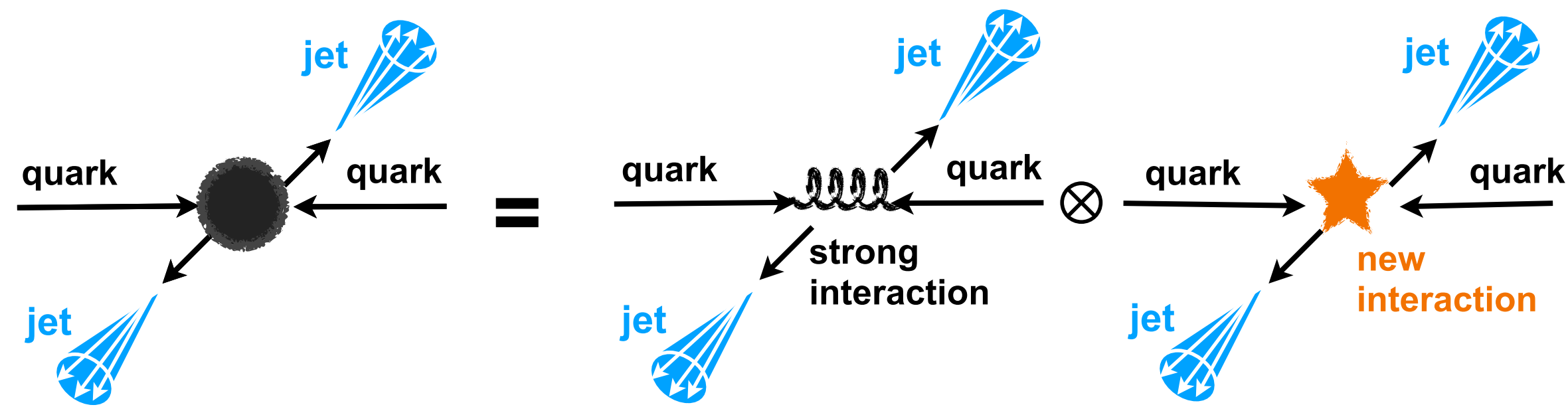
Status: February 2022



- ▶ SM process driven
- ▶ Detector-corrected
- ▶ Focus on precision/longevity



HADRONIC JETS AS PROBE OF THE STRONG FORCE



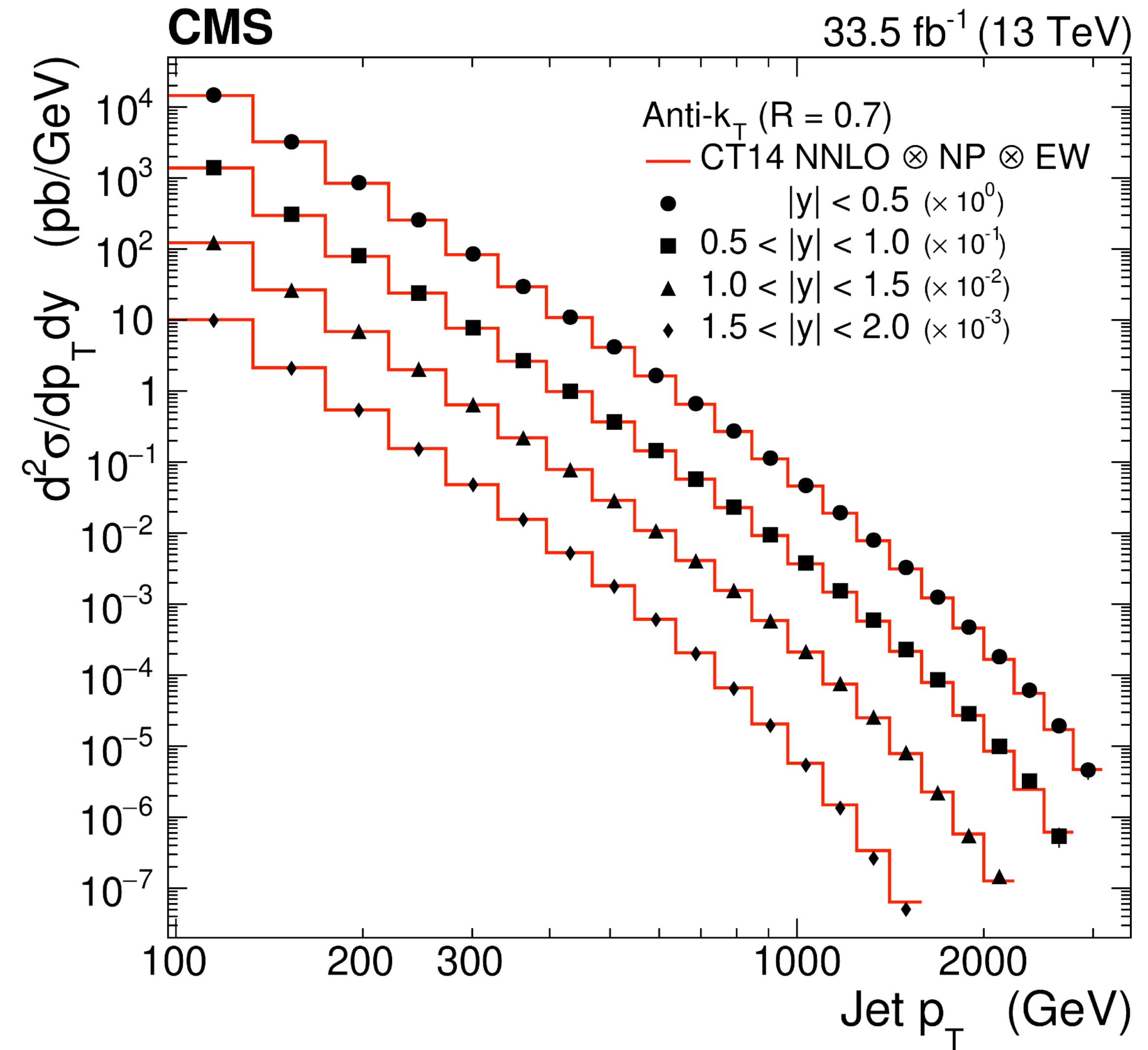
- * Test of the strong force at the highest collision energies
- Sensitive to the proton structure (PDFs)
- Extract strong coupling $\alpha_s(m_Z)$, least well known fundamental constant

$$\alpha_s(m_Z) = 0.1170 \pm 0.0017$$

Most precise $\alpha_s(m_Z)$ from collider experiment

- * Probe physics beyond the SM (i.e. contact-interactions)

- For vector-like couplings new physics scale $\Lambda > 32 \text{ TeV}$

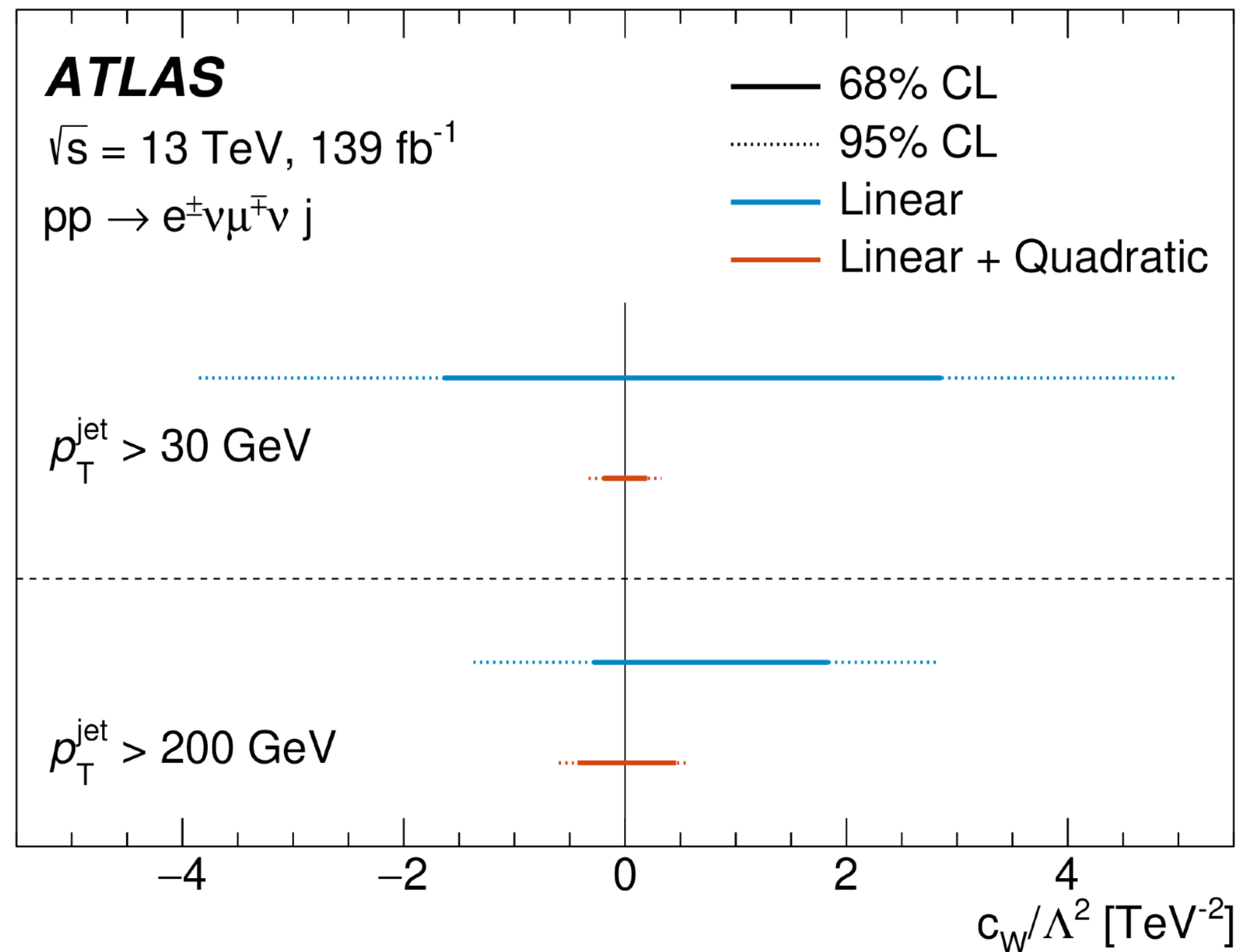


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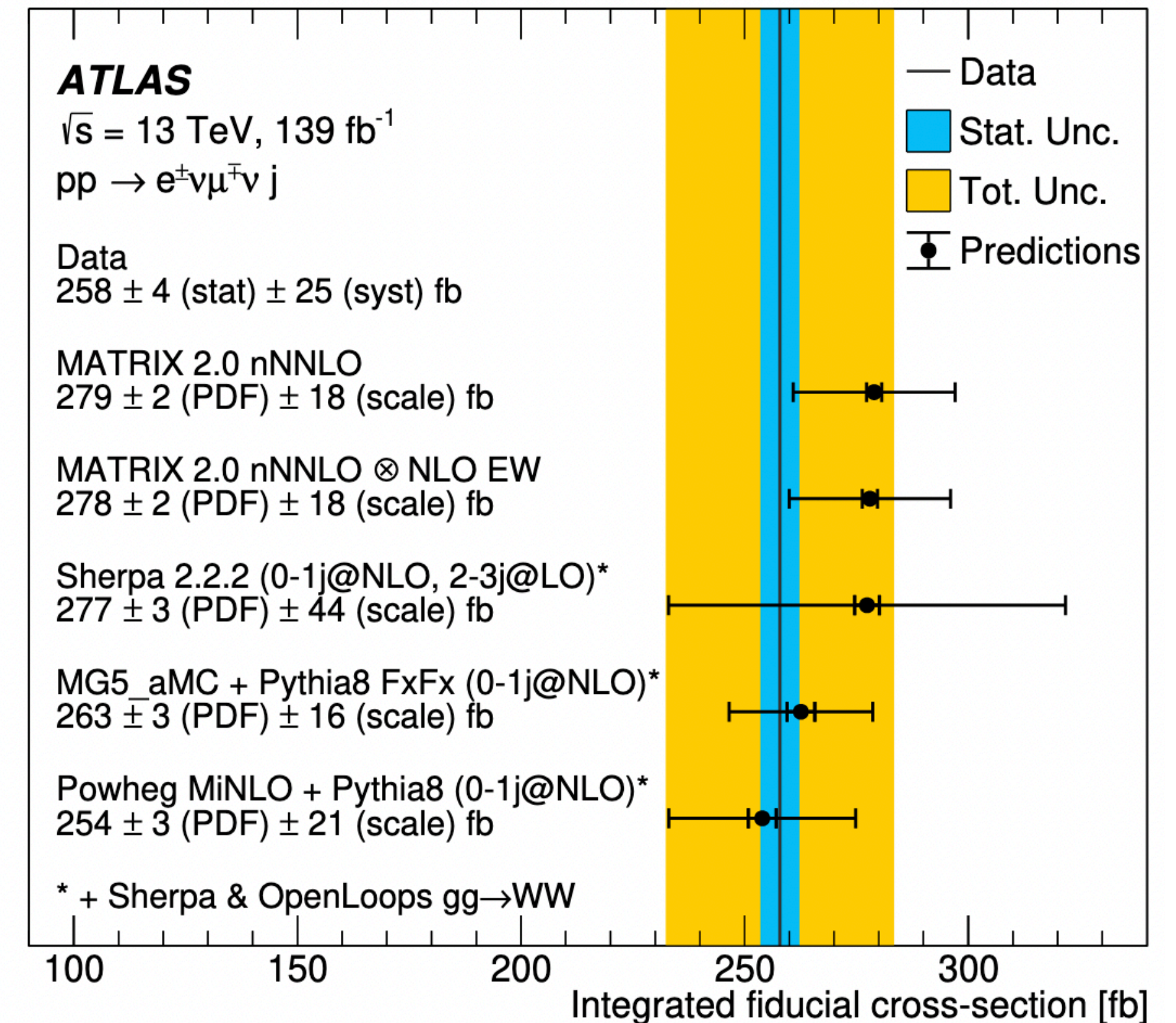
ELECTROWEAK INTERACTIONS IN $WW+JETS$

* ATLAS precise measurement of $pp \rightarrow e^\pm \nu \mu^\pm \nu j$

► Sensitive to electroweak boson self-interactions and higher orders in the strong coupling



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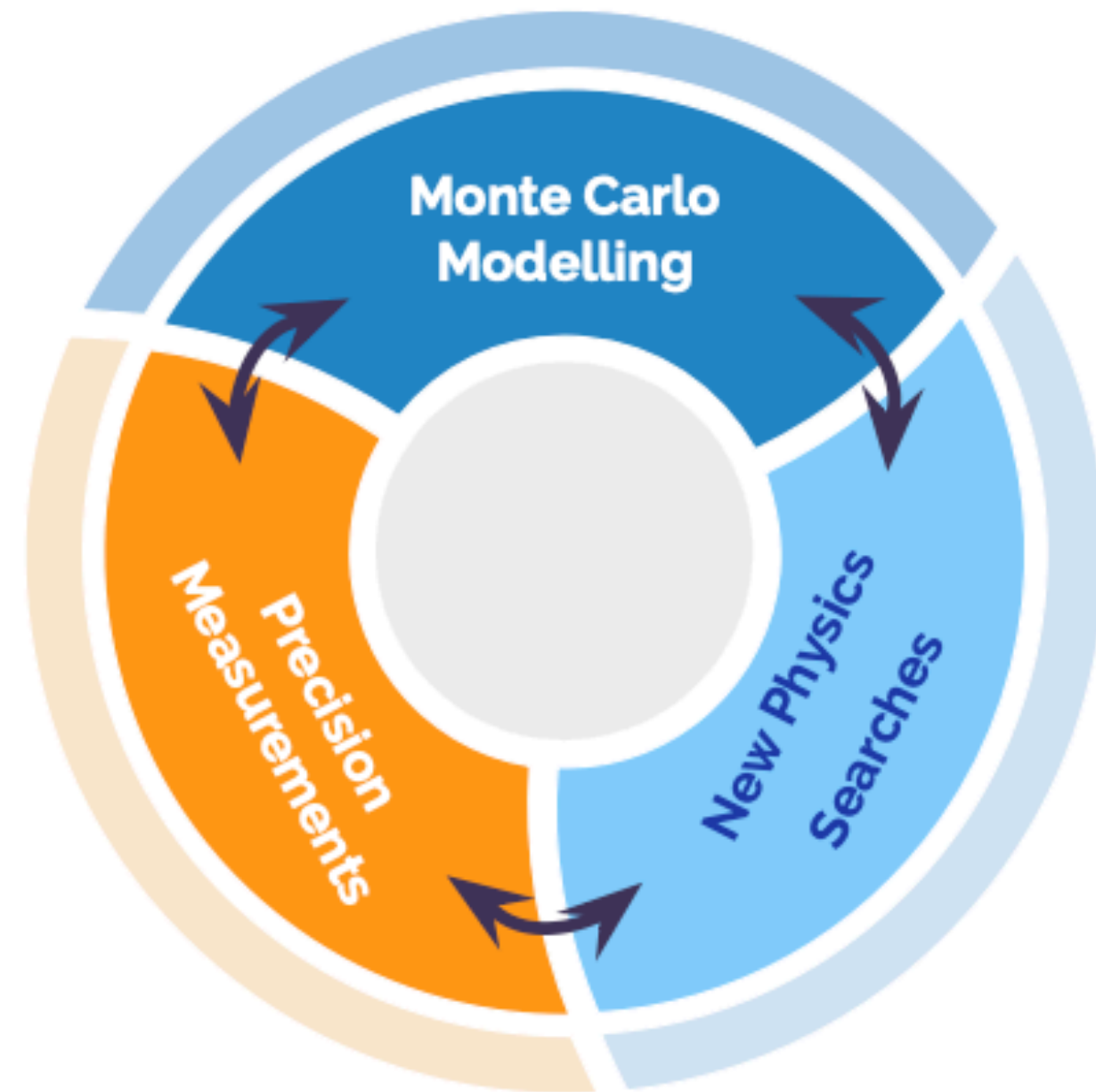


► Compared to state-of-the-art theoretical predictions

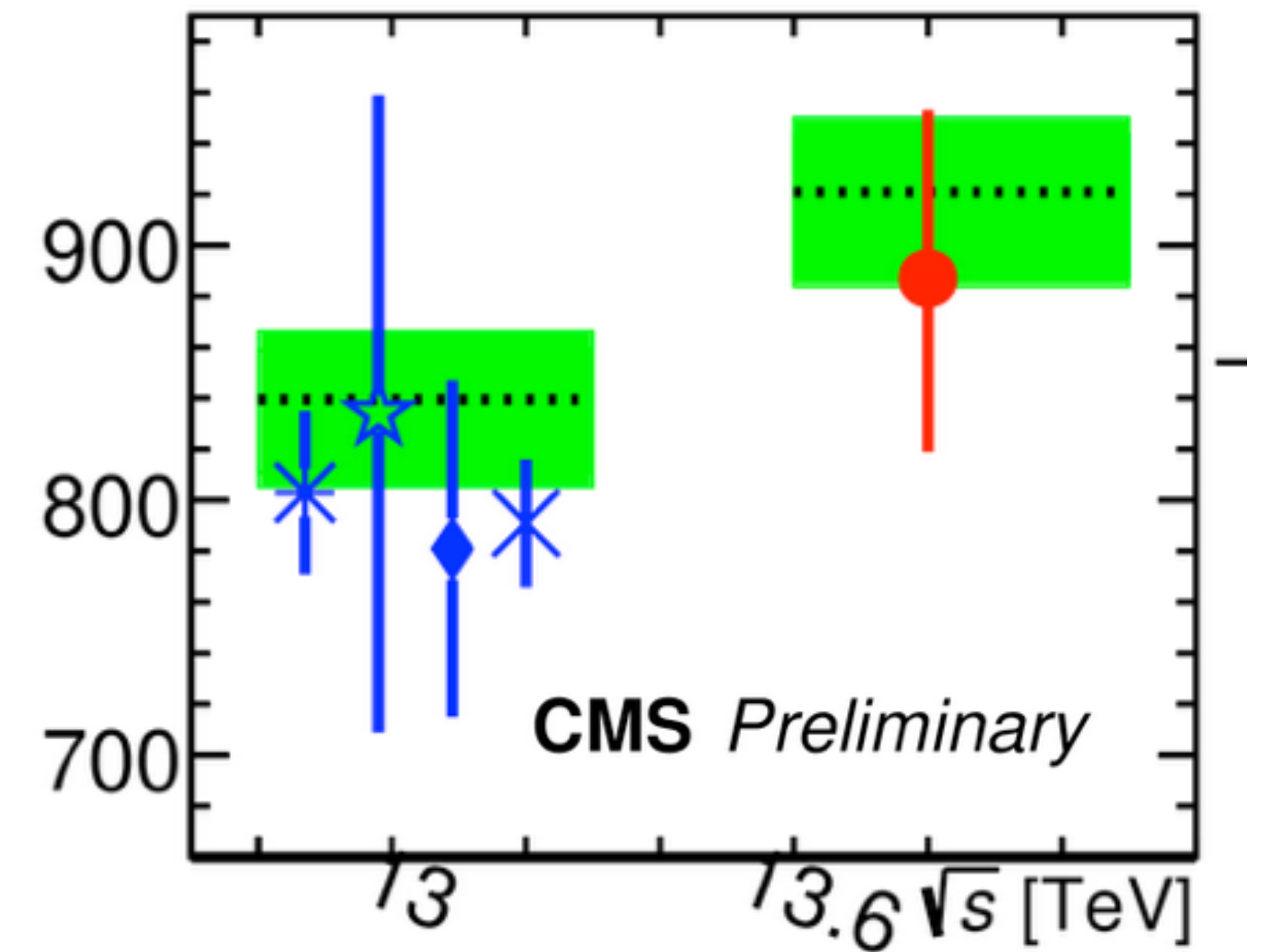
► Differential distributions constrain anomalous couplings

SUMMARY

- * We have only scraped the surface of the potential of the LHC data



- * SM measurements constraint BSM physics beyond the LHC direct reach



- * Only touched upon two 13 TeV results, but Run3 data is already with us

CMS-TOP-22-012