TOP-ANTITOP CHARGE ASYMMETRY MEASUREMENTS IN THE DILEPTON CHANNEL WITH THE ATLAS DETECTOR

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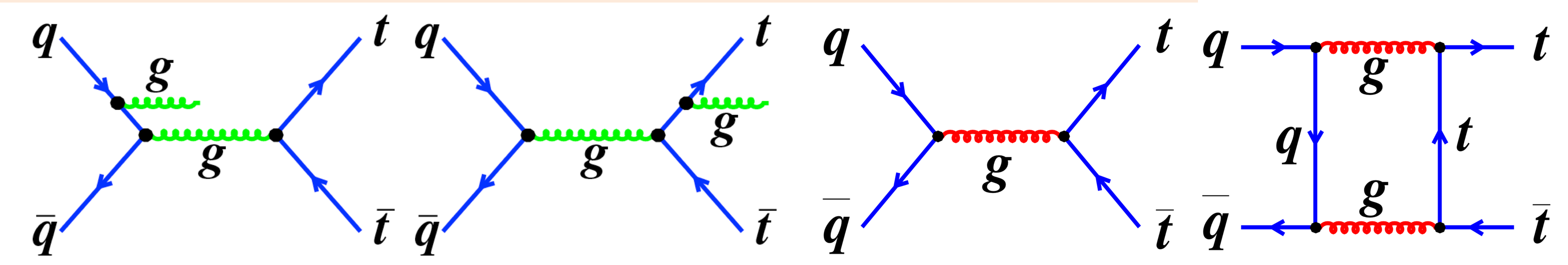
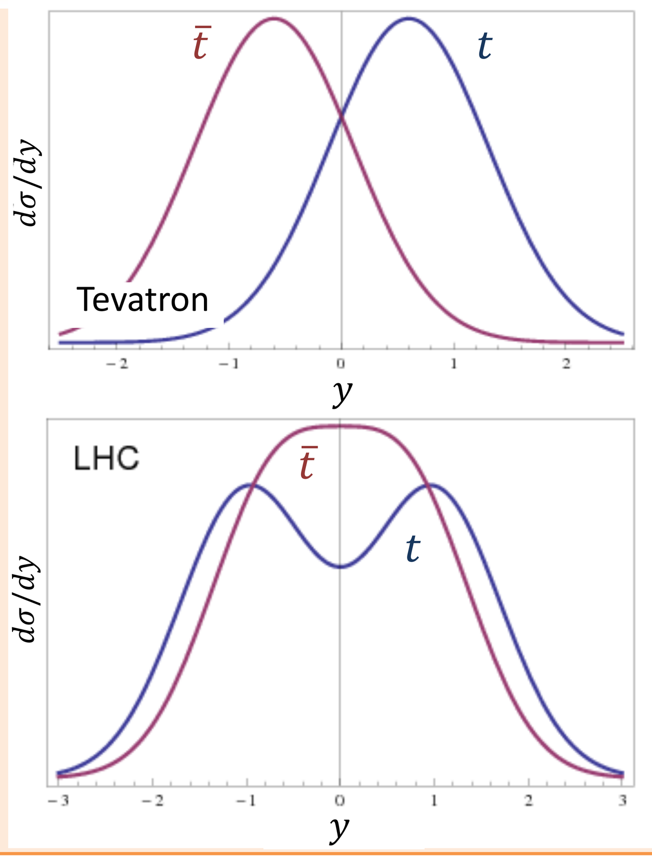
Top-antitop charge asymmetry

- Top-antitop charge asymmetry
  - Predicted asymmetry in Standard Model (SM) : interference between ISR/FSR, Box/Born diagrams
  - Enhanced asymmetry in various Beyond SM (BSM) physics
- Top-antitop charge asymmetry@LHC (A_C)
  - Yields small difference in the rapidity distributions of $t\bar{t}$
  - Asymmetry can be weakened due to higher center-of-mass energy
  - In the dilepton channel, leptonic charge asymmetry can be measured

$$A_C^{t\bar{t}} = \frac{N(\Delta|y|>0) - N(\Delta|y|<0)}{N(\Delta|y|>0) + N(\Delta|y|<0)}$$
$$\Delta|y| = |y(t)| - |y(\bar{t})|$$
$$A_C^{\ell\ell} = \frac{N(\Delta|\eta|>0) - N(\Delta|\eta|<0)}{N(\Delta|\eta|>0) + N(\Delta|\eta|<0)}$$
$$\Delta|\eta| = |\eta_{\ell^+}| - |\eta_{\ell^-}|$$





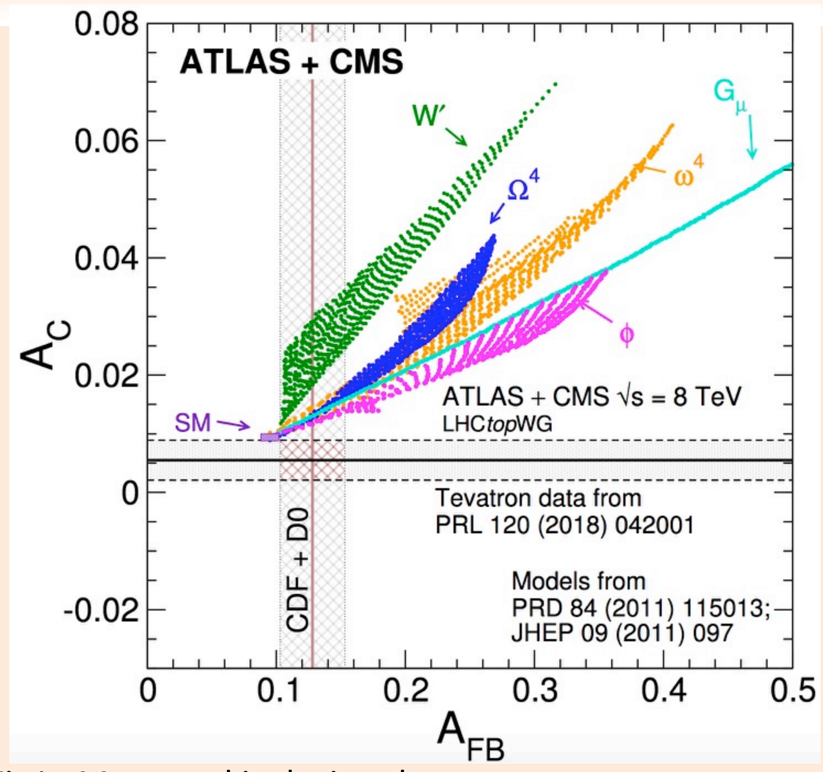
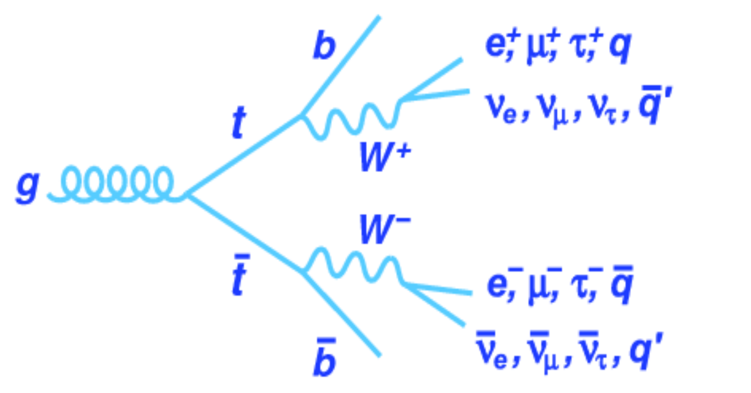


Fig1 : Measured inclusive charge asymmetry at the LHC@8 TeV vs. at the Tevatron@1.96 TeV [1].

Dilepton Selection

- Event selection (eμ, ee/μμ channel)

Requirements	$ee/\mu\mu$	$e\mu$
Leptons	2	2
Jets	≥2	≥2
$m_{\ell\ell}$	>15 GeV	>15 GeV
$\lvert m_{\ell\ell} - m_Z\rvert$	>10 GeV	
E_T^{miss}	>30 GeV	
b-tagged jets	≥1	
H_T		>130 GeV



  - Clean signature (excellent S/B ratio)
- Background estimation
  - Background free (eμ channel)
  - Z bosons with heavy-flavor jet (ee/μμ channel)

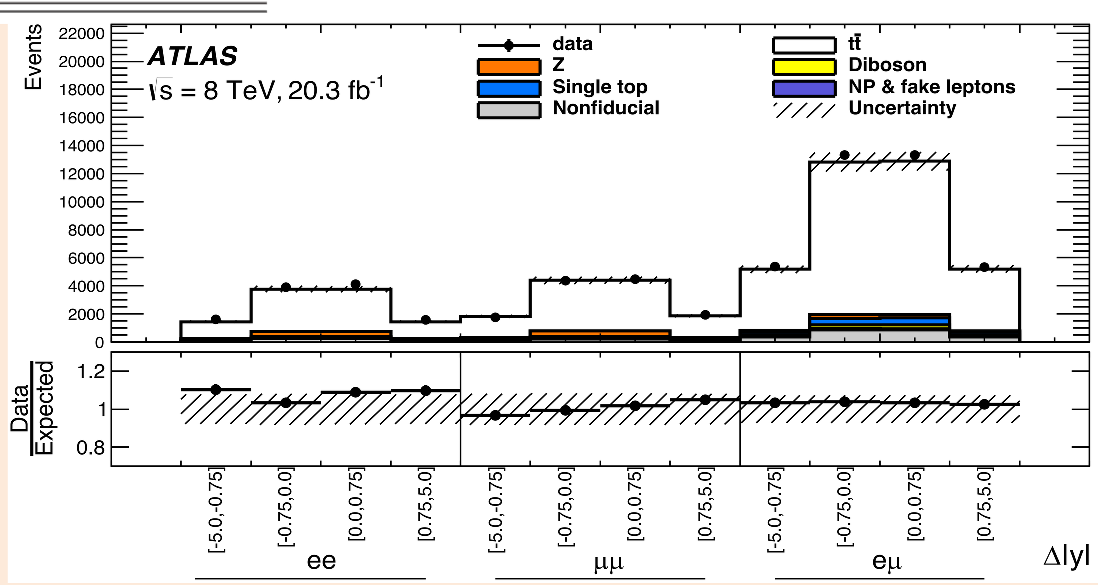


Fig2 : Input distributions for the inclusive $t\bar{t}$ asymmetry measurements [2].

- Reconstruction method
  - KINematic (KIN) method[2] is used for the reconstruction of top and antitop four-momenta
- Unfold to parton and particle level
  - Corrected for detector resolution and acceptance effects
  - Using the Fully Bayesian Unfolding (FBU)[3]
  - Migration matrix is obtained from the $t\bar{t}$ MC simulated sample

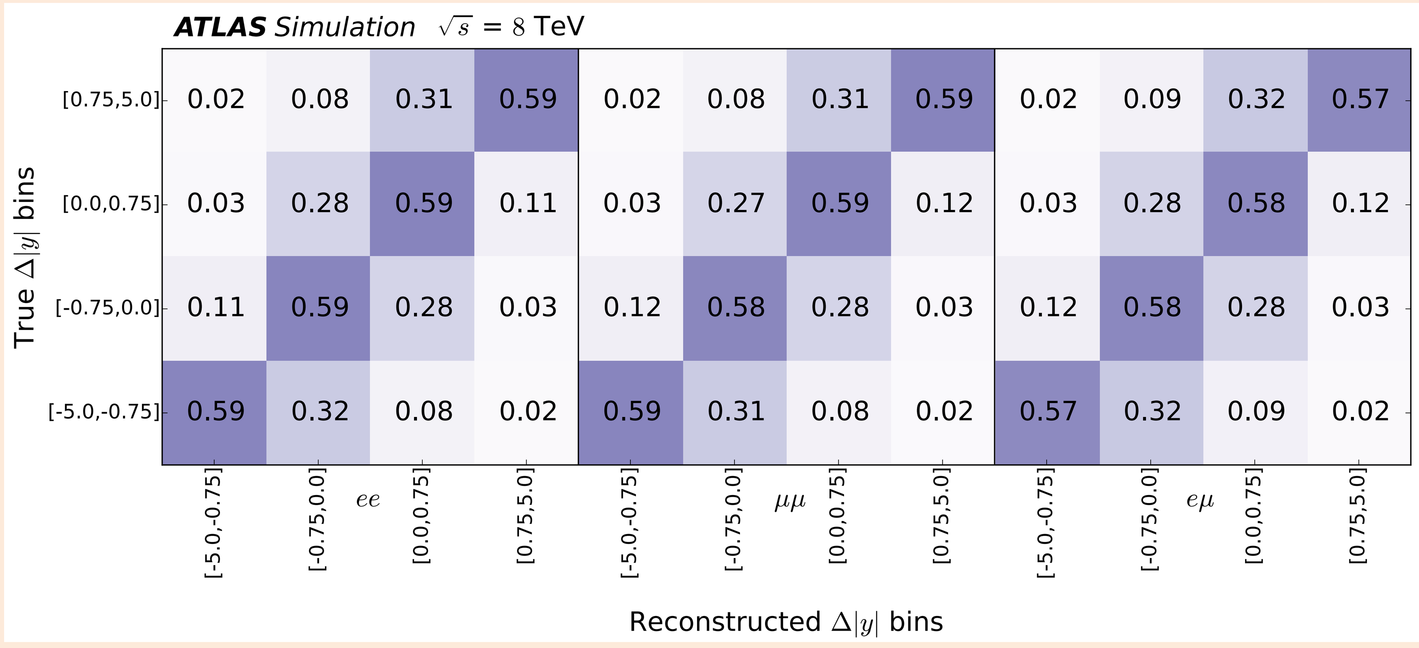


Fig3 : Rectangular migration matrix for the $\Delta|y|$ observable in the fiducial volume [2].

Uncertainties

Table1 : Absolute uncertainties from the different sources affecting $t\bar{t}$ asymmetry in the full phase space [2].

		Statistics	Detector	Bkg	Signal modeling	Other
	Inclusive	0.011	0.006	< 0.001	0.008	0.006
$m_{t\bar{t}}$	0–500 GeV	0.028	0.021	0.002	0.018	0.020
	500–2000 GeV	0.015	0.006	< 0.001	0.016	0.008
$\beta_{t\bar{t}}$	0–0.6	0.023	0.019	0.002	0.015	0.017
	0.6–1.0	0.018	0.009	0.001	0.013	0.010
$p_T^{t\bar{t}}$	0–30 GeV	0.031	0.015	0.004	0.019	0.017
	30–1000 GeV	0.025	0.013	0.003	0.014	0.015

- Four classes of systematic uncertainties:
  - Detector modeling uncertainties (The largest systematic effect is related to jet energy scale)
  - Background- related uncertainties
  - Signal modeling uncertainties (The largest systematic effect is related to MC generator)
  - Other uncertainties (Unfolding bias and MC statistical uncertainty)
- In the dilepton channel, uncertainties on both measurements are statistically dominated

Results

- Measurements of both asymmetries

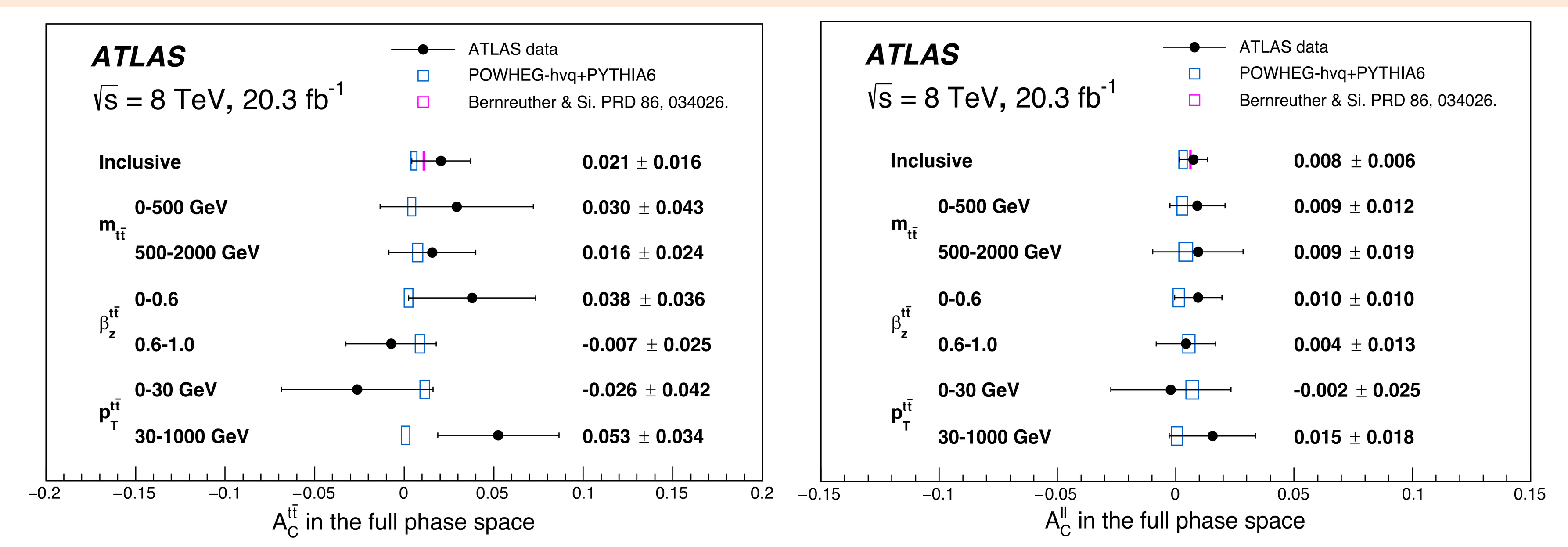


Fig4 : Summary of all the measurements for the $t\bar{t}$ (left) and leptonic (right) charge asymmetry in the full phase space [2].

- Comparison of the inclusive $A_C^{\ell\ell}$ and $A_C^{t\bar{t}}$ measurement values in the full phase space to two benchmark BSM models[5]

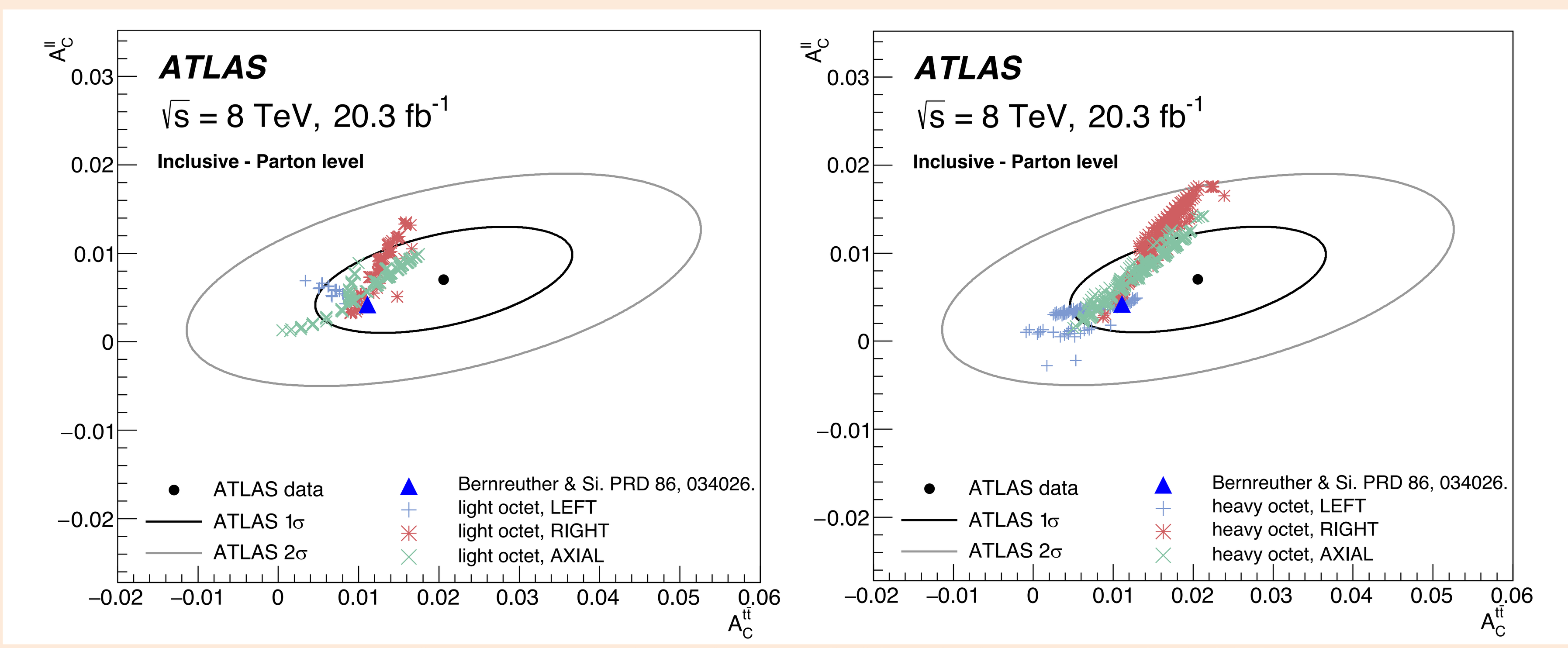


Fig5 : Comparison of asymmetry with a light octet (left) and a heavy octet (right) [2].

- The measurements are compatible with SM and do not exclude the two sets of BSM models

Outlook@13TeV

- Owing to higher center-of-mass energy, the A_C measurement is sensitive to the higher mass of $t\bar{t}$ system
  → A BSM search at the heavier mass of $t\bar{t}$ system is possible
- In effective field theory, the BSM contribution can be described through Wilson coefficients C_1 and C_2 [6]

$$(O_i - O_i^{SM}) = AC_i\left(\frac{1\ \text{TeV}}{\Lambda}\right)^2 + A'C_i^2\left(\frac{1\ \text{TeV}}{\Lambda}\right)^4$$

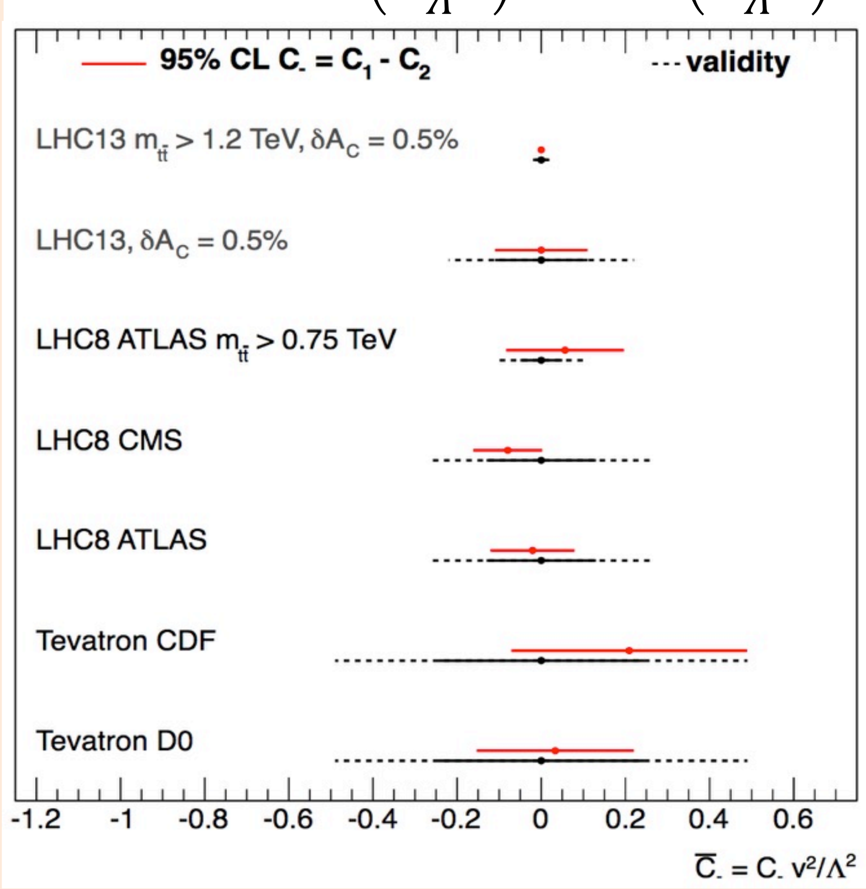


Fig6 : The 95% C.L. limits on the linear combination of four-fermion operators C_i extracted from A_C measurements at hadron colliders [6].

- The limits on C_i can be recast into limits on the mass of axigluon [7]
- The axigluon contributes to positive charge asymmetry
- Many interesting possibilities with 13 TeV dataset

Reference: [1] The ATLAS and CMS Collaborations, HEP 1804 (2018) 033
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