Measurement of CP-violating *Wtb* couplings using EFT in single top *t*-channel production with CMS Run 2 data

Top LHC France
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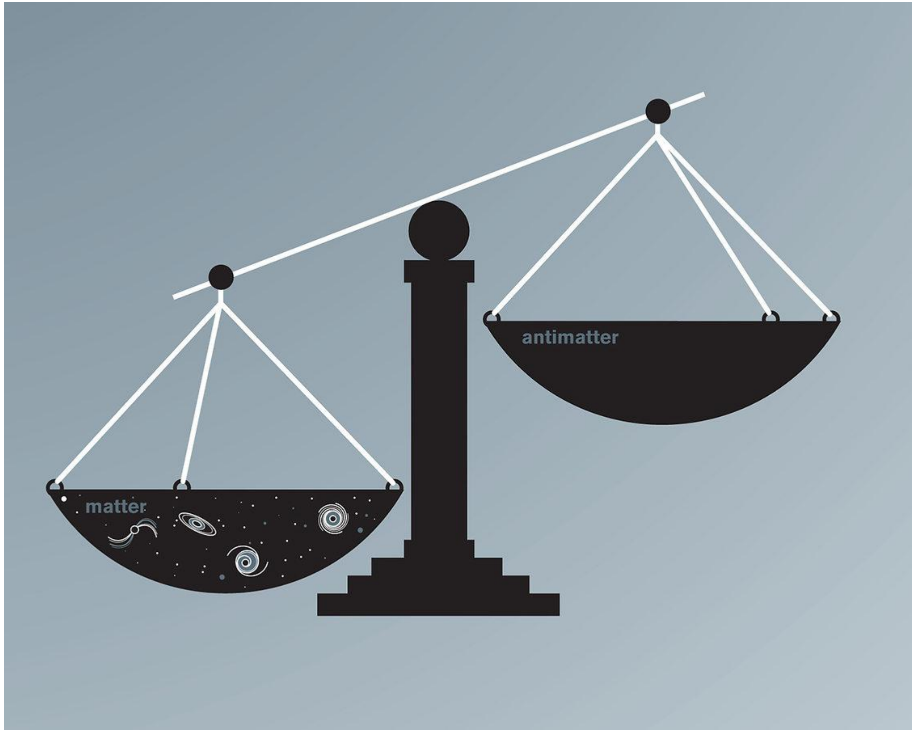
Motivation : Matter-antimatter asymmetry

Asymmetry of the baryon-number in the Universe

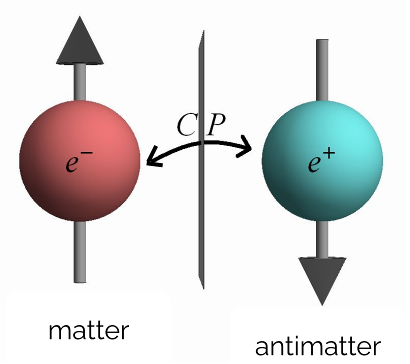


SM predictions : $\eta_{SM} = \frac{n_B - n_{\bar{B}}}{n_\gamma} \propto 10^{-20}$

Observations : $\eta_{obs} = \frac{n_B - n_{\bar{B}}}{n_\gamma} \propto 10^{-10}$

$$\boxed{\Rightarrow \frac{\eta_{SM}}{\eta_{obs}} \propto 10^{-10}}$$

Discrepancy between the SM prediction and observations



C : Charge conjugation Q ⟶ -Q

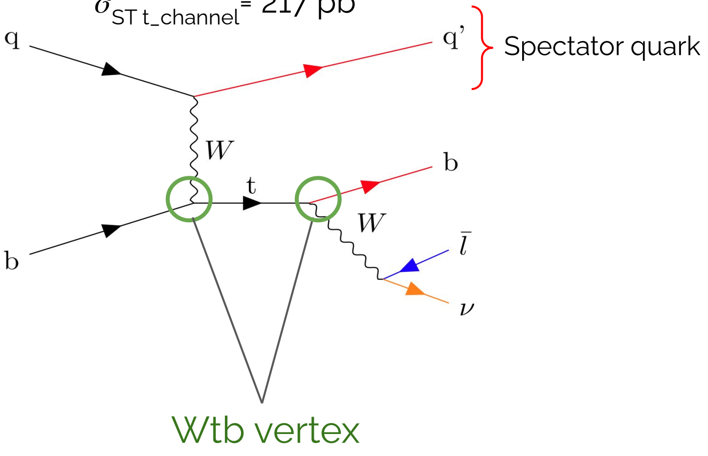
P : Parity transformation $\vec{r} \longrightarrow -\vec{r}$

This asymmetry can be explained by the existence of new sources of CP violation during baryogenesis.

Goal of the analysis

Measure CP violation through the t-channel production of single-top quarks and their subsequent decay to Wb. *This process has the advantage of involving the Wtb vertex in production and decay*

$\sigma_{\text{ST t\_channel}}$ = 217 pb



Analysis performed in the context of Effective Field Theory

$$\mathscr{L}_{eff}^{(6)} = \mathscr{L}_{SM} + \sum_i \frac{C_i^{(6)}}{\Lambda_i^2} O_i^{(6)} + h.c.$$

Non-Hermitian Operators involving two quarks and a boson	Wilson Coefficients
$O_{uW}^{(6)} = (\bar{q}\sigma^{\mu\nu}\tau^I t)\tilde{\varphi}W_{\mu\nu}^I$	$c_{tW} + ic_{tW}^I$
$O_{dW}^{(6)} = (\bar{q}\sigma^{\mu\nu}\tau^I b)\varphi W_{\mu\nu}^I$	$c_{bW} + ic_{bW}^I$
$O_{\varphi ud}^{(6)} = (\tilde{\varphi}^\dagger iD_\mu\varphi)(\bar{u}\gamma^\mu d)$	$c_{\varphi tb} + ic_{\varphi tb}^I$

CP violation if

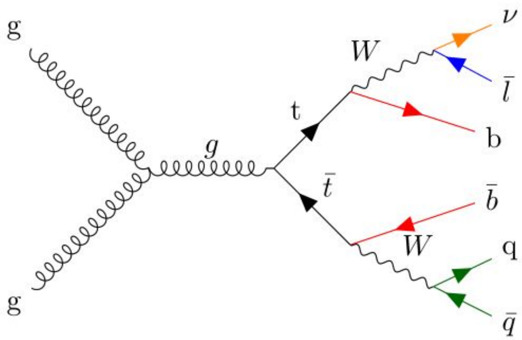
$c^i_{tW} \neq 0$, $c^i_{bW} \neq 0$ or $c^i_{\varphi tb} \neq 0$

➔ EFT impacts both the production and decay of top quark

➔ This vertex can be modified by CP violation

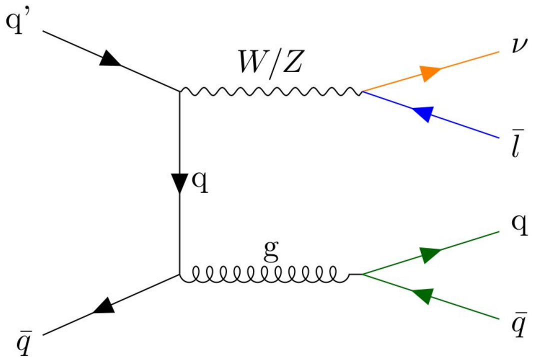
Main background processes :

$t\bar{t}$



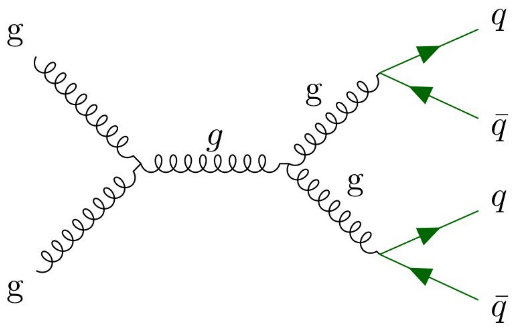
σ_{ttbar}= 452 pb

W/Z + jets (with Drell-Yan)



σ_{Wjets}= 84 847 pb

QCD processes



Other backgrounds :

- ➔ Diboson
- ➔ ttX
- ➔ Single top s-channel and tW process

Event samples

- **Single Top/AntiTop t-channel (SM)** : POWHEG + MadSpin + Pythia8, scheme 4F, TuneCP5
- **$t\bar{t}$ semileptonic** : POWHEG + Pythia8, TuneCP5
- **tW top and anti-top** : POWHEG + Pythia8, scheme 5F, inclusive decays, TuneCP5
- **W + Jets** :
  - *old sample* : MG5_aMC@NLO FxFx + Pythia8, jet-binned 0,1,2j, TuneCP5
  - *new sample* : POWHEG MiNNLO + Pythia8 + PHOTOS (W^+/W^- split, TuneCP5)
  - The new sample is the one used in the W mass measurement analysis and has a larger statistical sample size.

EFT samples :

- ➢ Generated using the dim6Top LO UFO model from Madgraph5
- ➢ Using dim6=2 to insert EFT in top production and/or decay (including interferences) while maintaining quadratic behaviour
- ➢ A reweighting technique is used to get all the EFT combination

Object definition

The **single isolated muon** HLT trigger with p_T > 24 GeV (2016, 2018) and p_T > 27 GeV (2017) are used in this analysis

Jet selection

	Good jets
$\|\eta\|$	< 4.7
p_T 2016 (GeV)	> 40
p_T 2017 and 2018 (GeV)	> 40 ($\|\eta\|$ < 2.4) > 60 (2.4 < $\|\eta\|$ < 4.7)
Overlap	Removed overlap between jets and leptons in a ΔR < 0.4 cone
Jet Id	**Tight** (discriminate real jets from fake lepton, pile up and detector noise)

Muon selection

	Isolated muon	Loose muon
$\|\eta\|$	< 2.4	< 2.4
pT 2017 (GeV)	> 30	> 10
pT 2016 and 2018 (GeV)	> 26	> 10
Relative isolation	< 15%	< 25%
Id	tight	loose

b-jets :

- Must be good jets
- $|\eta|$ < 2.5 (2017 & 2018)
- $|\eta|$ <2.4 (2016)
- Tight/medium working point of DeepJet tagger used

A reversed isolated muon is also defined by reverting the isolation : > 15%

➔ All recommended CMS corrections are applied (including pileup and b-tag weights, muon Rochester momentum correction, JEC, MET phi modulation)

Analysis regions

Loose preselection applied to reduce fake lepton contribution :

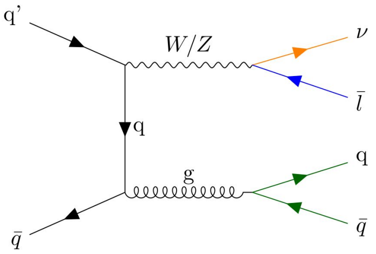
- ➢ **MET** > 20 GeV
- ➢ **Transverse mass of W boson with fixed lepton p_T at 45 GeV ($M_T^{W,fix}$**) > 25 GeV

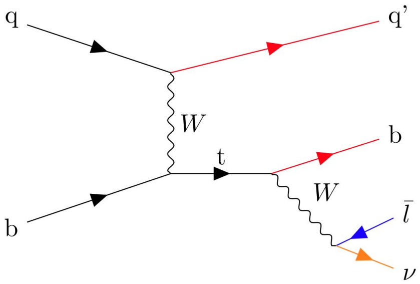
Lepton selection :

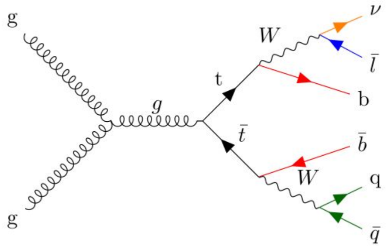
- Exactly one isolated tight muon
- Veto events with additional loose muons
- Veto events with veto electrons

Event categorization based on the number of Jets and b-tagged jets : Signal region (SR) , W/Z-Jets control region (CR) and ttbar CR

	= 0 tight and 1 medium b-jet	= 1 tight b-jet	>= 1 tight b-jet
= 2 jets	W/Z-Jets Control Region.	Signal Region	Not Used
≥ 3 jets	Not Used	Not Used	TTbar Control Region



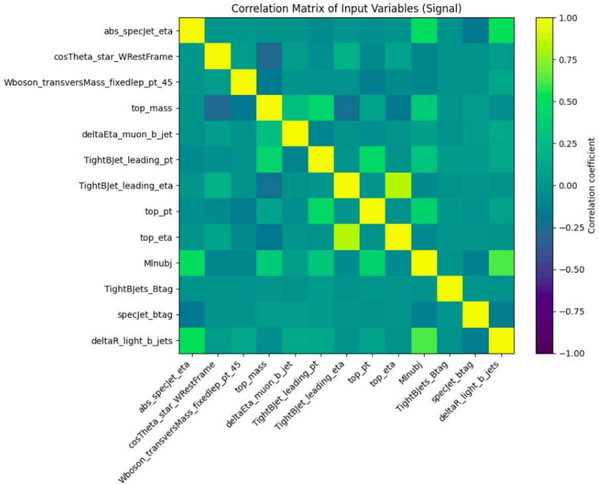


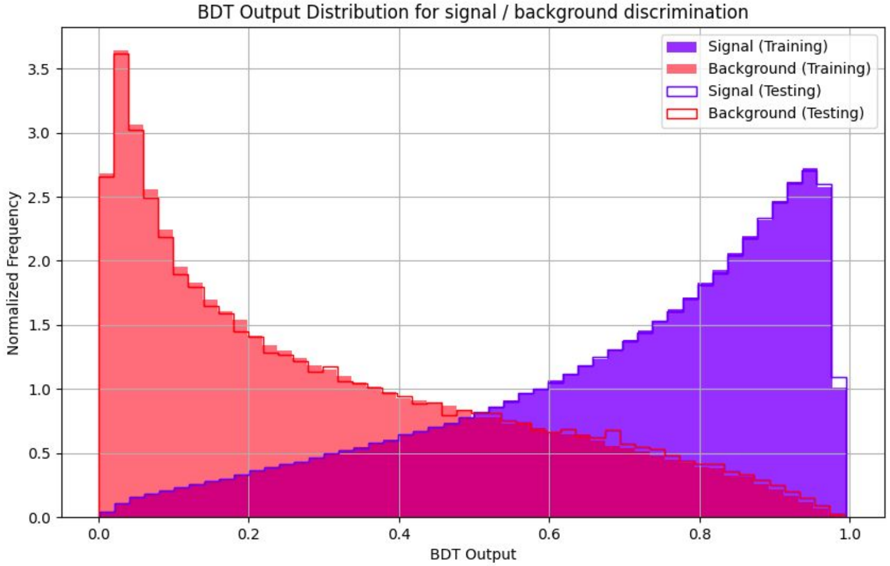


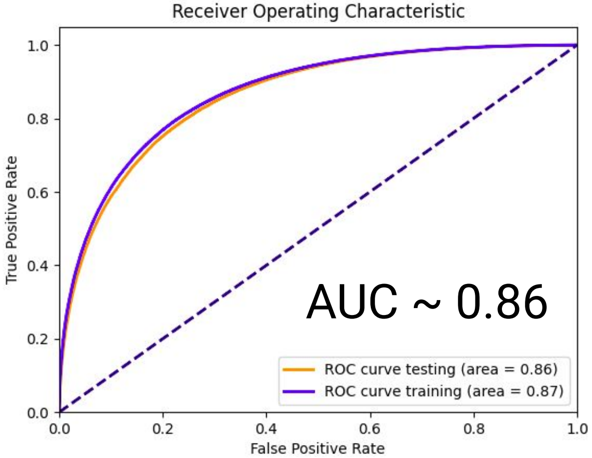
Analysis strategy - MVA in the **Signal Region**

Trained a **BDT** in the SR to discriminate **single top (ST) t-channel** from **W+jets and QCD processes**

Input variables for the BDT : cos(θ*), η of the spectator jet, spec jet btagging score, $M_T W^{,fix}$, top p_T, top η, M_{top}, Δη(μ, b-jet), ΔR(spec jet, b-jet), b-jet p_T, b-jet η, b-jet btagging score, lepton p_T, $M_{l\nu bj}$







Analysis strategy - **QCD sideband region** (1/2)

A **QCD measurement region** (sideband region) is defined for each signal and control region, with the same selection but reverted muon isolation cut.

Observed limitation :

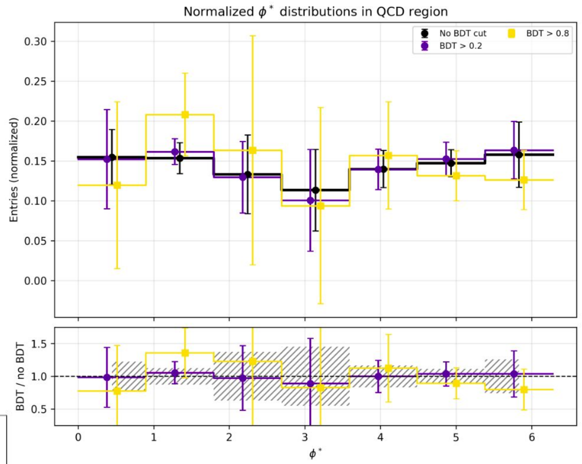
- ➢ Large impact of the MC stat uncertainty on the sensitivity of the analysis
- ➢ Traced back to the QCD process (see table of the relative contribution to the total MC stat uncertainty from each process in the SR)
- ➢ QCD sideband needs to be further populated to reduce uncertainties

Process	σ_{MC}	Fraction (%)	σ_{tot}
qcd_2018	3763.5583	97.82	3805.1868
vjets	522.6826	1.89	
ttbar	145.8065	0.15	
singletop	114.6261	0.09	
sm	80.4689	0.04	
diboson	31.7001	0.01	

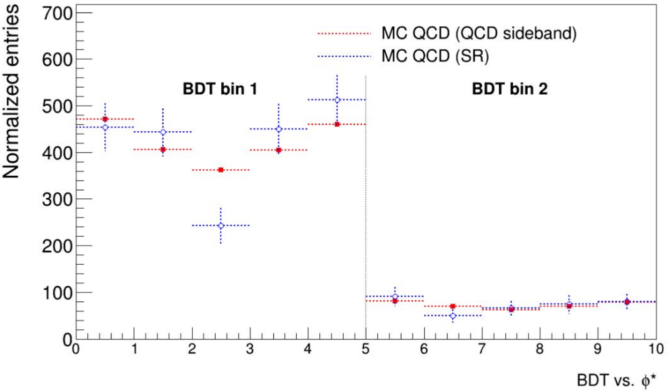
Analysis strategy - **QCD sideband region (2/2)**

Applied modifications :

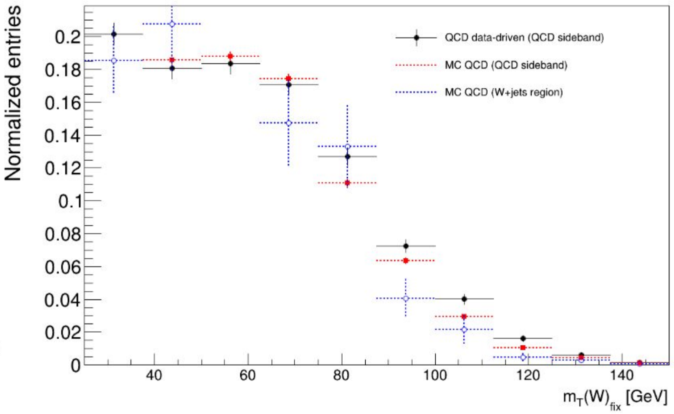
- Any **BDT cut** applied in the SR is **removed in the QCD sideband**
- The shape of data-driven QCD with and without BDT cut for the ϕ^* distribution agrees within uncertainties



SR



W+jets CR

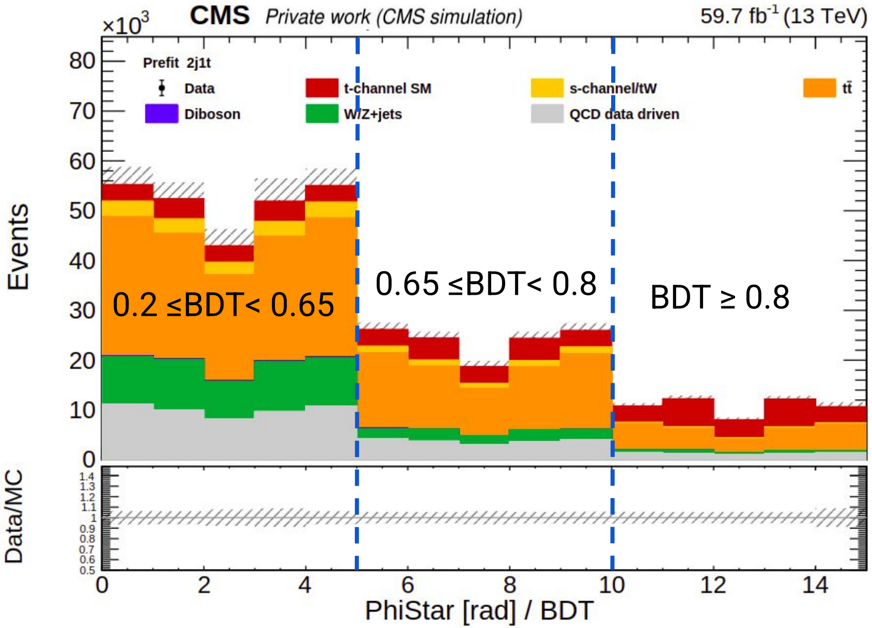


QCD MC in the QCD sideband matches the QCD MC in the SR and CR, validating the method

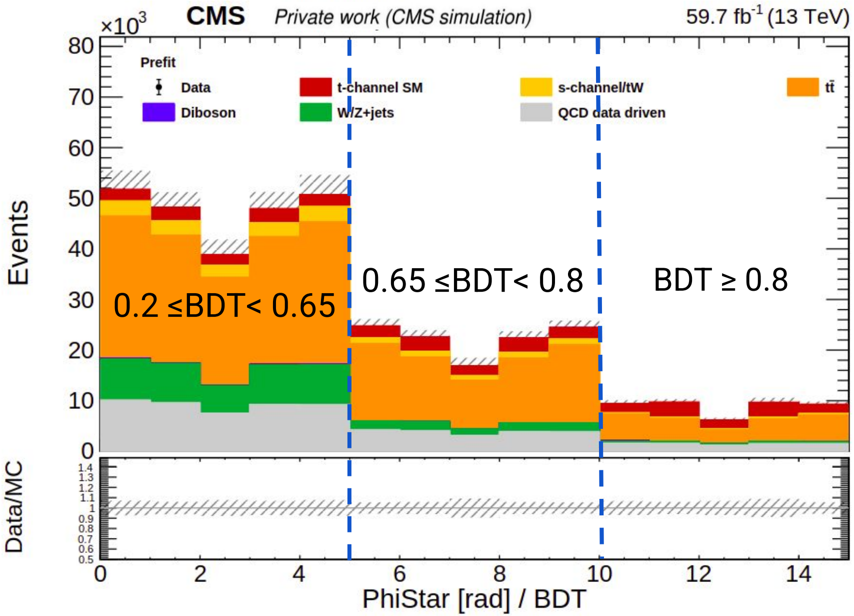
Analysis strategy - **Signal Region**

➔ **The SR is divided into Top and Antitop channels (determined from the lepton charge)**

➔ As the measurement observable we are using the ϕ^* distribution in bins of the BDT



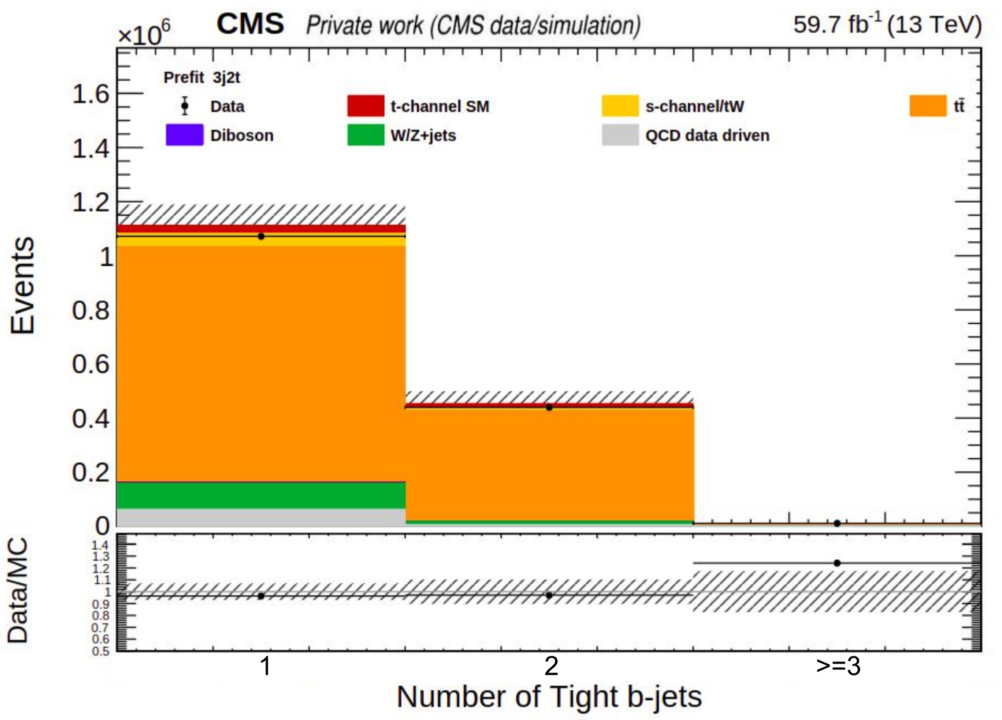
Top channel



Antitop channel

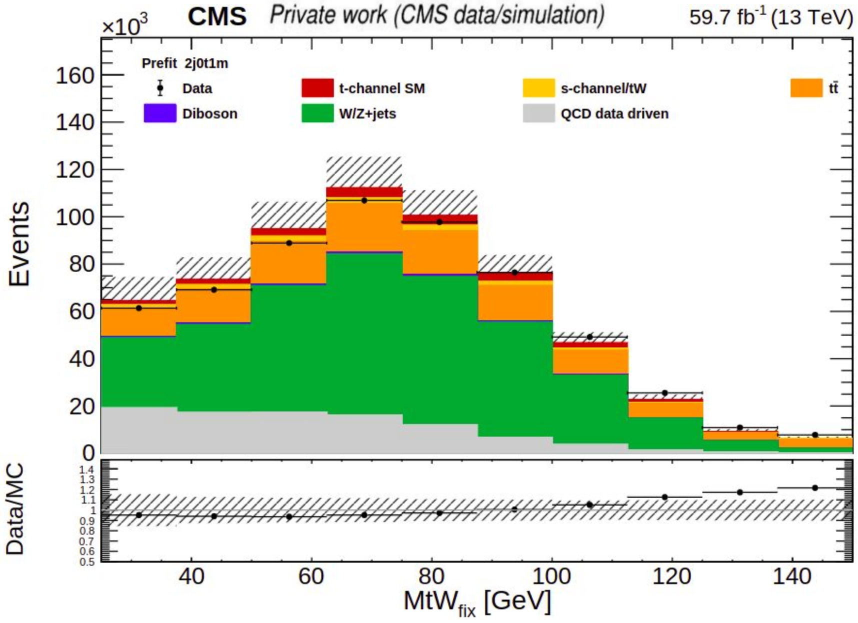
Analysis strategy - **$t\bar{t}$ Control Region**

In the $t\bar{t}$ control region, we are using the **number of tight b-jets** (3 bins) as our discriminating distribution.



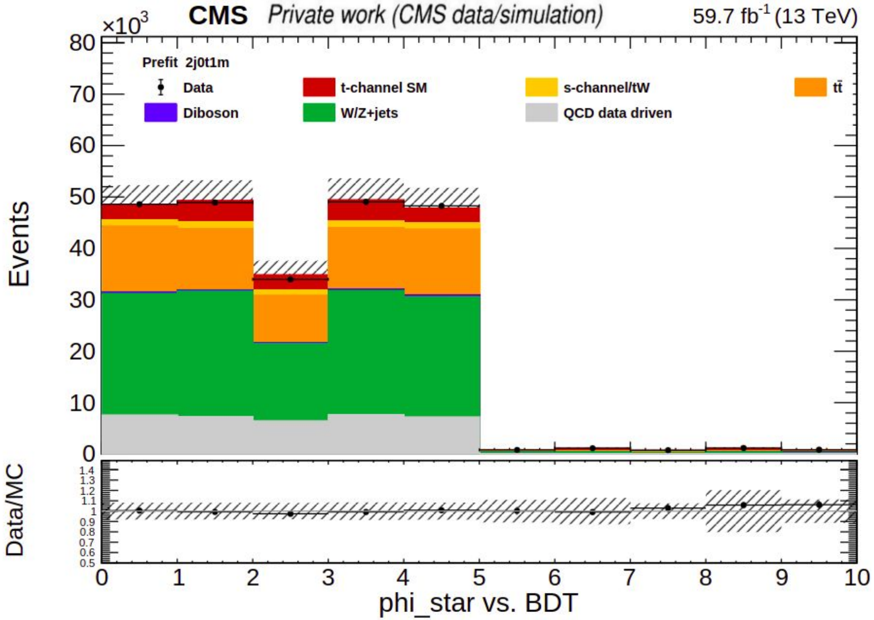
Analysis strategy - **W + jets Control Region**

Current strategy



Distribution of the W boson transverse mass with fixed lepton p_T at 45 GeV ($M_T^W{}_{,fix}$)

Modeling of the ϕ^* in bins of BDT observable in the W+jets CR where the data is unblinded

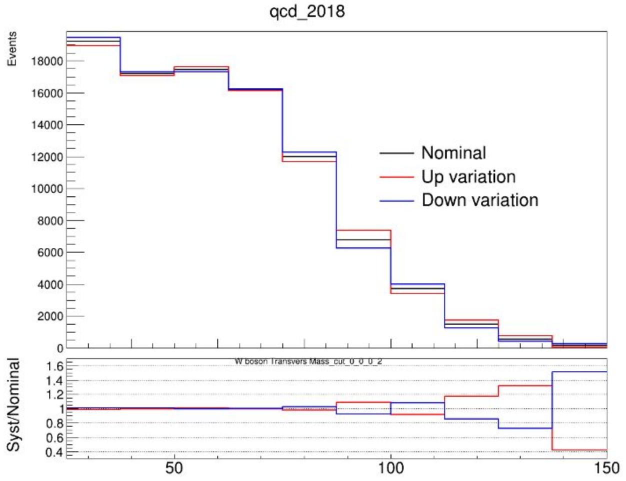


Systematic uncertainties

NAMES	USED	CORRELATION
Muon Reco	Y	All channel
Muon HLT	Y	All channel
Muon ID	Y	All channel
Muon Iso	Y	All channel
B Tagging SF	Y	All channel
Prefiring	Y	All channel
Pile Up	Y	All channel
Top pt	Y	Only TTbar
Lumi	Y	All channel
JES/JER	Y	As per Recom
ISR	Y	Not correlated
FSR	Y	Not correlated
PDF + alpha_s	Y	All channels
QCD Scale	Y	All channels

We introduce 3 uncertainties dedicated to this analysis :

- A shape uncertainty on QCD data-driven distribution, constructed by varying the **run era** (uncorrelated between years)
- A shape **difference between QCD data-driven and MC QCD** (uncorrelated between years and regions)
- Difference between POWHEG ST t-channel in the **4fs and 5fs** (fully correlated)



Down : 2018 A, B, C era
Up : 2018 D era

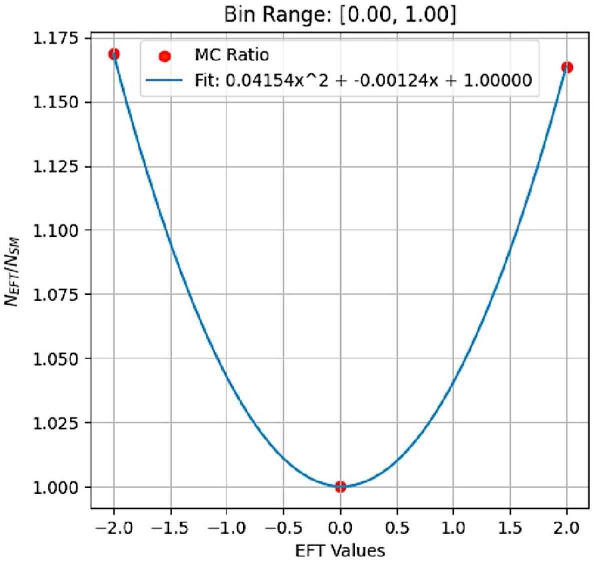
$M_T^{W,fix}$ distribution with Up and Down variations of QCD era uncertainty

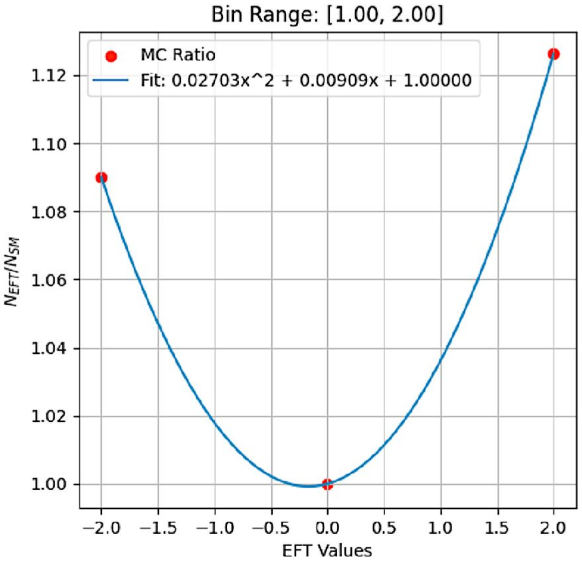
EFT parameter extraction

Evaluating the expected statistical sensitivity by fitting the SM+EFT model to the Asimov (SM) dataset using a profile likelihood statistical method (CMS Combine)

Using AnalyticAnomalousCoupling plugging to model the EFT template :
https://github.com/amassiro/AnalyticAnomalousCoupling

This framework provides a Combine-based model for EFT fits overcoming the issues of negative templates that may arise from interference terms





- Fitting polynomial of order 2 in each bin of our observable
- Using the three parameters of the fit to produce the templates

$$\text{Sm} = |\mathcal{A}_{SM}|^2,$$

$$\text{Lin}_\alpha = 2\Re(\mathcal{A}_{SM}\mathcal{A}^\dagger_{Q_\alpha})$$

$$\text{Quad}_\alpha = |\mathcal{A}_{Q_\alpha}|^2$$

EFT parameter extraction with **full Run 2**

A profile likelihood scan is performed with Asimov dataset. A best-fit value (at 68% CL) including expected statistical and systematic uncertainties is obtained.

This analysis

Source	C^I_{tW}	C^I_{bW}
Best fit	-0.00	$+0.00$
Total unc.	$\mathbf{+0.09\ /\ -0.09}$	$\mathbf{+1.08\ /\ -1.13}$
Stat. unc.	$+0.08\ /\ -0.08$	$+0.44\ /\ -0.44$
MC stat. unc.	$+0.04\ /\ -0.04$	$+0.43\ /\ -0.48$
Other syst. unc.	$+0.01\ /\ -0.02$	$+0.88\ /\ -0.92$

ATLAS analysis arXiv:2510.23372

Source of uncertainty	C^I_{tW}	C^I_{bW}
Jet energy scale	−0.01, +0.01	−0.3, +0.3
Pile-up	–	−0.1, –
b-tagging	−0.01, +0.01	−0.1, +0.1
Jet energy resolution	−0.01, +0.01	−0.1, +0.1
PDF	−0.01, +0.01	−0.1, +0.1
Muon	–	−0.1, +0.1
E_T^{miss}	–	−0.2, +0.2
e/γ	–	−0.1, +0.1
Jet vertex tagging	–	–
Lumi. & cross-section	–	−0.1, +0.1
τ_{had} energy scale	–	–
Non-prompt leptons	–	−0.1, +0.1
t-channel modelling	–	–
$t\bar{t}$ modelling	−0.01, –	−0.1, +0.1
W+jets modelling	−0.01, +0.01	–, +0.1
MC sample sizes	−0.03, +0.03	−0.2, +0.2
Data sample size	−0.04, +0.04	−0.5, +0.5
Total	−0.06, +0.06	−0.7, +0.7

Expected sensitivity by ATLAS analysis is still better by a factor ~1.5 for C_{tW}^{I} and C_{bW}^{I} compared to our analysis.

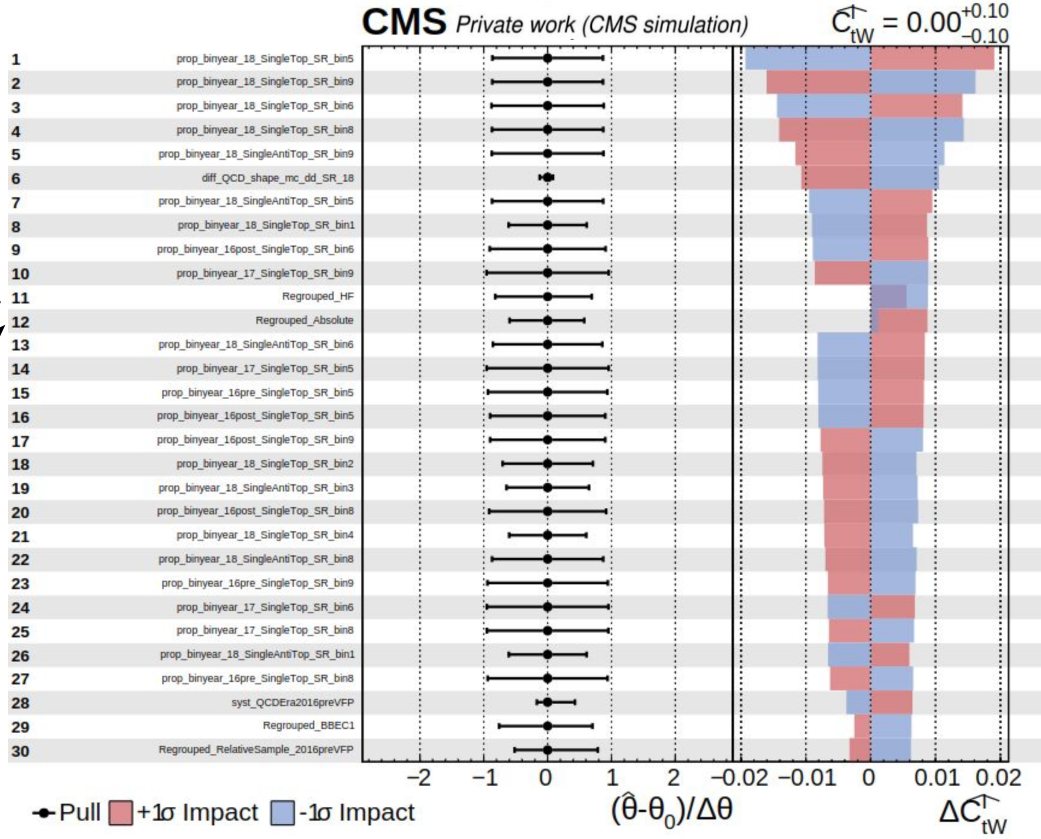
MC stat is also the largest systematic in the ATLAS analysis.

Uncertainties impact on C^{I}_{tW} **Full Run 2**

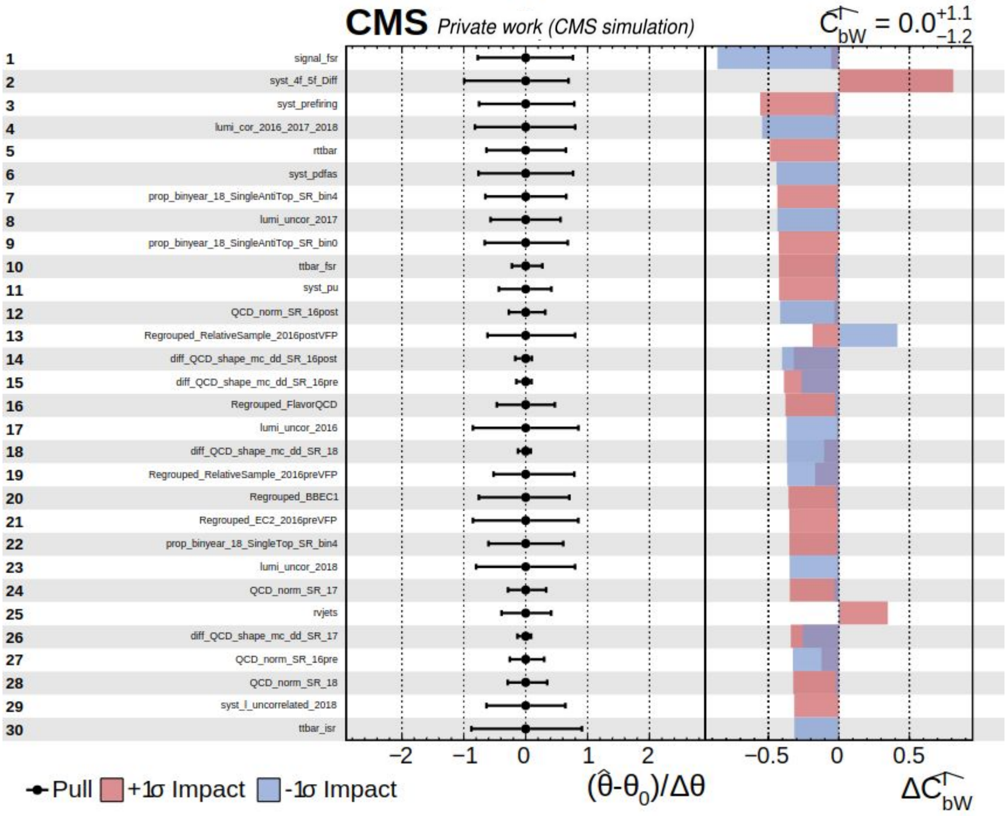
MC statistical uncertainties remain among the highest-ranked nuisance parameters, but their overall impact is significantly reduced compared to the previous strategy

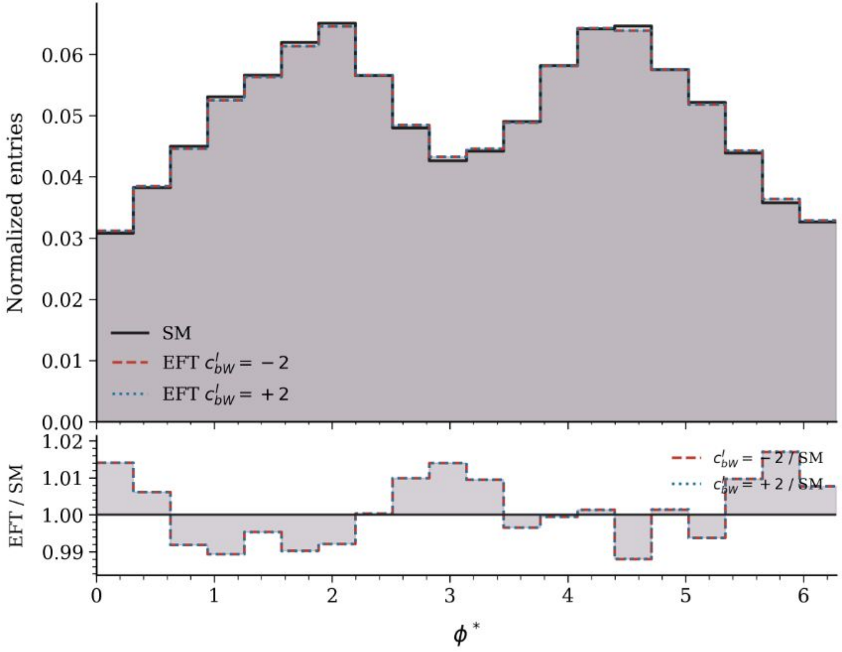
Uncertainty on the shape **difference between QCD data-driven and MC QCD** in the SR

Need to move to full set of JEC uncertainties (reduced one is constrained)



Uncertainties impact on C^l_{bW} **Full Run 2**





Many nuisances are one sided because C_{bW}^l = +2 and C_{bW}^l = -2 effect goes in the same direction.

Conclusion

Overview of the analysis :

- Produced private EFT samples
- Divided the analysis into signal (top and antitop channel) and control regions (W+jets and $t\bar{t}$ CR)
- Trained a BDT to improve the sensitivity of the analysis on EFT measurement
- Developed a QCD estimation strategy
- Performed the fit for 2 Wilson coefficients : C^{l}_{tW} and C^{l}_{bW}

Plans :

➔ The binning of the BDT in the SR still needs to be optimized

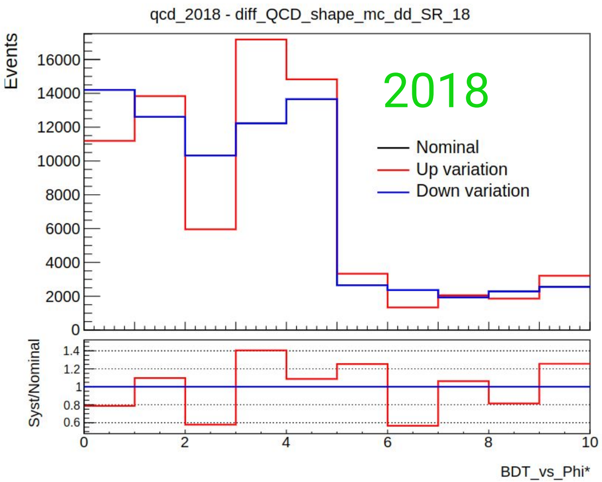
➔ Consider moving to tight lepton MVA (lepton identification with machine learning technique)

➔ Add the measurement of the third coefficient : $C^{l}_{\varphi tb}$

Thank you for your attention

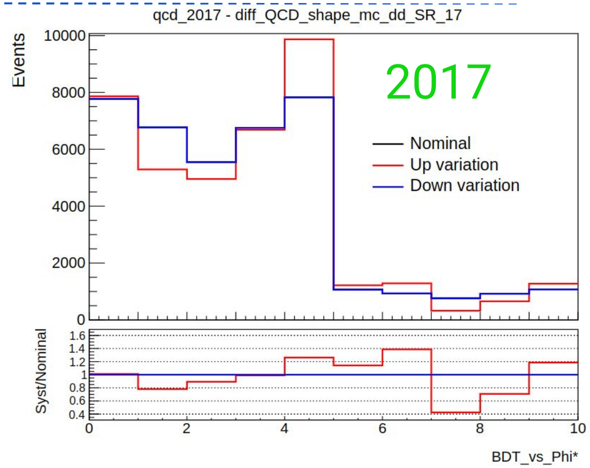
Backup

Systematic variation of difference between MC and data-driven QCD

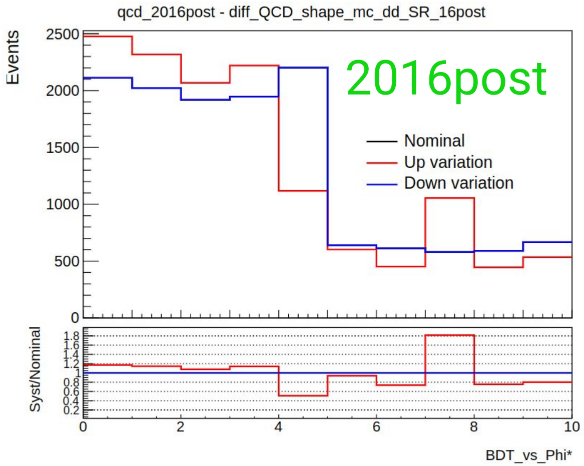


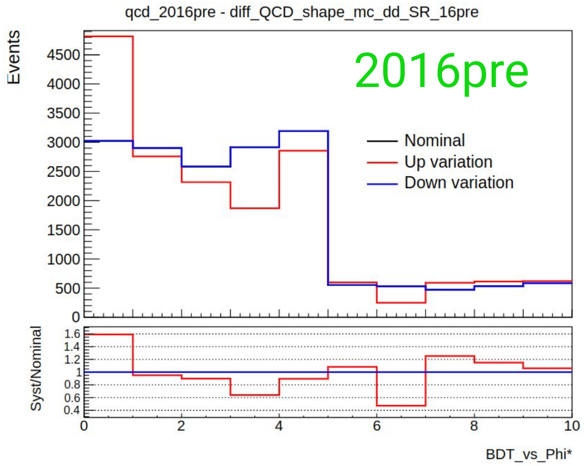
Down : data-driven shape

Up : MC QCD shape

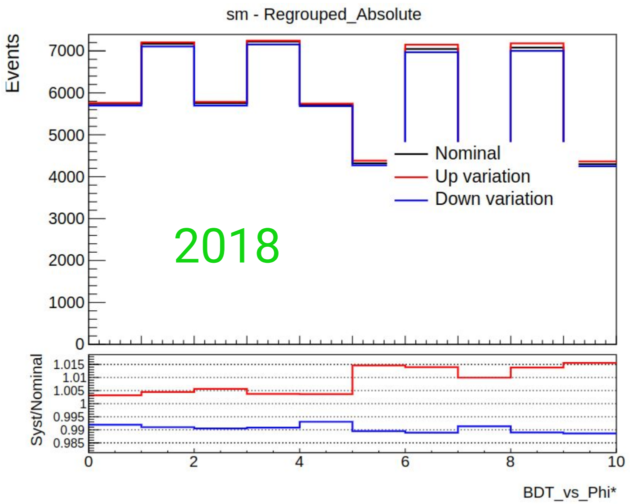


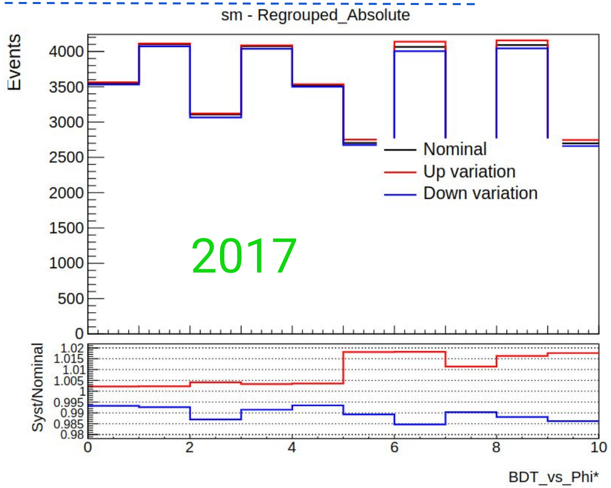
SR





Systematic variation of Regrouped Absolute uncertainty for ST t-channel process





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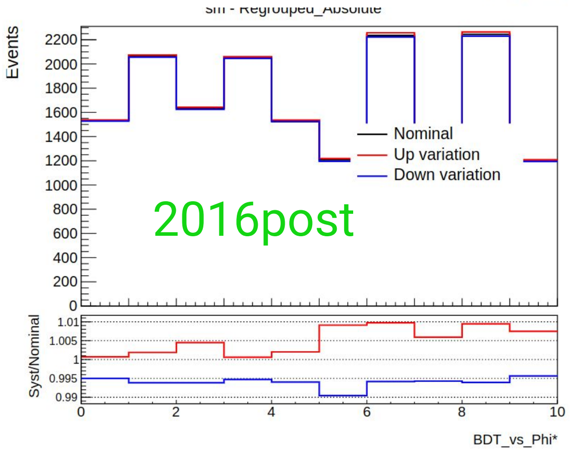
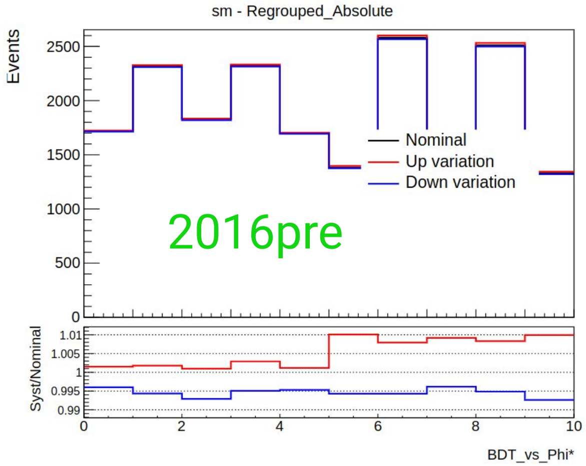
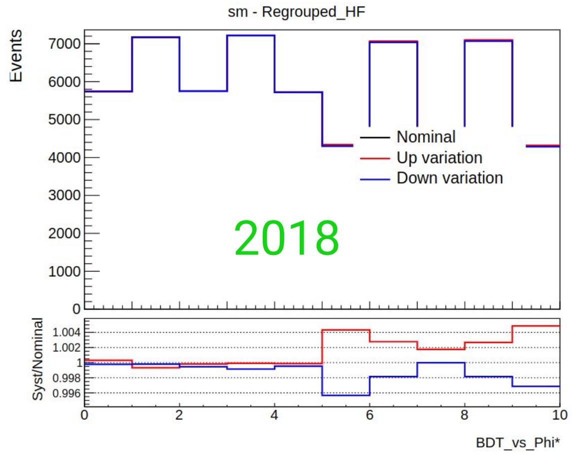
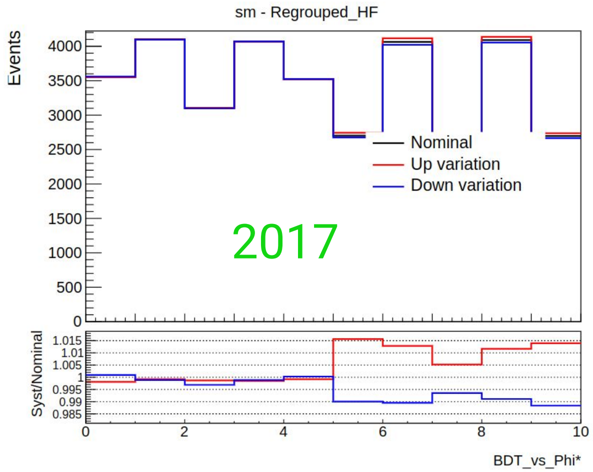




Systematic variation of Regrouped HF uncertainty for ST t-channel process





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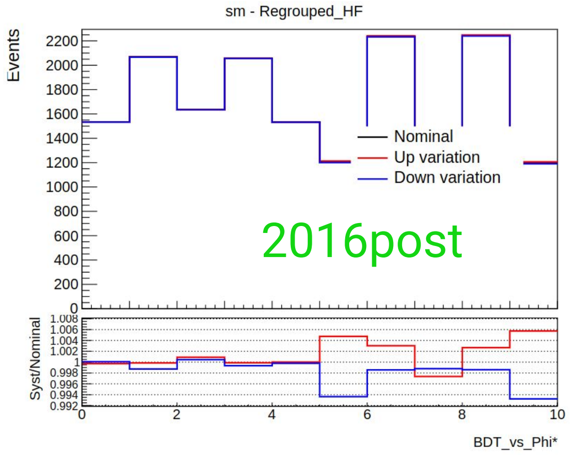
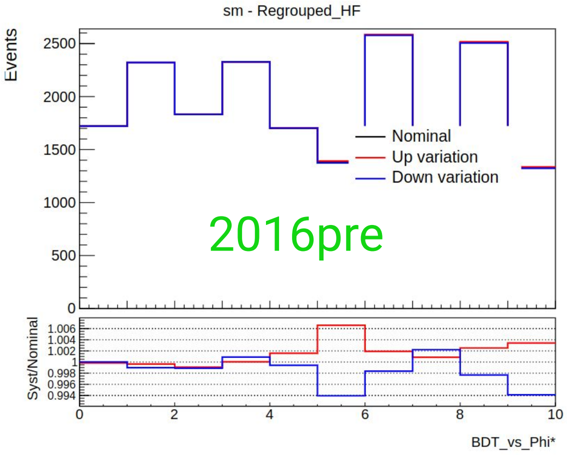




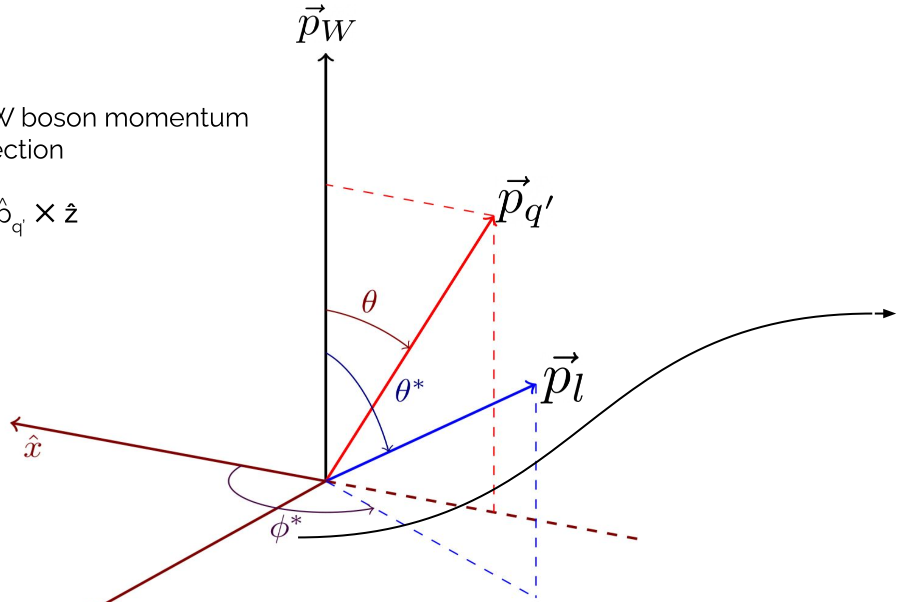
EFT impact on angular variables

Top quark rest frame

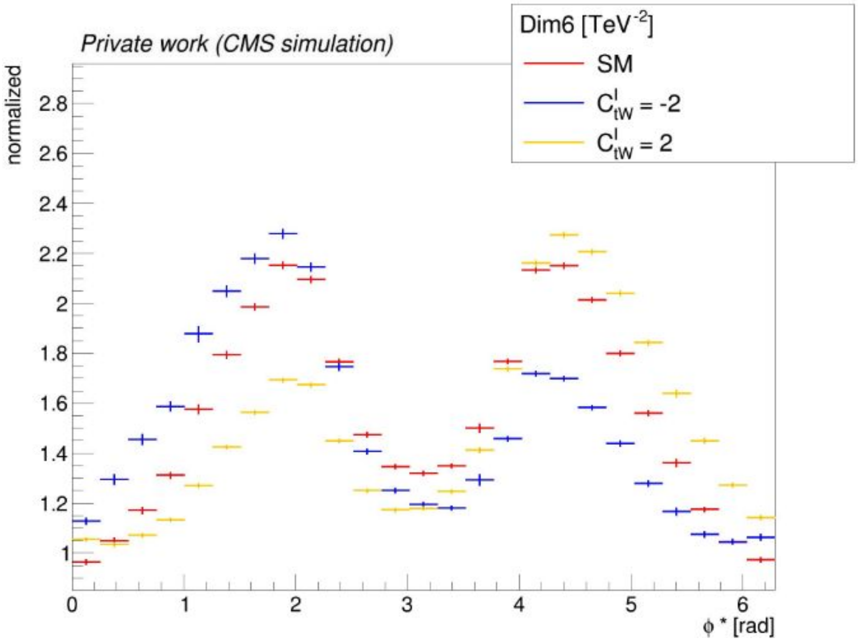
Reference frame used in ATLAS 8 TeV [arXiv:1707.05393]

ẑ : W boson momentum direction

$\hat{y} = \hat{p}_{q'} \times \hat{z}$

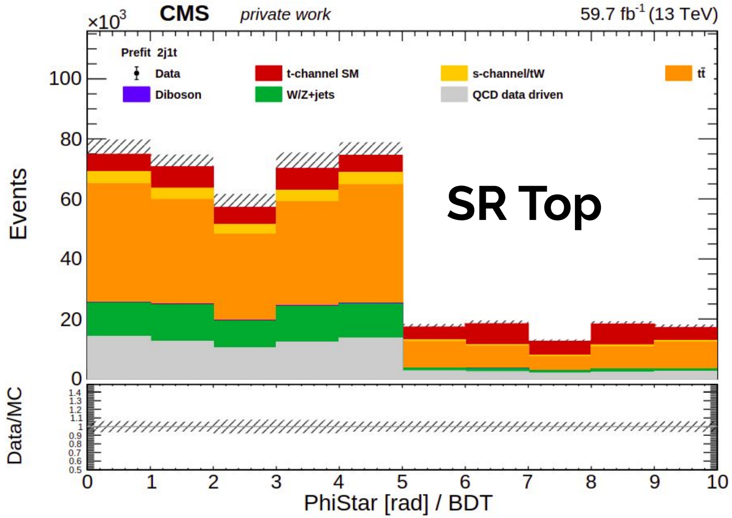


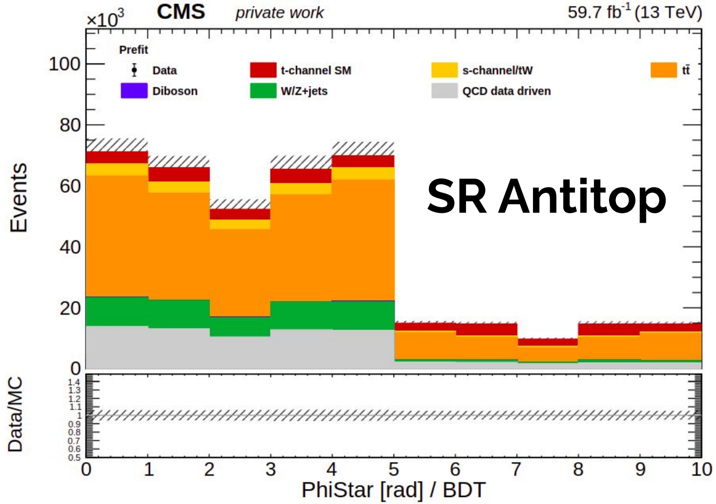
ϕ^*= angle between x-axis and projection of lepton momentum on the xy plane



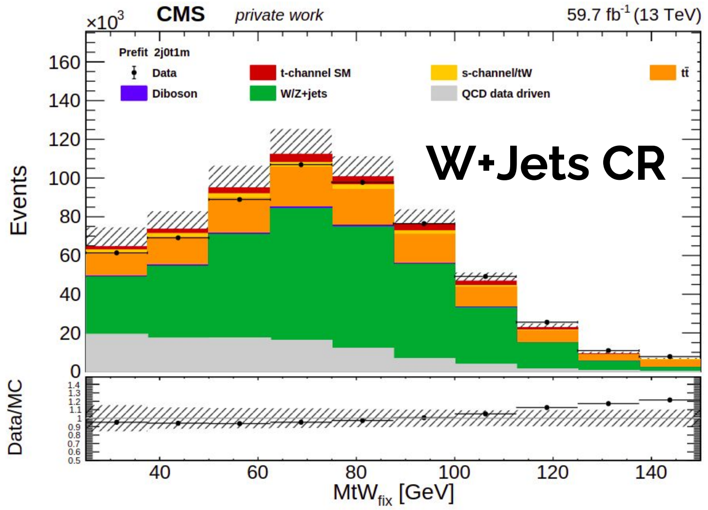
The shape of the distribution varies depending on the value of the EFT coefficient

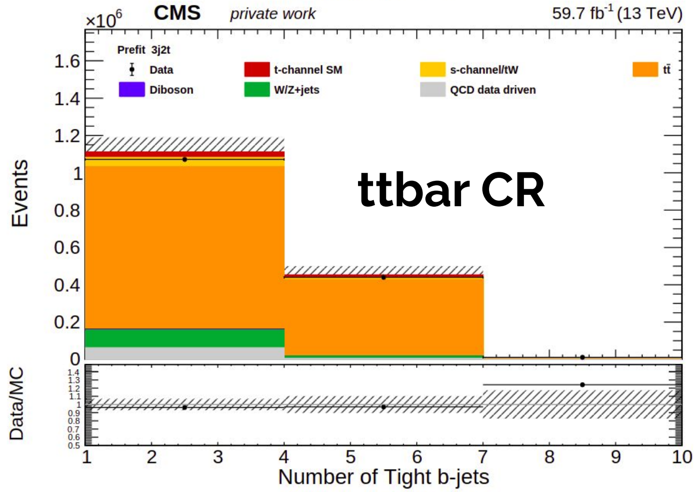
The value of EFT coefficients can be extracted using such angular distributions

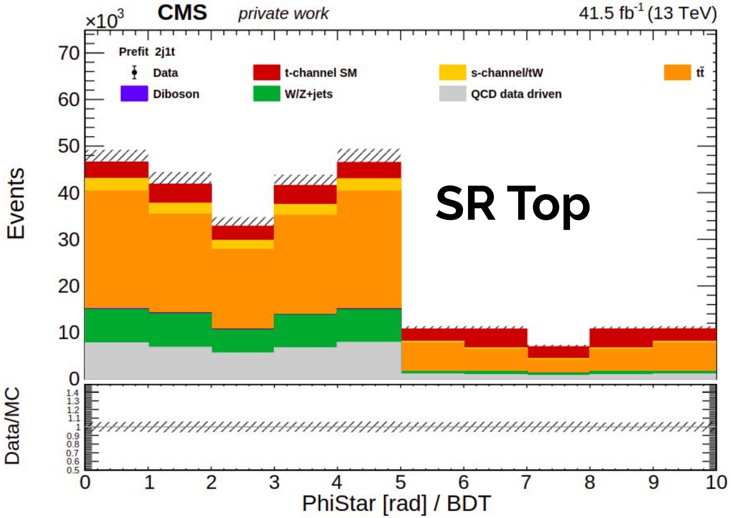

CMS private work
59.7 fb-1 (13 TeV)
Prefit 2j1t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Top
Events
Data/MC
PhiStar [rad] / BDT

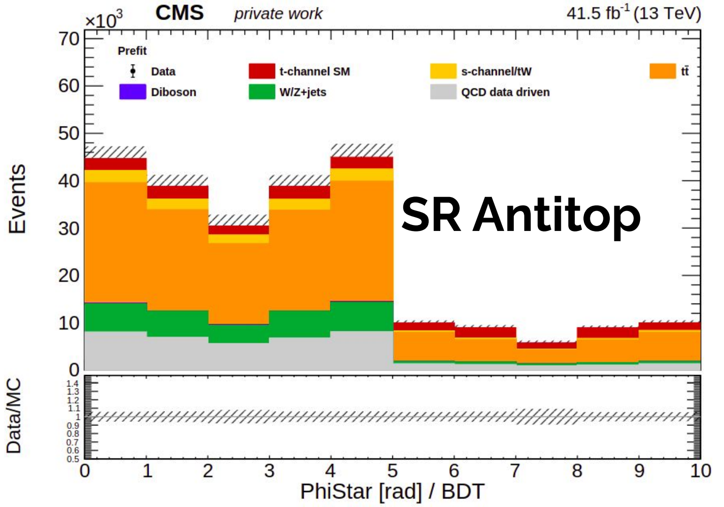

CMS private work
59.7 fb-1 (13 TeV)
Prefit
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Antitop
Events
Data/MC
PhiStar [rad] / BDT

2018

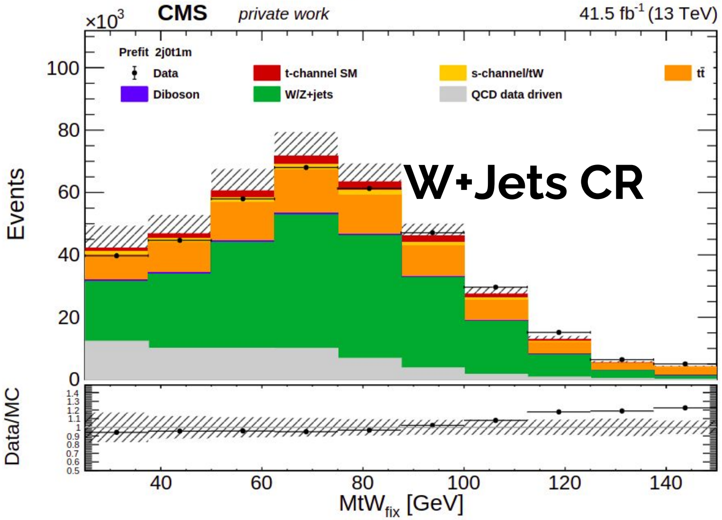

CMS private work
59.7 fb-1 (13 TeV)
Prefit 2j0t1m
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
W+Jets CR
Events
Data/MC
MtW_fix [GeV]

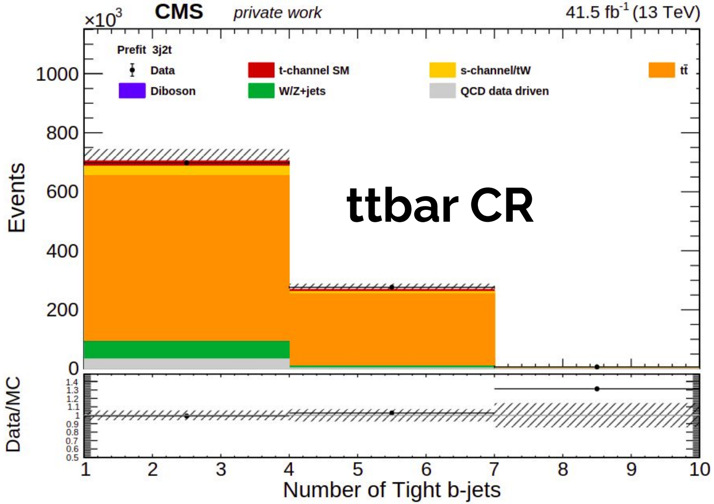

CMS private work
59.7 fb-1 (13 TeV)
Prefit 3j2t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
ttbar CR
Events
Data/MC
Number of Tight b-jets

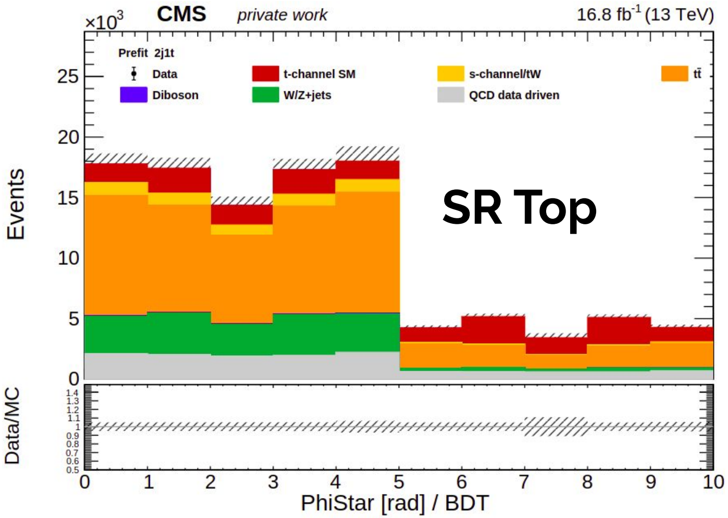

CMS private work
41.5 fb-1 (13 TeV)
Prefit 2j1t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Top
Events
Data/MC
PhiStar [rad] / BDT


CMS private work
41.5 fb-1 (13 TeV)
Prefit
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Antitop
Events
Data/MC
PhiStar [rad] / BDT

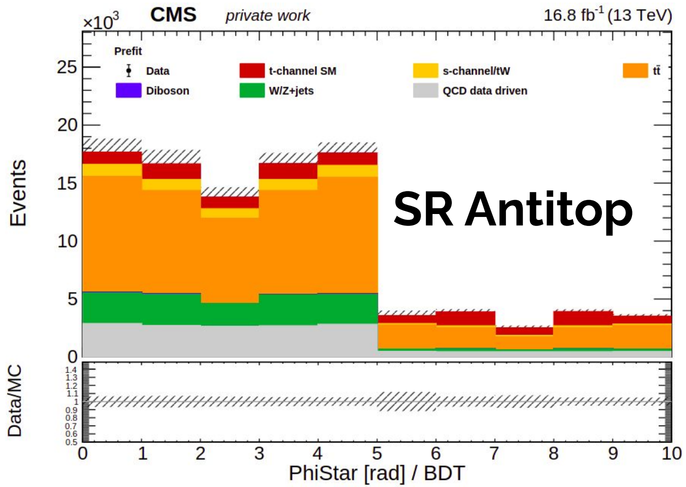
2017


CMS private work
41.5 fb-1 (13 TeV)
Prefit 2j0t1m
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
W+Jets CR
Events
Data/MC
MtWfix [GeV]


CMS private work
41.5 fb-1 (13 TeV)
Prefit 3j2t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
ttbar CR
Events
Data/MC
Number of Tight b-jets

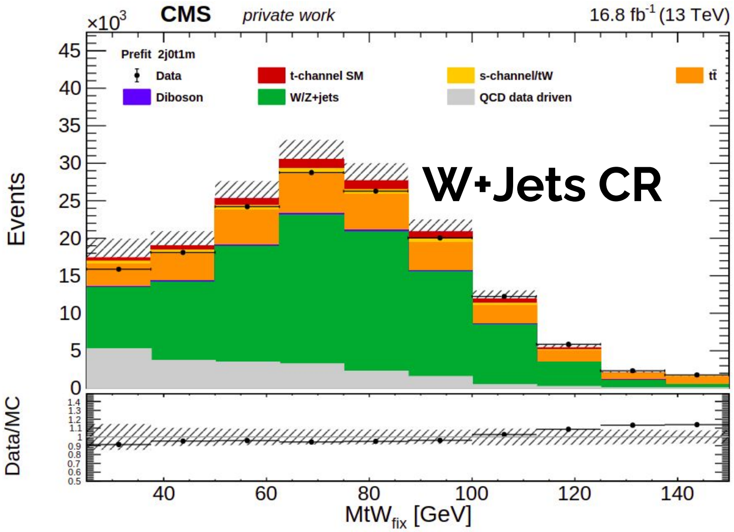


CMS private work
16.8 fb-1 (13 TeV)
Prefit 2j1t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Top
Events
Data/MC
PhiStar [rad] / BDT

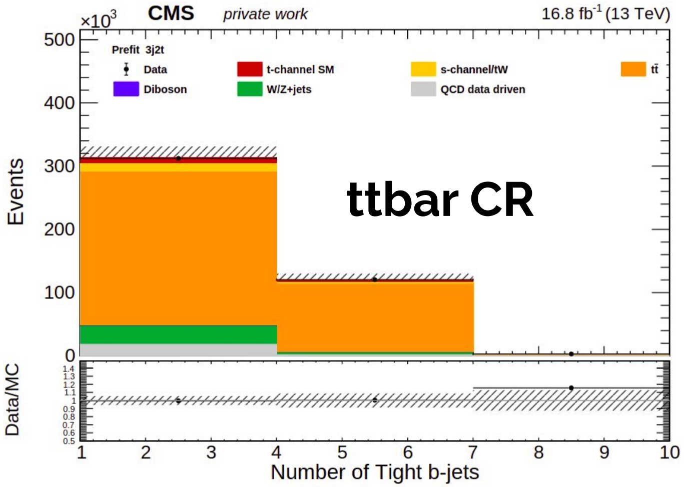


CMS private work
16.8 fb-1 (13 TeV)
Prefit
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Antitop
Events
Data/MC
PhiStar [rad] / BDT

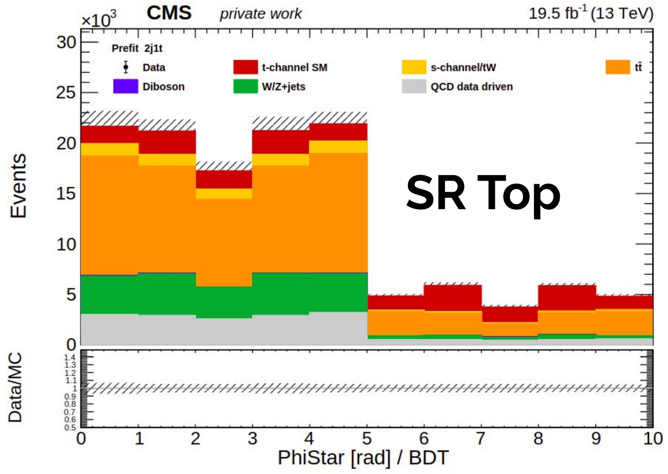
2016post

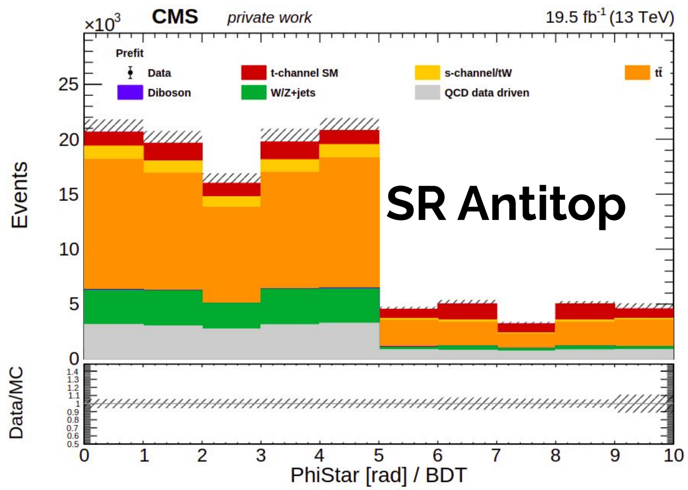


CMS private work
16.8 fb-1 (13 TeV)
Prefit 2j0t1m
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
W+Jets CR
Events
Data/MC
MtW_fix [GeV]

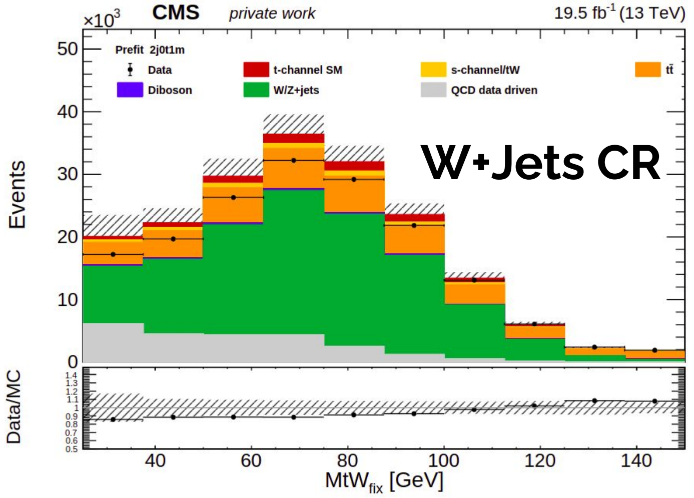


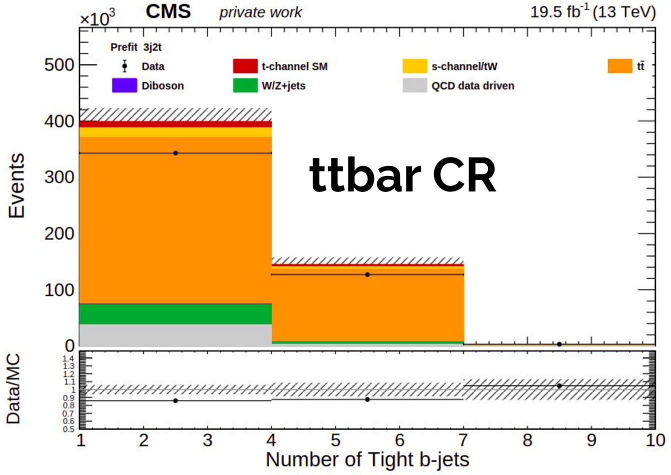
CMS private work
16.8 fb-1 (13 TeV)
Prefit 3j2t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
ttbar CR
Events
Data/MC
Number of Tight b-jets


CMS private work
19.5 fb-1 (13 TeV)
×10^3
Prefit 2j1t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Top
Events
Data/MC
PhiStar [rad] / BDT


CMS private work
19.5 fb-1 (13 TeV)
×10^3
Prefit
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
SR Antitop
Events
Data/MC
PhiStar [rad] / BDT

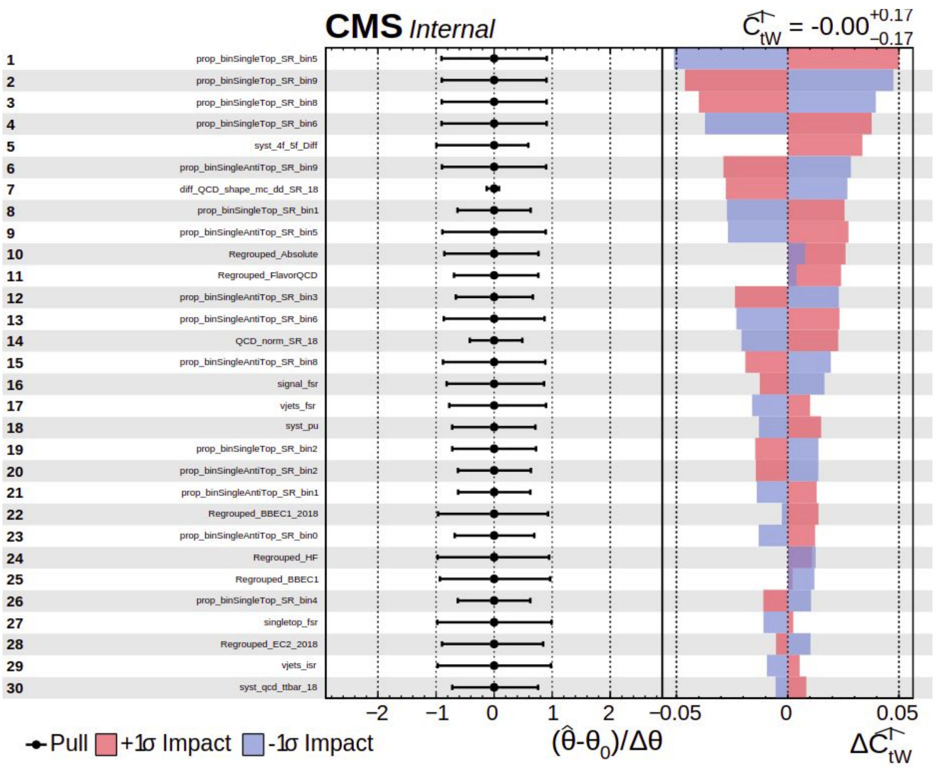
2016pre


CMS private work
19.5 fb-1 (13 TeV)
×10^3
Prefit 2j0t1m
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
W+Jets CR
Events
Data/MC
MtW_fix [GeV]

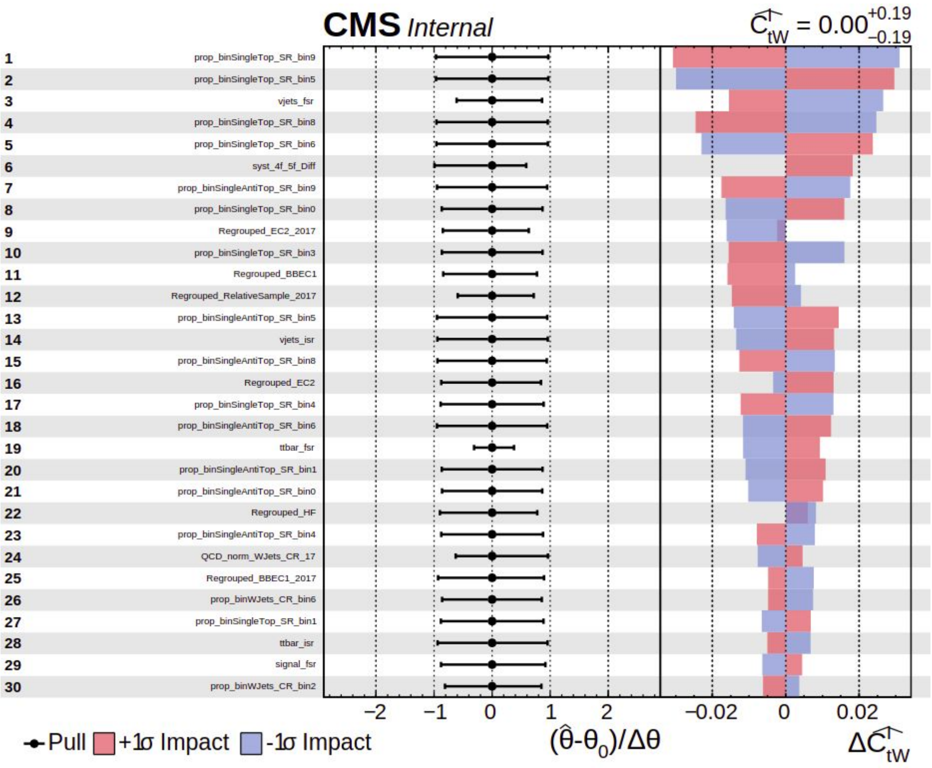

CMS private work
19.5 fb-1 (13 TeV)
×10^3
Prefit 3j2t
Data
t-channel SM
s-channel/tW
tt̄
Diboson
W/Z+jets
QCD data driven
ttbar CR
Events
Data/MC
Number of Tight b-jets

C$^{l}_{t}$ w

2018

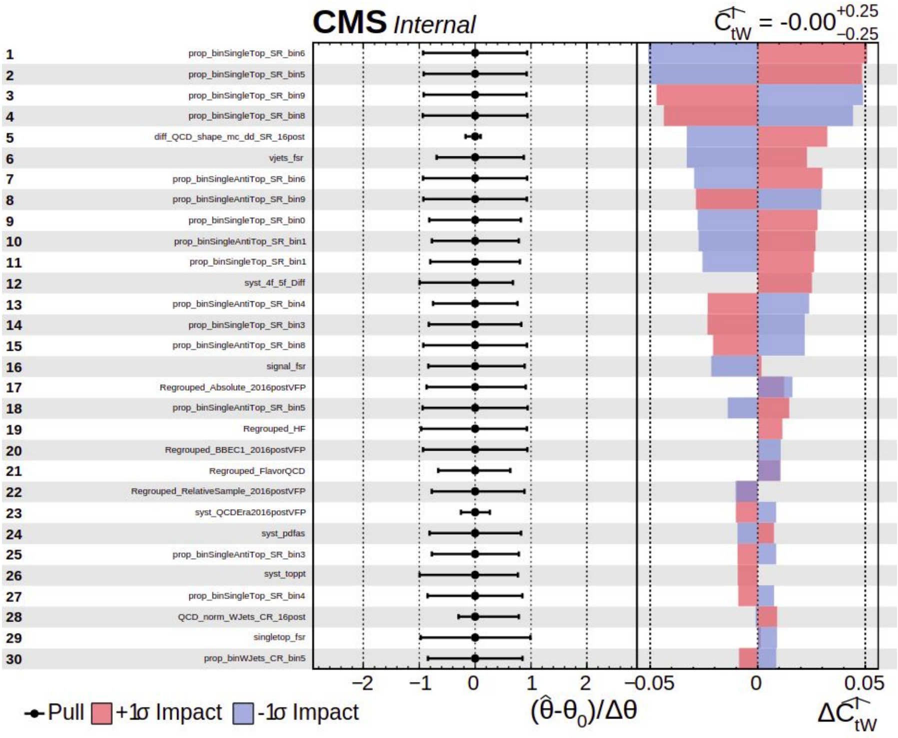


2017

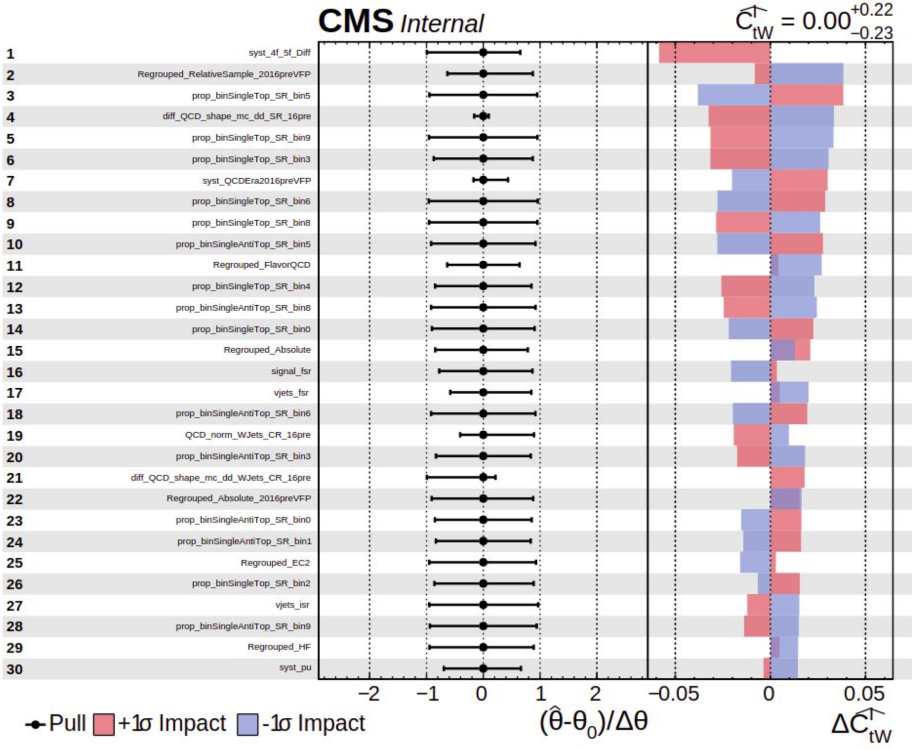


C^{I}_{tW}

2016post

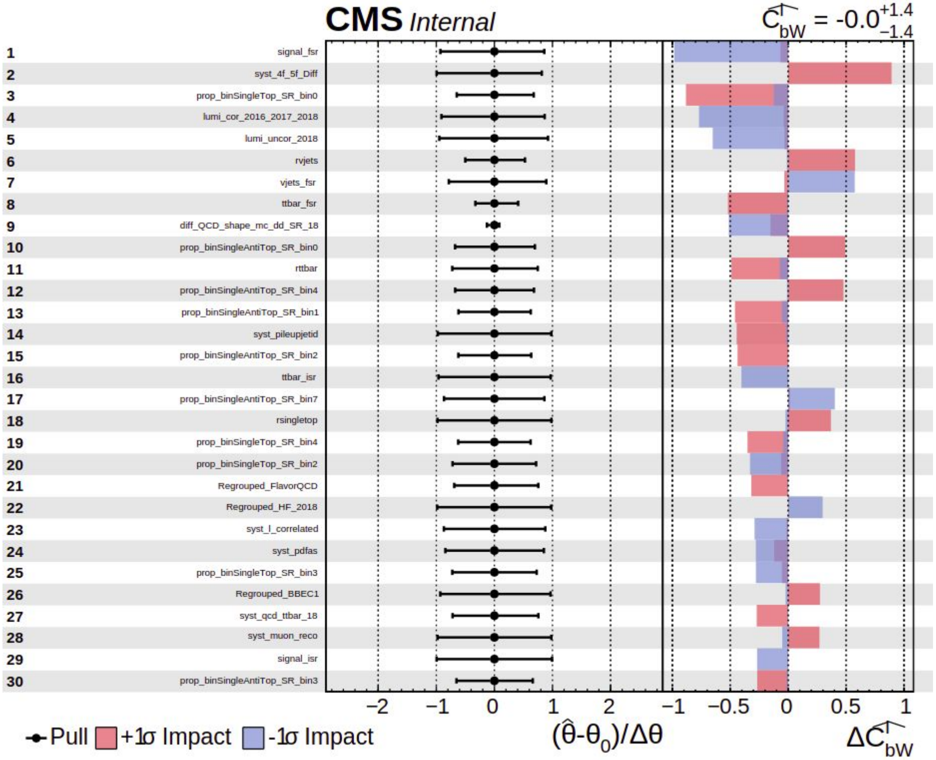


2016pre

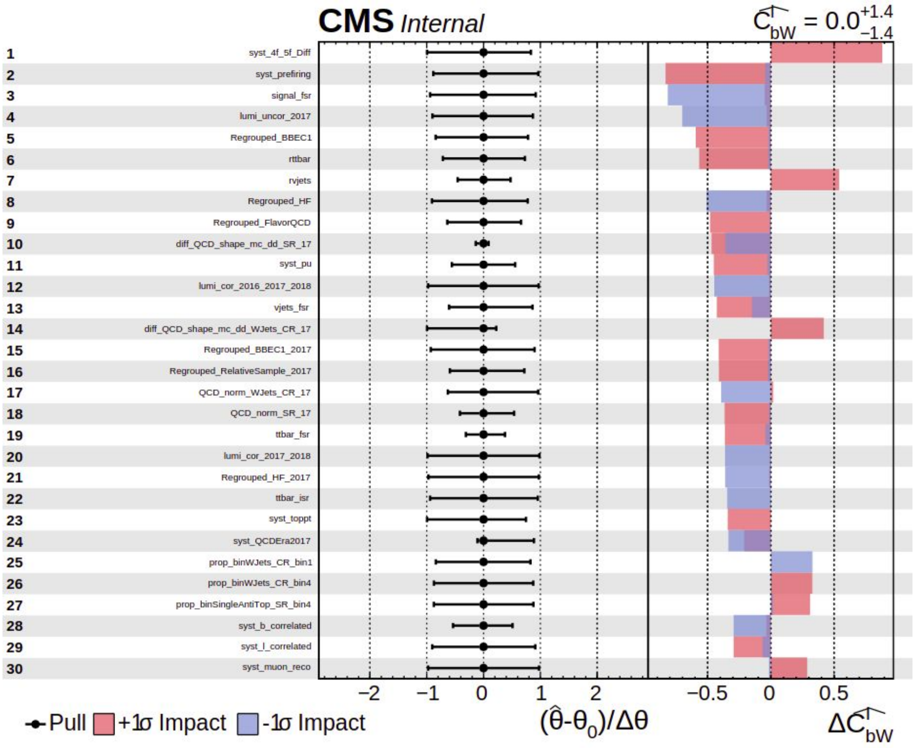


C^{I}_{bW}

2018

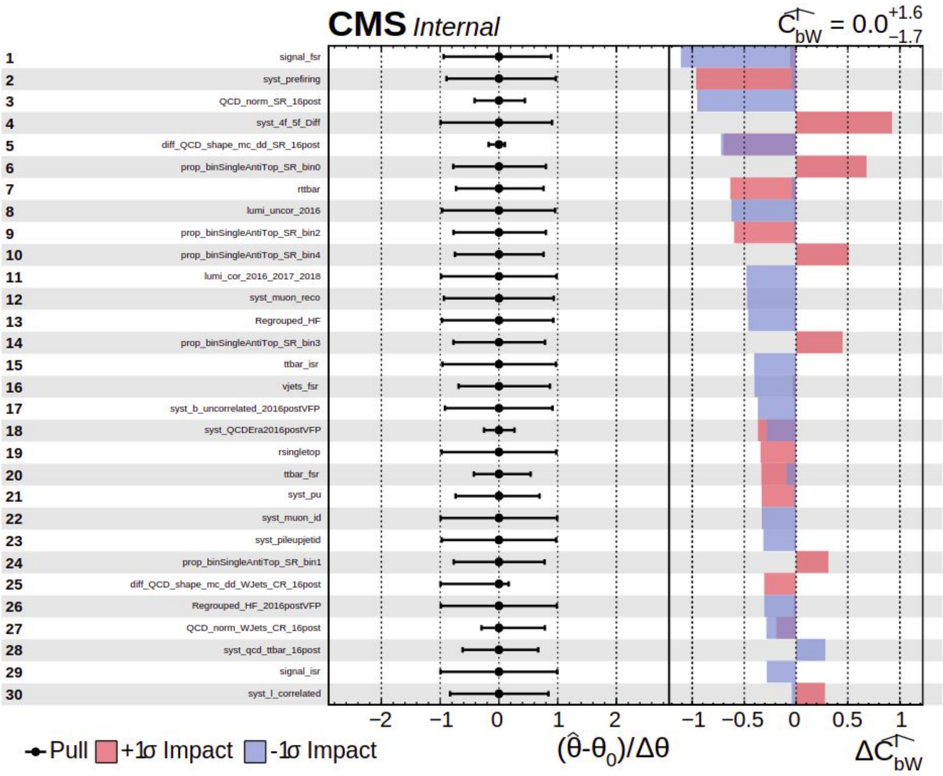


2017

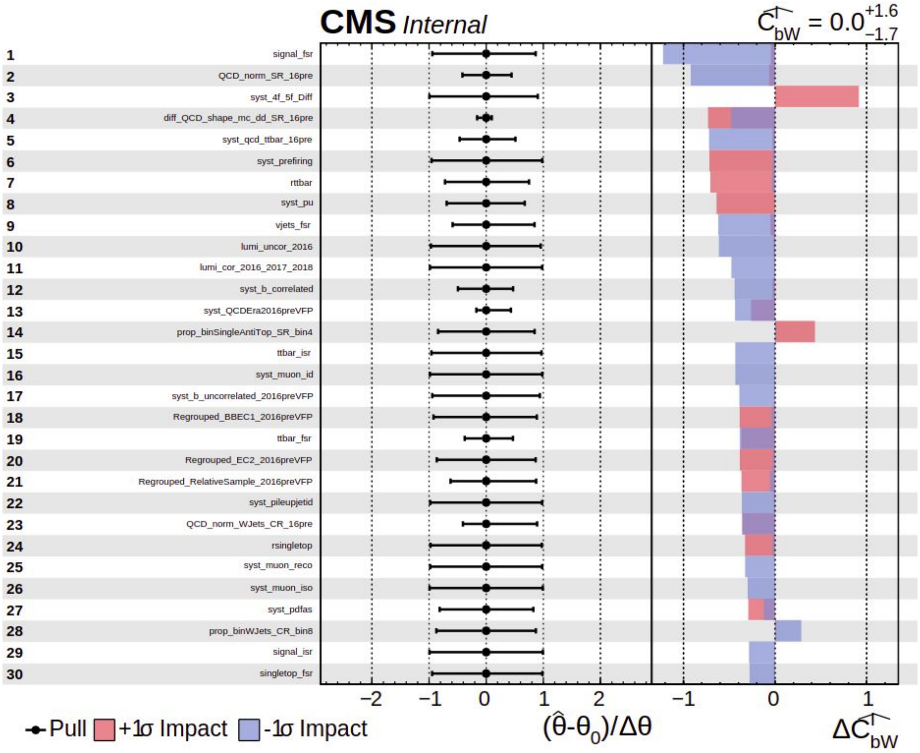


C^{l}_{bW}

2016post



2016pre



Sensitivity of the analysis for different BDT cuts

BDT > 0.2

Uncertainty Breakdown for k_cuWPh

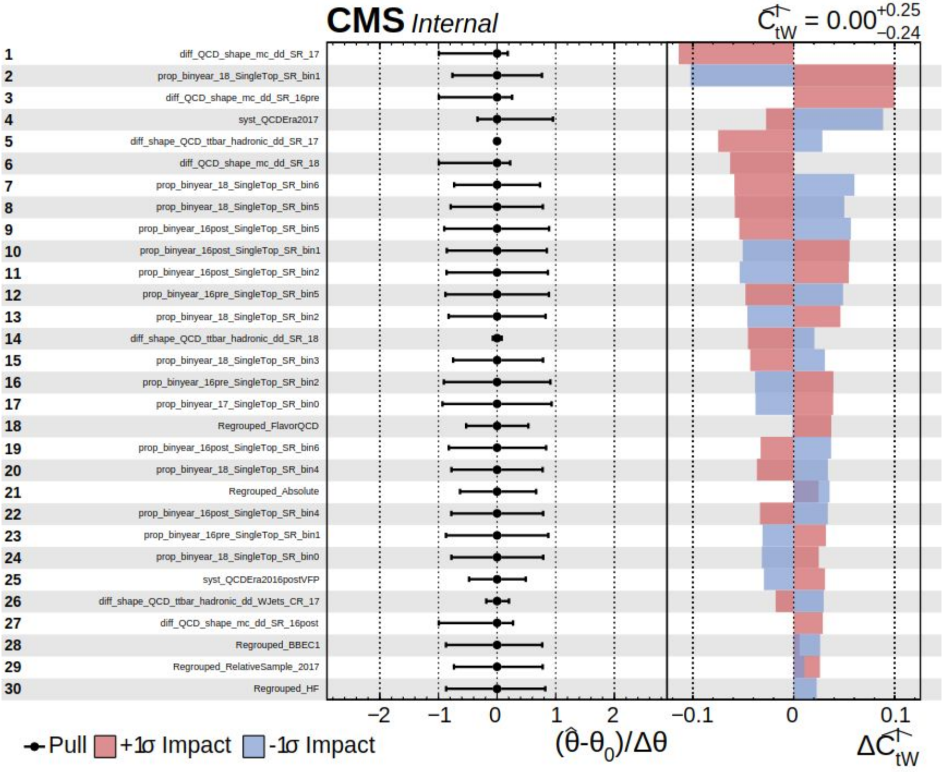
Category	Value
Best fit k_cuWPh	-0.000
Total uncertainty	+0.237 -0.234
Stat. uncertainty	+0.118 -0.118
MC stat. uncertainty	+0.177 -0.175
Other syst. uncert.	+0.105 -0.102

BDT > 0.8

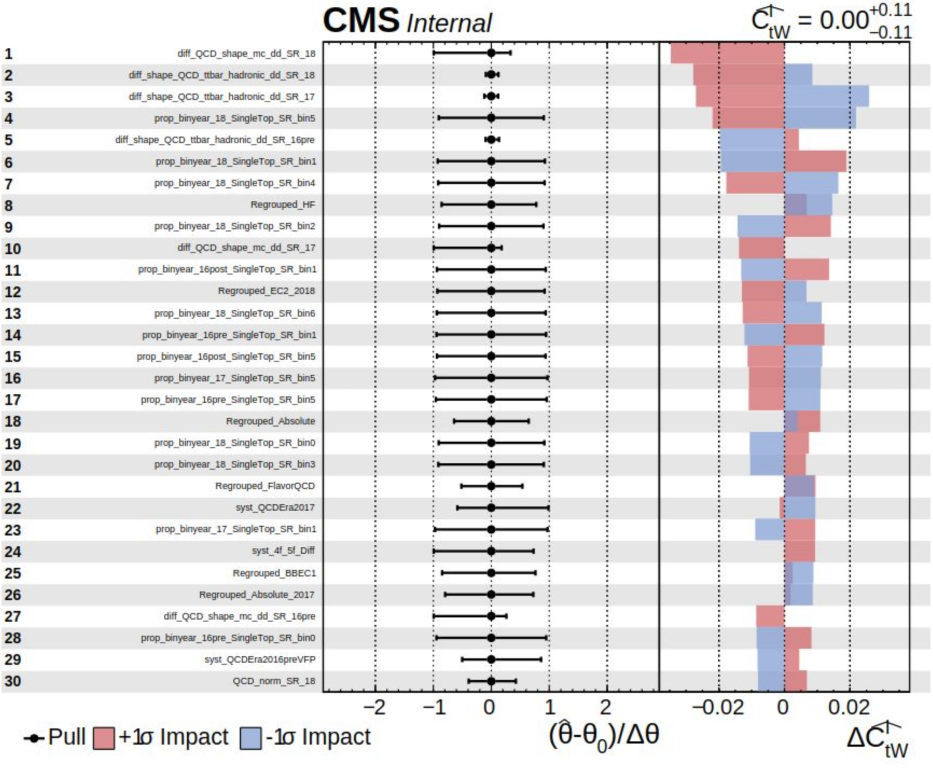
Uncertainty Breakdown for k_cuWPh

Category	Value
Best fit k_cuWPh	0.000
Total uncertainty	+0.113 -0.113
Stat. uncertainty	+0.088 -0.088
MC stat. uncertainty	+0.052 -0.052
Other syst. uncert.	+0.047 -0.049

BDT > 0.2

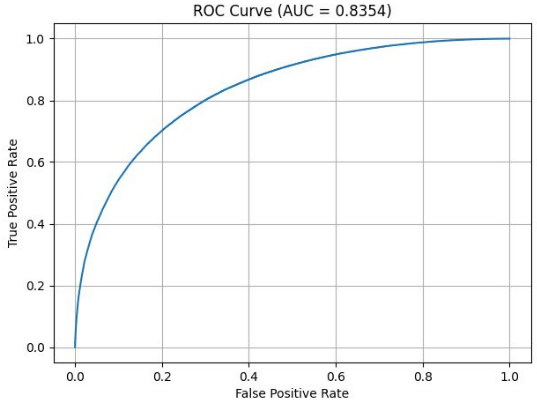

CMS Internal
$\hat{C}_{tW} = 0.00^{+0.25}_{-0.24}$
1 diff_QCD_shape_mc_dd_SR_17
2 prop_binyear_18_SingleTop_SR_bin1
3 diff_QCD_shape_mc_dd_SR_16pre
4 syst_QCDEra2017
5 diff_shape_QCD_ttbar_hadronic_dd_SR_17
6 diff_QCD_shape_mc_dd_SR_18
7 prop_binyear_18_SingleTop_SR_bin6
8 prop_binyear_18_SingleTop_SR_bin5
9 prop_binyear_16post_SingleTop_SR_bin5
10 prop_binyear_16post_SingleTop_SR_bin1
11 prop_binyear_16post_SingleTop_SR_bin2
12 prop_binyear_16pre_SingleTop_SR_bin5
13 prop_binyear_18_SingleTop_SR_bin2
14 diff_shape_QCD_ttbar_hadronic_dd_SR_18
15 prop_binyear_18_SingleTop_SR_bin3
16 prop_binyear_16pre_SingleTop_SR_bin2
17 prop_binyear_17_SingleTop_SR_bin0
18 Regrouped_FlavorQCD
19 prop_binyear_16post_SingleTop_SR_bin6
20 prop_binyear_18_SingleTop_SR_bin4
21 Regrouped_Absolute
22 prop_binyear_16post_SingleTop_SR_bin4
23 prop_binyear_16pre_SingleTop_SR_bin1
24 prop_binyear_18_SingleTop_SR_bin0
25 syst_QCDEra2016postVFP
26 diff_shape_QCD_ttbar_hadronic_dd_WJets_CR_17
27 diff_QCD_shape_mc_dd_SR_16post
28 Regrouped_BBEC1
29 Regrouped_RelativeSample_2017
30 Regrouped_HF
−2 −1 0 1 2
$(\hat{\theta}-\theta_0)/\Delta\theta$
−0.1 0 0.1
$\Delta\hat{C}_{tW}$
Pull +1σ Impact -1σ Impact

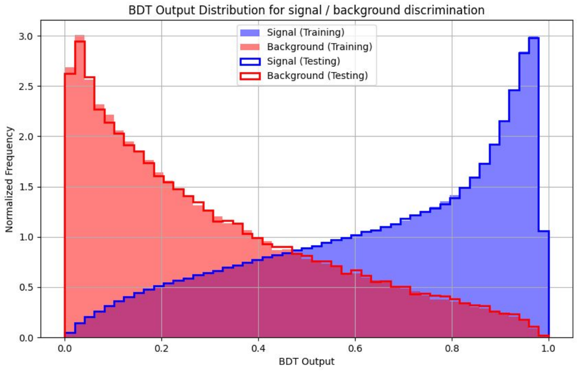
BDT > 0.8


CMS Internal
$\hat{C}_{tW} = 0.00^{+0.11}_{-0.11}$
1 diff_QCD_shape_mc_dd_SR_18
2 diff_shape_QCD_ttbar_hadronic_dd_SR_18
3 diff_shape_QCD_ttbar_hadronic_dd_SR_17
4 prop_binyear_18_SingleTop_SR_bin5
5 diff_shape_QCD_ttbar_hadronic_dd_SR_16pre
6 prop_binyear_18_SingleTop_SR_bin1
7 prop_binyear_18_SingleTop_SR_bin4
8 Regrouped_HF
9 prop_binyear_18_SingleTop_SR_bin2
10 diff_QCD_shape_mc_dd_SR_17
11 prop_binyear_16post_SingleTop_SR_bin1
12 Regrouped_EC2_2018
13 prop_binyear_18_SingleTop_SR_bin6
14 prop_binyear_16pre_SingleTop_SR_bin1
15 prop_binyear_16post_SingleTop_SR_bin5
16 prop_binyear_17_SingleTop_SR_bin5
17 prop_binyear_16pre_SingleTop_SR_bin5
18 Regrouped_Absolute
19 prop_binyear_18_SingleTop_SR_bin0
20 prop_binyear_18_SingleTop_SR_bin3
21 Regrouped_FlavorQCD
22 syst_QCDEra2017
23 prop_binyear_17_SingleTop_SR_bin1
24 syst_4f_5f_Diff
25 Regrouped_BBEC1
26 Regrouped_Absolute_2017
27 diff_QCD_shape_mc_dd_SR_16pre
28 prop_binyear_16pre_SingleTop_SR_bin0
29 syst_QCDEra2016preVFP
30 QCD_norm_SR_18
−2 −1 0 1 2
$(\hat{\theta}-\theta_0)/\Delta\theta$
−0.02 0 0.02
$\Delta\hat{C}_{tW}$
Pull +1σ Impact -1σ Impact

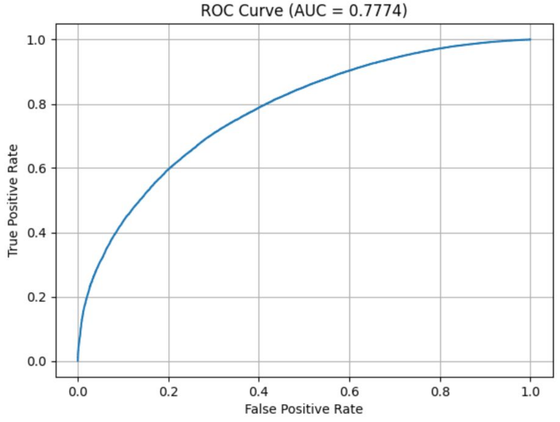
Complements on the BDT

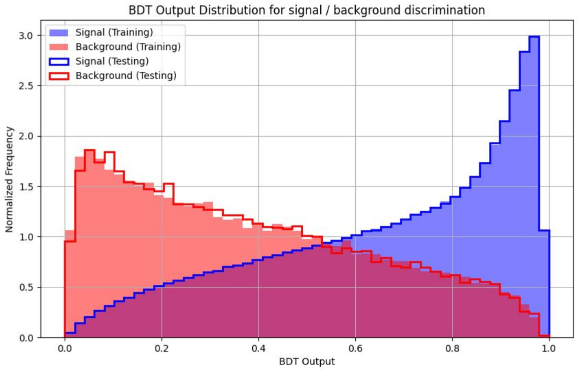
W+jets



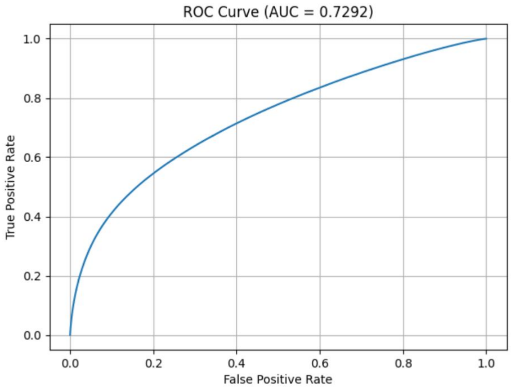


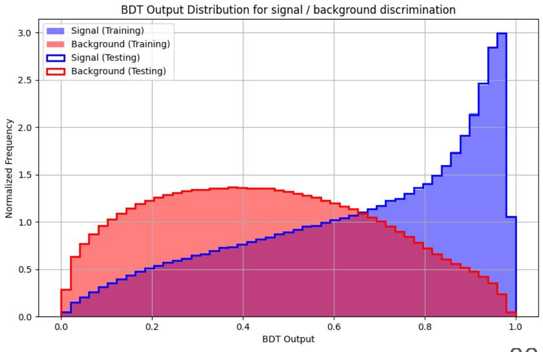
QCD





$t\bar{t}$





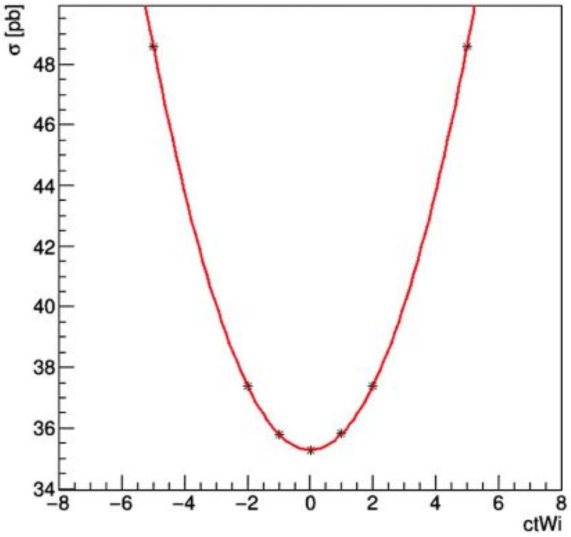
EFT impact on top width and cross section

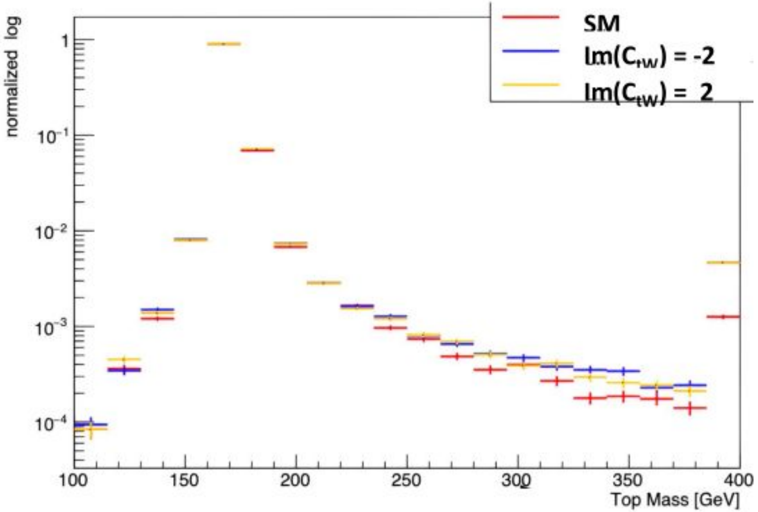
$$\mathcal{M} = \mathcal{M}_{SM} + \sum_i \frac{c_i}{\Lambda^2}\overbrace{\mathcal{M}_i}^{\text{BSM Matrix Element}}$$

$$\sigma \propto |\mathcal{M}|^2$$

Quadratic behavior on the cross section as expected, [EPJC 78 (2018) 999].

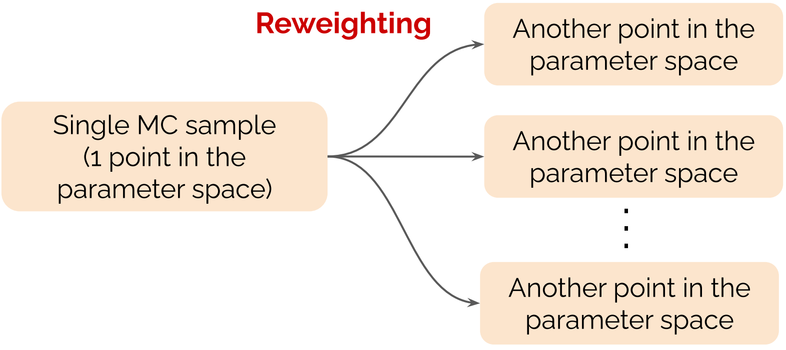
Same quadratic behavior with the top width.
N.B. First sample in CMS that has top width varying with EFT value.





Reweighting technique

- We produce a simulation sample for single top production including EFT coefficients at top production and decay
- Reweighting method: different regions of the parameter space to be probed with a single Monte Carlo (MC) sample



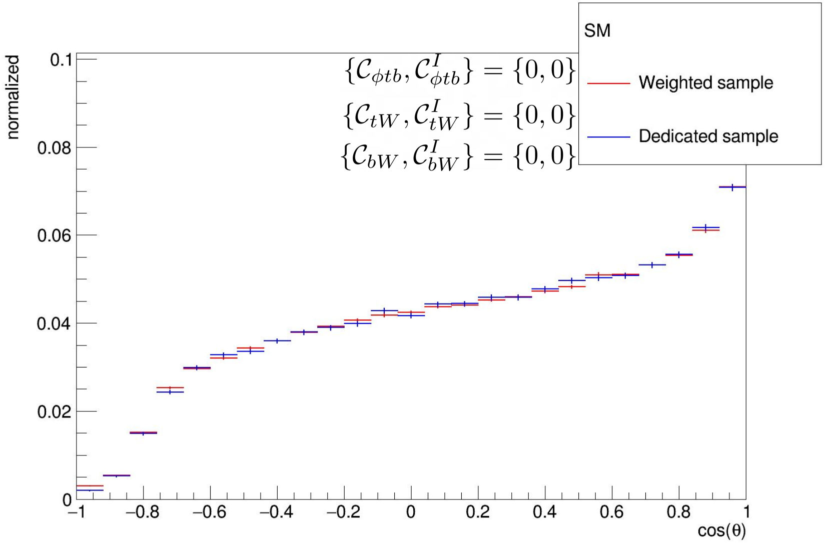
$$\{ C_{tW} , C^{I}_{tW} \} = \{-2,0,2\}$$
$$\{ C_{bW} , C^{I}_{bW} \} = \{-2,0,2\}$$
$$\{ C_{\varphi tb} , C^{I}_{\varphi tb} \} = \{-5,0,5\}$$

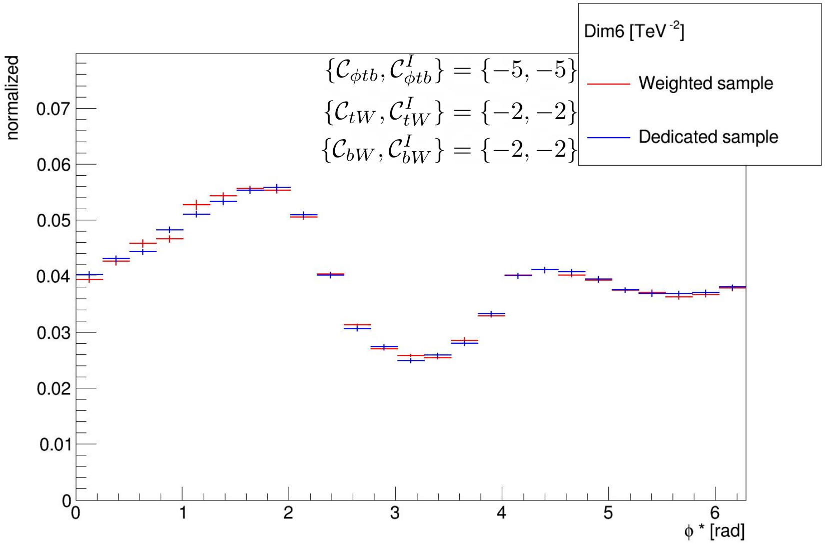
Our 6 axes of the parameter space — Different combination values

1 simulation $\longrightarrow$ **729 points**

The reweighting method allows to produce a single sample instead of 729

Reweighting technique

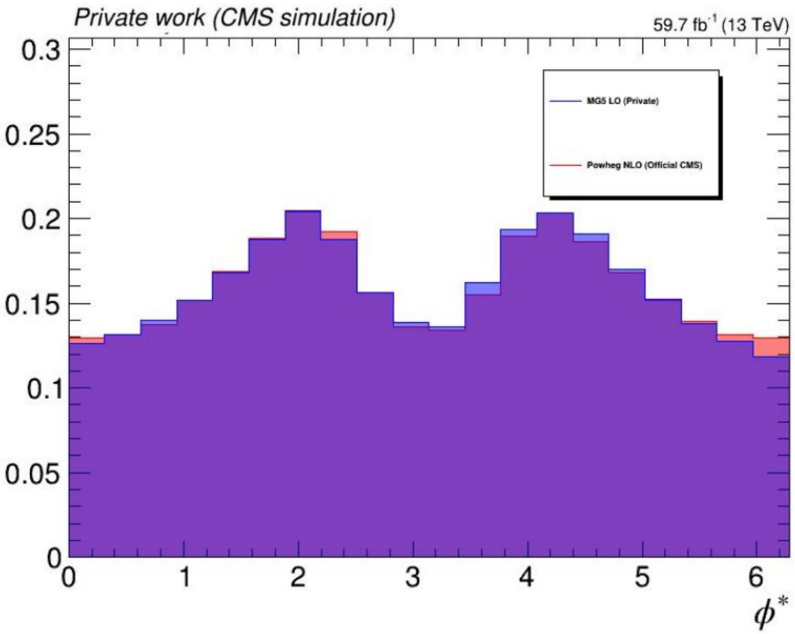


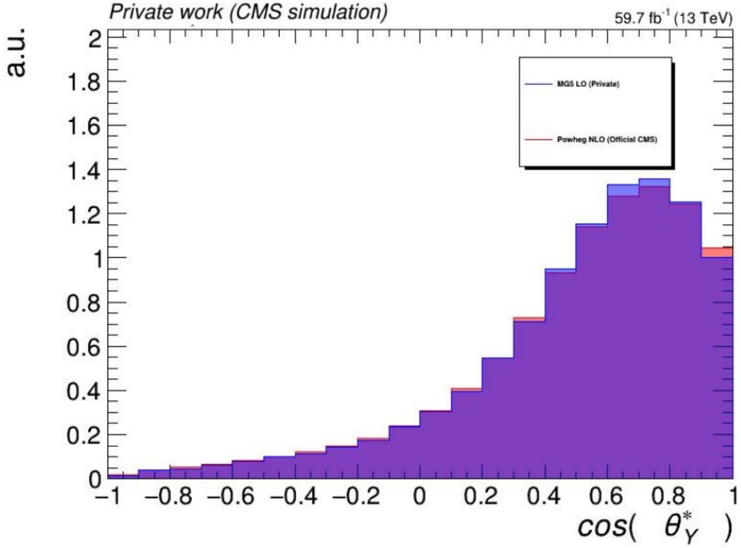


Comparing reweighted distributions of cos(θ) and ϕ^* to dedicated (non-reweighted) samples at two different distant points of the parameter space

➔ **Reweighting is validated**

Reweighting technique





Reweighting technique