

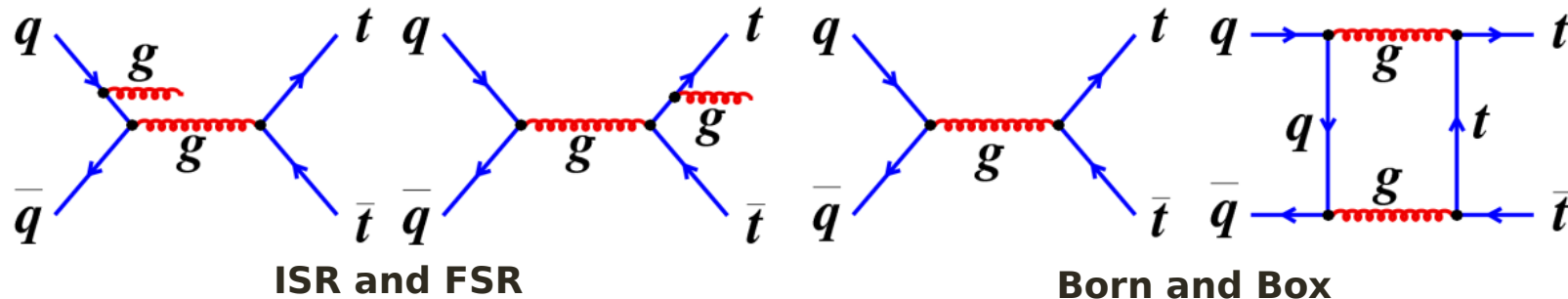
Measurements of the charge asymmetry in top-quark pair production in the dilepton final state at 8 TeV with the ATLAS detector

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- Roger Naranjo on behalf of the ATLAS Collaboration

Introduction

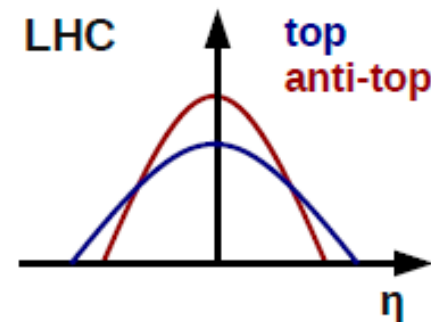
- Effect comes from interferences between NLO processes.
- Top is preferentially emitted in the direction of the incoming quark.



At the LHC:

- antiquark → sea quark
- quark → valence quark

Different Momenta
between Top/Antitop



The observables:

Top based asymmetry:

$$\Delta|y| = |y_{top}| - |y_{antitop}| \quad A_c = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| < 0) + N(\Delta|y| > 0)}$$

Lepton based asymmetry:

$$\Delta|\eta| = |\eta_+^\ell| - |\eta_-^\ell| \quad A_c^{lep} = \frac{N(\Delta|\eta| > 0) - N(\Delta|\eta| < 0)}{N(\Delta|\eta| < 0) + N(\Delta|\eta| > 0)}$$

Analysis Strategy

— Lepton Asymmetry
— Top Asymmetry

Selection

Kinematic Reconstruction

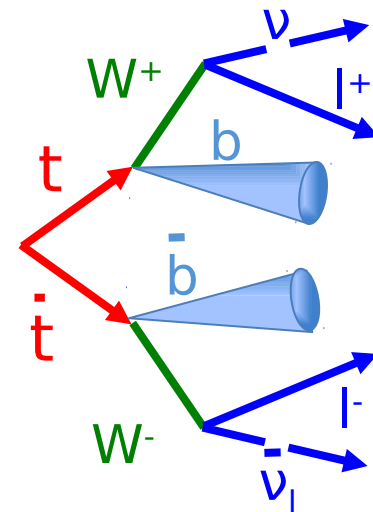
Unfolding

(Inclusive and differential)

Particle Level
(Fiducial Measurement)

Parton Level
(Full phase-space)

Dilepton channel



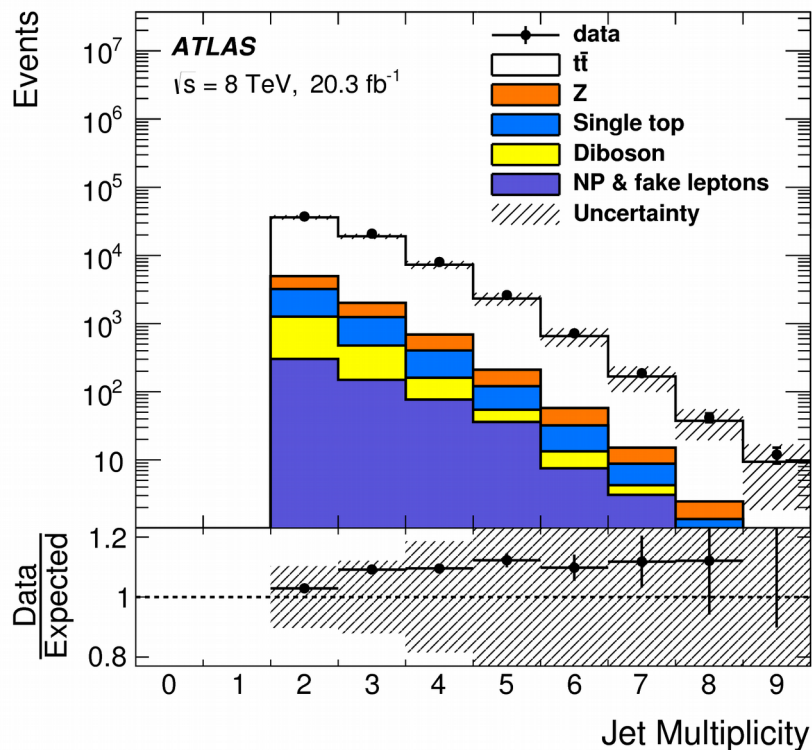
Differential measurements are performed as a function of the boost ($\beta_z^{t\bar{t}}$), mass ($m_{t\bar{t}}$) and transverse momentum ($p_T^{t\bar{t}}$) of the top pair system:

Enhance the asymmetry value
→ Discriminant for different BSM models

Selection

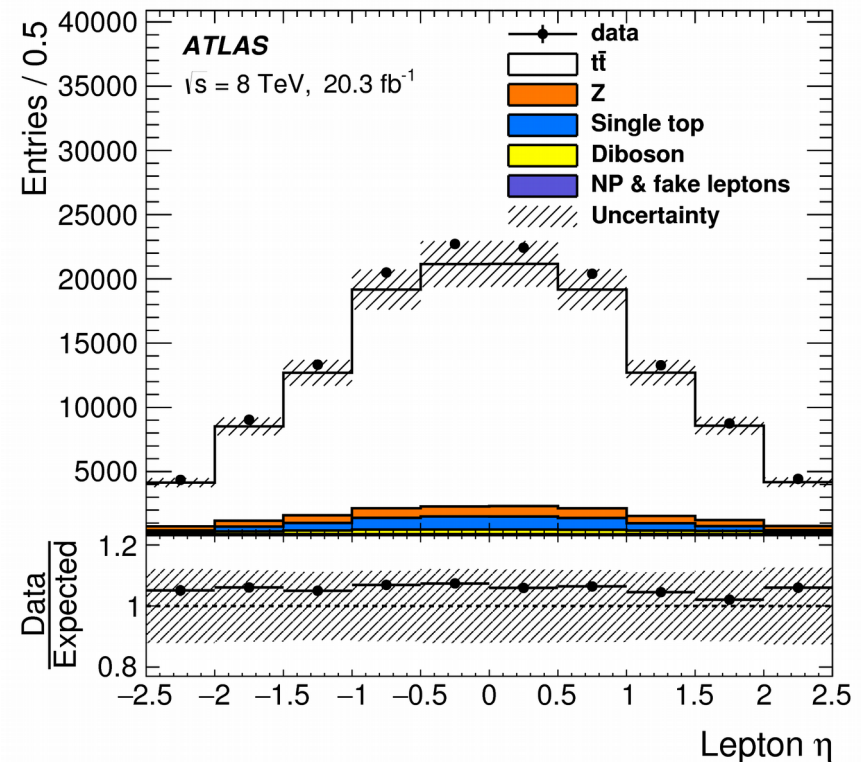
• Selection

- Channels $ee/e\mu/\mu\mu$ are considered
- 2 leptons with opposite charge
- At least 2 jets
- $ee/\mu\mu$: Z-veto, $MET > 30$ GeV
- $e\mu$: $H_t > 130$ GeV
- B-tagging in ee and $\mu\mu$



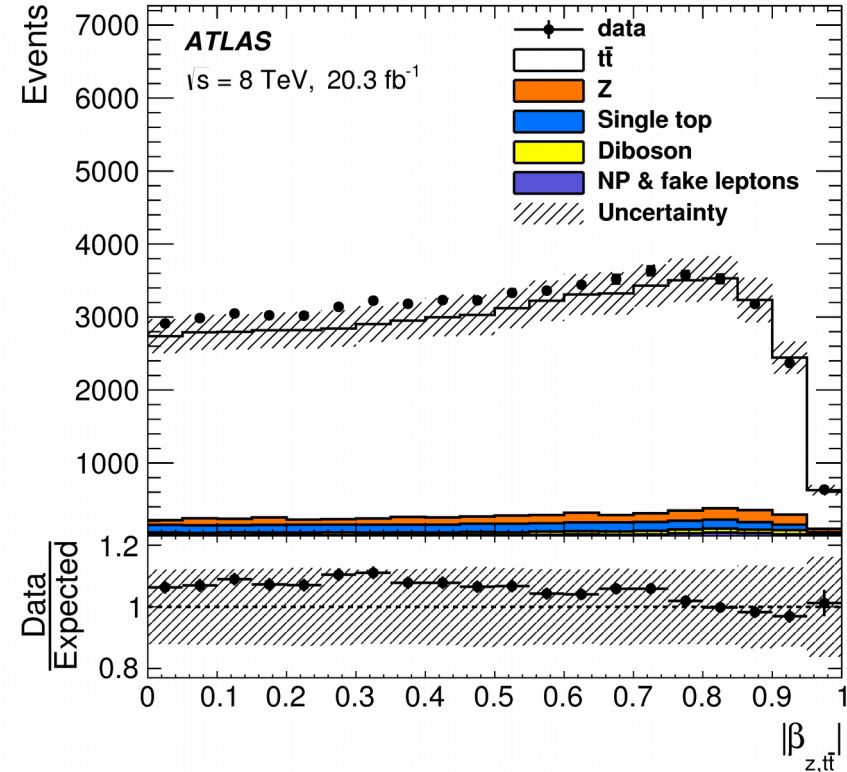
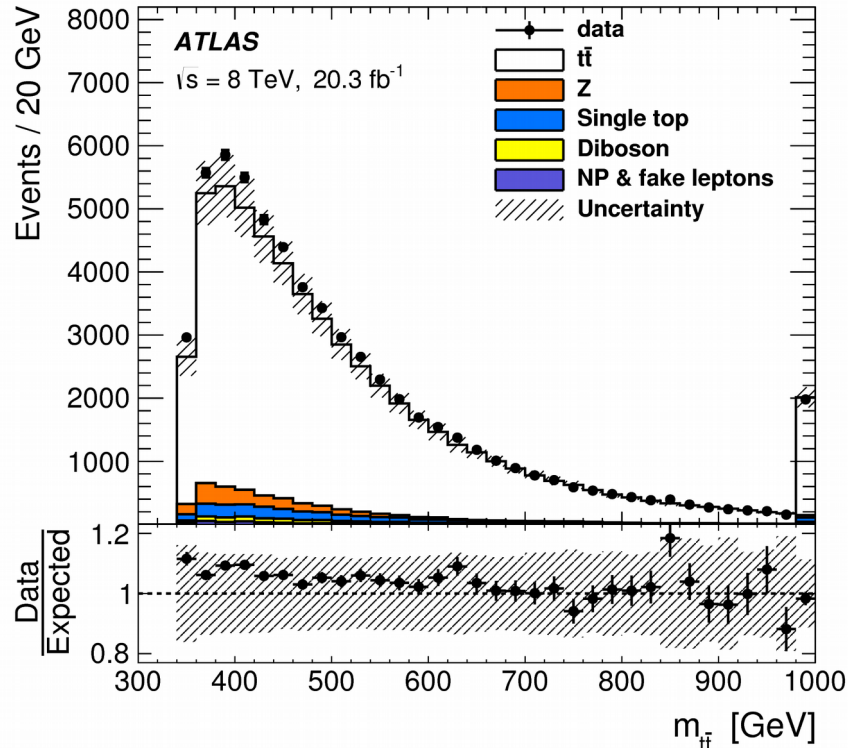
• The background contributions

- Diboson: Alpgen + Herwig
- Drell-Yan: Alpgen + Pythia + data driven SF
- Single Top – Wt channel: Powheg+Pythia
- Mis-identified leptons (fakes): Monte Carlo + data driven SF



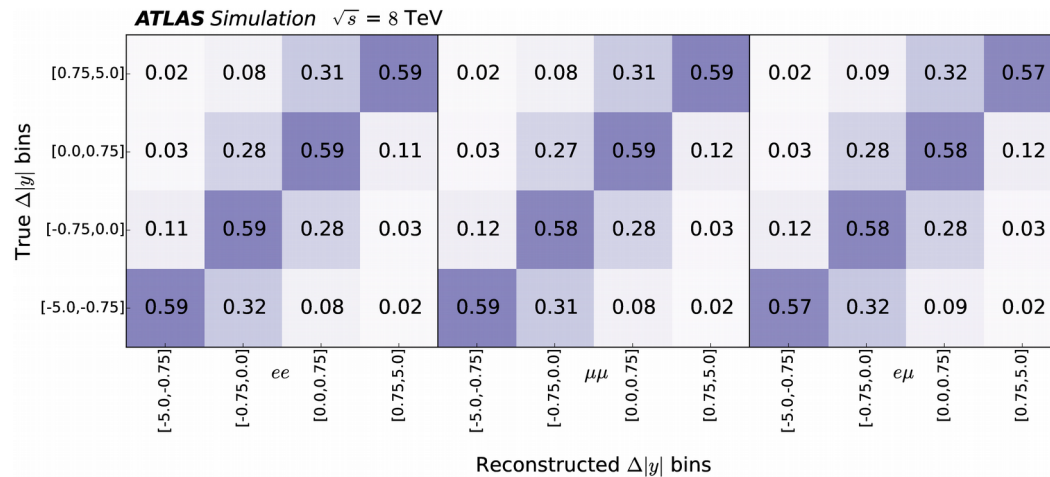
Kinematic Reconstruction

- Top quark's kinematics has to be reconstructed in order to compute the charge asymmetry.
- Under-constrained system: 2 neutrinos – MET
- KIN Method is used to solve the system
 - System of equations is solved numerically assuming top and W mass

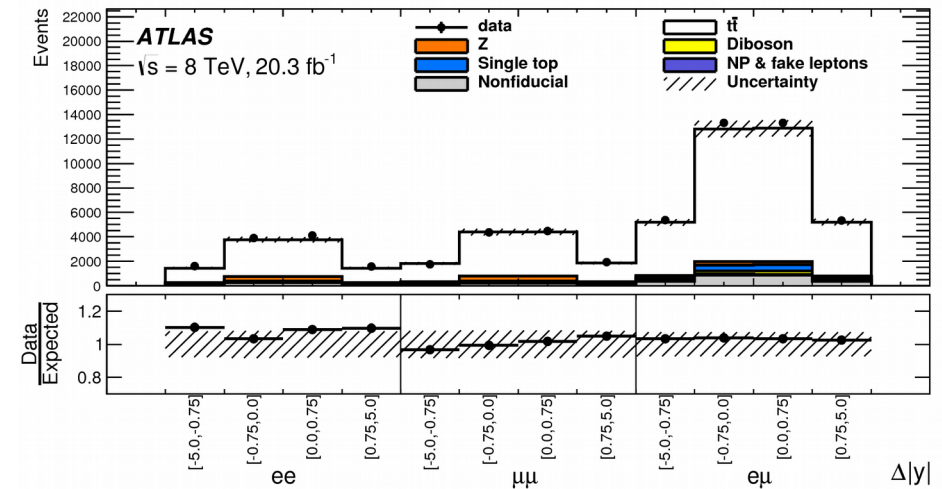


Unfolding

- Using Fully Bayesian Unfolding (FBU)
 - Based on Bayes Theorem $\rho(\mathbf{T}|\mathbf{D}) \propto \mathcal{L}(\mathbf{D}|\mathbf{T}) \cdot \pi(\mathbf{T})$
 - The unfolded asymmetry value is obtained from the posterior probability density for all the scanned „Truth“ distributions.
 - Marginalization procedure is used for systematics computation.
 - Combination of the 3 channels is done within the method.



Response Matrix



Input distribution

Systematic Uncertainties

Leptonic Asymmetry

Absolute uncertainties in $A_C^{\ell\ell}$										
Fiducial volume						Full phase space				
	Statistics	Detector	Bkg	Signal modeling	Other	Statistics	Detector	Bkg	Signal modeling	Other
Inclusive	0.005	0.001	0.001	0.002	0.001	0.005	0.001	0.001	0.004	0.001
$m_{t\bar{t}}$ 0–500 GeV	0.008	0.002	0.001	0.005	0.005	0.008	0.002	0.001	0.005	0.006
500–2000 GeV	0.012	0.004	< 0.001	0.013	0.005	0.011	0.004	< 0.001	0.014	0.005
$\beta_{t\bar{t}}$ 0–0.6	0.007	0.003	< 0.001	0.004	0.004	0.007	0.002	< 0.001	0.005	0.005
0.6–1.0	0.010	0.005	0.001	0.005	0.004	0.010	0.003	0.001	0.006	0.004
$p_T^{t\bar{t}}$ 0–30 GeV	0.015	0.009	0.001	0.015	0.006	0.015	0.010	0.001	0.017	0.007
30–1000 GeV	0.011	0.004	0.001	0.012	0.005	0.010	0.004	0.001	0.013	0.006

Dominant

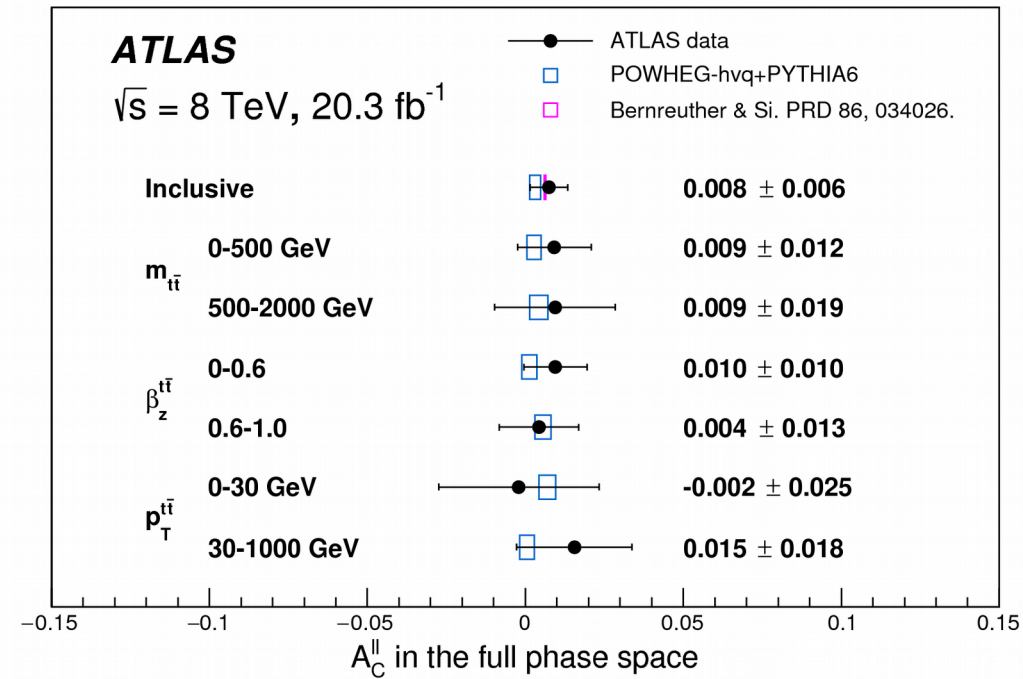
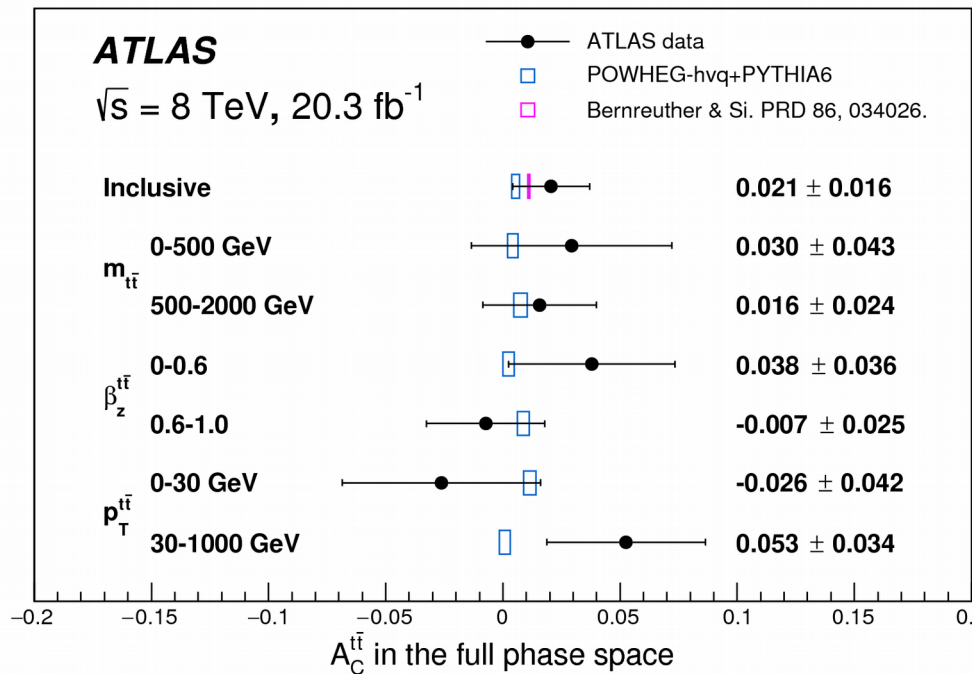
uncertainties are
Signal Modeling
and the Kinematic Reconstruction

Top Asymmetry

Absolute uncertainties in $A_C^{t\bar{t}}$										
Fiducial volume						Full phase space				
	Statistics	Detector	Bkg	Signal modeling	Other	Statistics	Detector	Bkg	Signal modeling	Other
Inclusive	0.013	0.008	< 0.001	0.007	0.007	0.011	0.006	< 0.001	0.008	0.006
$m_{t\bar{t}}$ 0–500 GeV	0.030	0.024	0.001	0.016	0.021	0.028	0.021	0.002	0.018	0.020
500–2000 GeV	0.018	0.007	< 0.001	0.015	0.009	0.015	0.006	< 0.001	0.016	0.008
$\beta_{t\bar{t}}$ 0–0.6	0.023	0.021	0.002	0.014	0.018	0.023	0.019	0.002	0.015	0.017
0.6–1.0	0.021	0.009	0.001	0.013	0.011	0.018	0.009	0.001	0.013	0.010
$p_T^{t\bar{t}}$ 0–30 GeV	0.035	0.019	0.003	0.018	0.020	0.031	0.015	0.004	0.019	0.017
30–1000 GeV	0.027	0.015	0.003	0.018	0.017	0.025	0.013	0.003	0.014	0.015

Reduction of the modeling uncertainties in the fiducial region

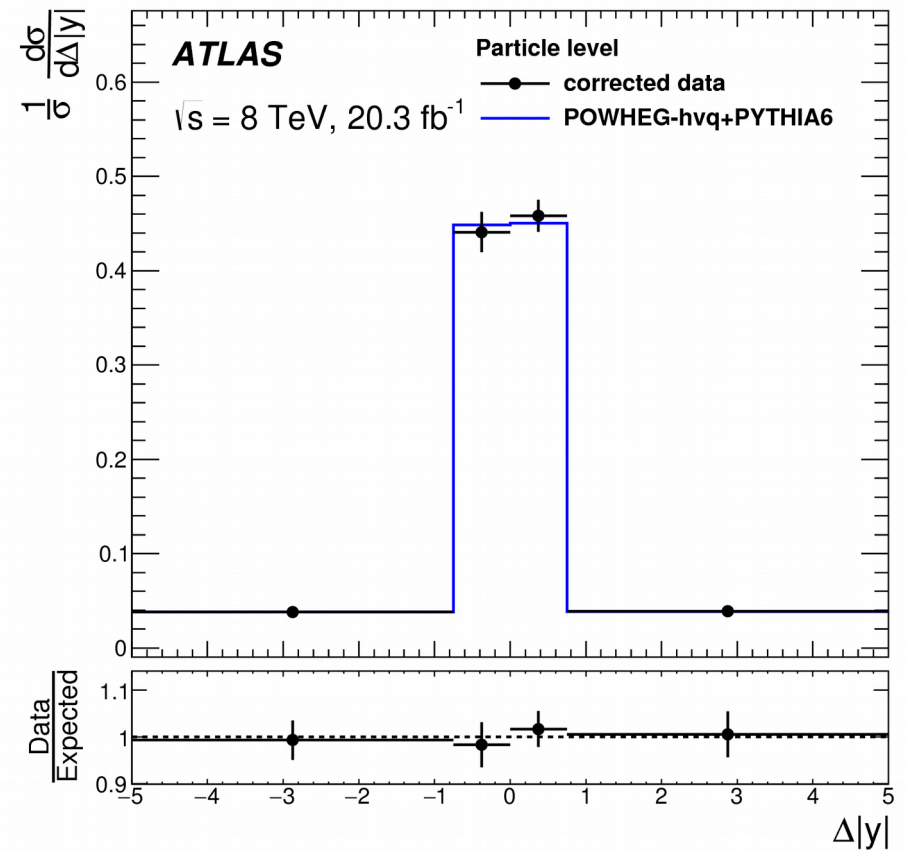
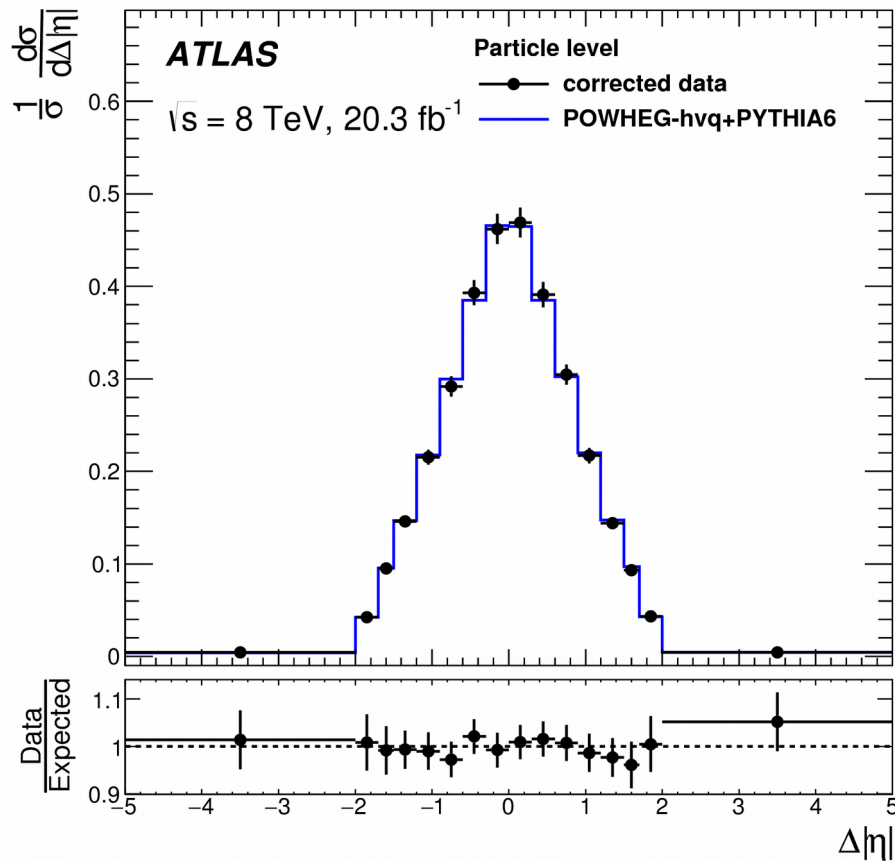
Results



Results are compatible with SM predictions

Similar behaviour in the fiducial region

Results



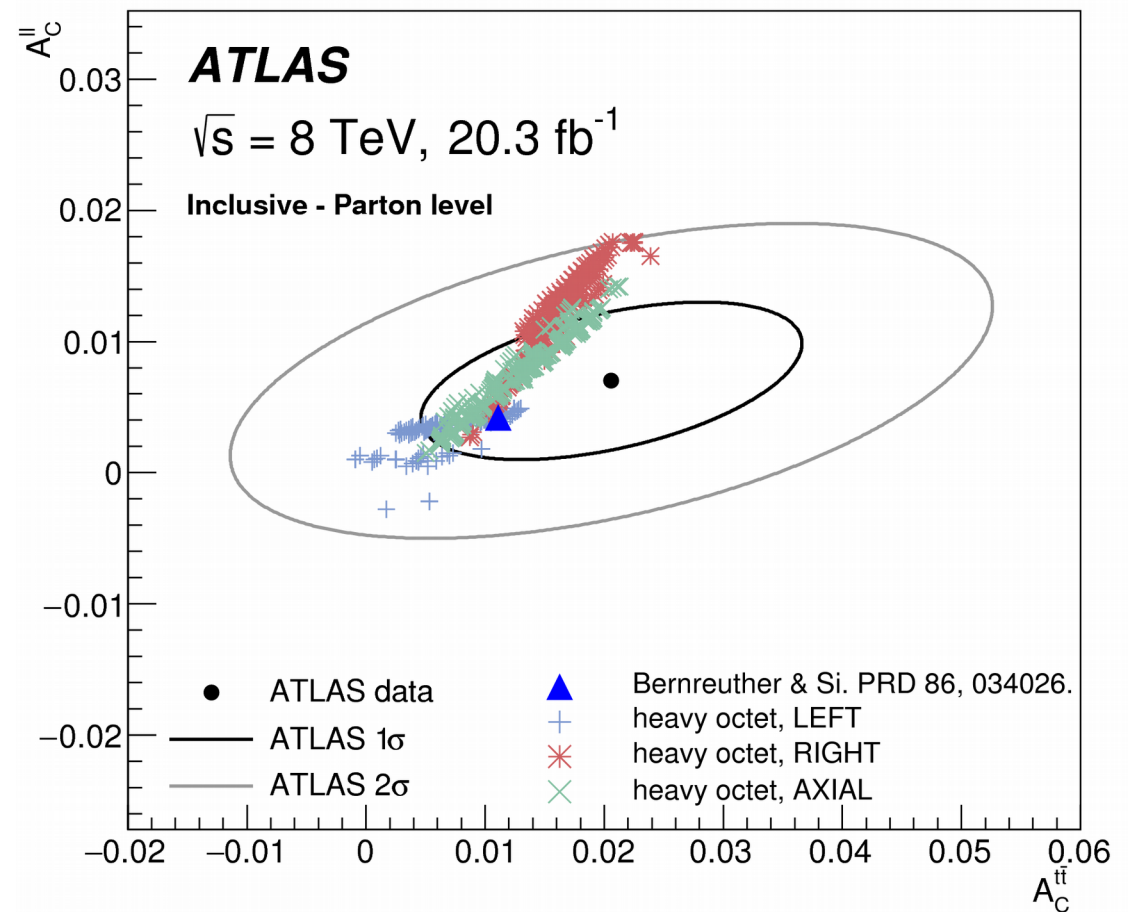
Unfolded distributions are compatible with the distribution provided by POWHEG-hvq

Results

The leptonic and top asymmetry measurement can be compared to different BSM models

Correlations between the measurements is about of 49%

The measurements are statistically limited



Summary

- Inclusive and differential measurements of the charge asymmetry at 8 TeV in the dilepton channel were presented.
- For the top pair reconstruction the KIN method is used.
- The Fully Bayesian Unfolding (FBU) is applied as unfolding procedure.
 - Systematic uncertainties are evaluated within the method using marginalization.
 - Unfolding back to:
 - Parton Level
 - Particle level
- Results are compatible with SM predictions
- Increased the precision by factor of ~ 2 with respect to the 7 TeV results
- More statistics will further constrain the different BSM model

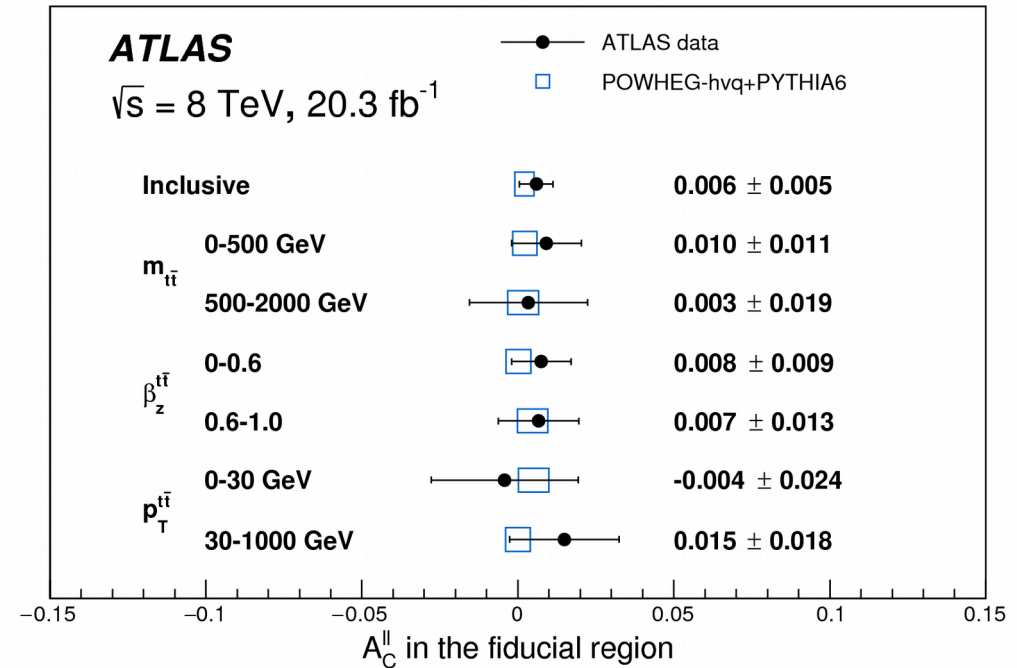
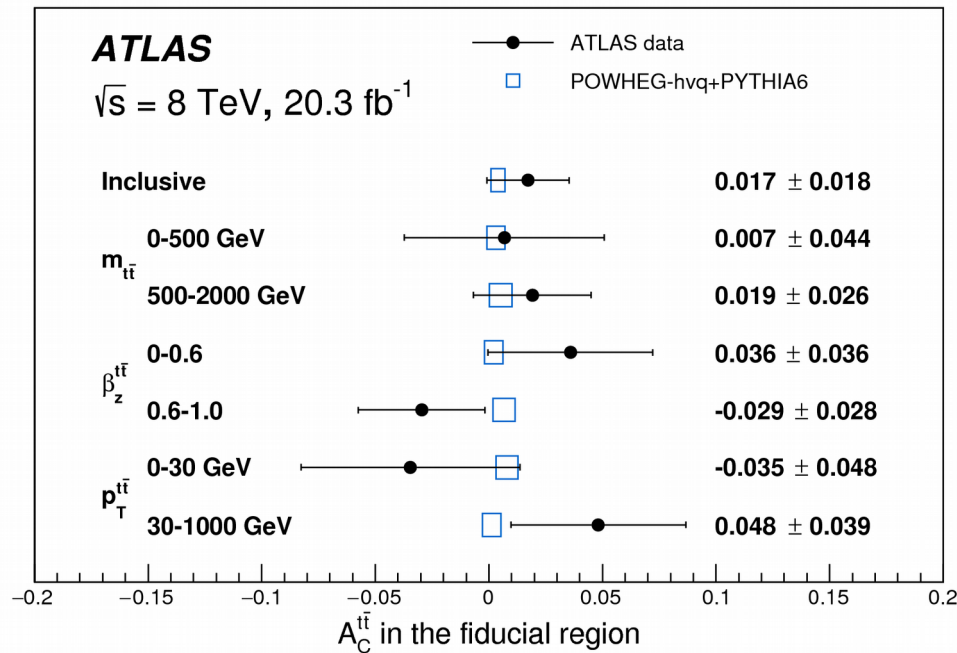


Backup

Yields

Channel	ee	$\mu\mu$	$e\mu$
$t\bar{t}$	10200 ± 800	12100 ± 800	36000 ± 2400
Single-top	510 ± 50	590 ± 50	1980 ± 170
Diboson	31 ± 5	40 ± 6	1320 ± 100
$Z \rightarrow ee$ (DD)	1200 ± 260	—	—
$Z \rightarrow \mu\mu$ (DD)	—	1520 ± 300	—
$Z \rightarrow \tau\tau$ (DD/MC)	31 ± 15	58 ± 25	1120 ± 430
NP & fake leptons (DD)	62^{+119}_{-29}	45^{+36}_{-24}	480^{+240}_{-220}
Total Expected	12010^{+860}_{-850}	14350 ± 830	40900 ± 2450
Data	12785	14453	42363

Results for the fiducial region



Results are compatible with SM predictions

Used Binning

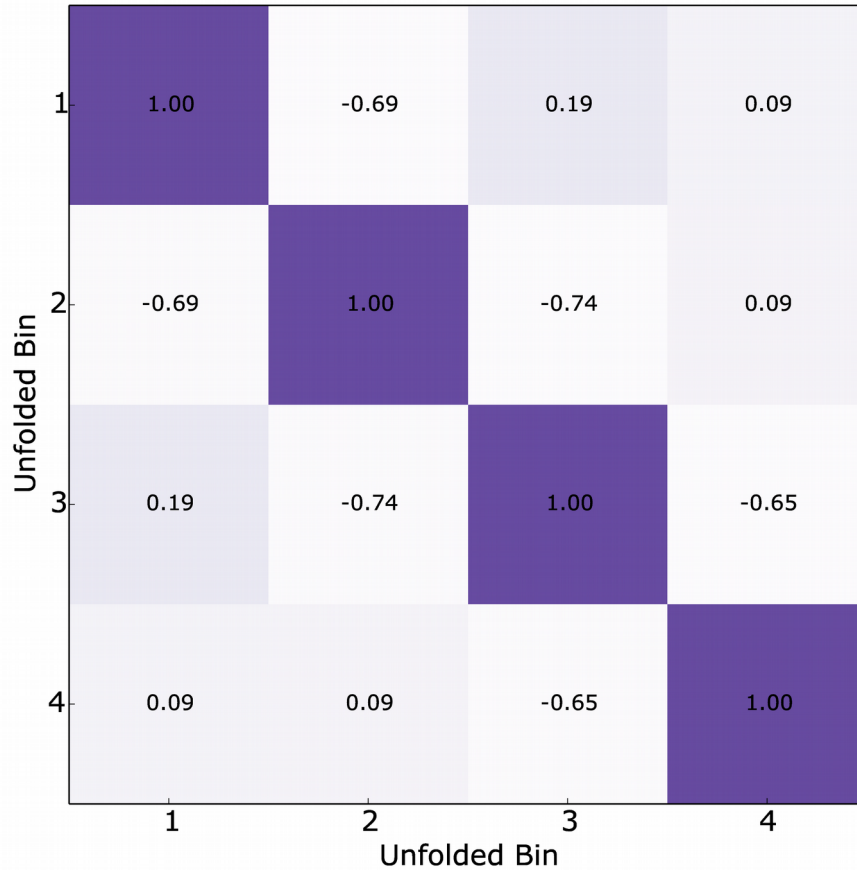
	$\Delta \eta $	$\Delta y $
Inclusive	[0.0, 0.3, 0.6, 0.9, 1.2, 1.5, 1.7, 1.9, 5.0]	[0.0, 0.75, 5.0]
$m_{t\bar{t}}$	0–500 GeV	[0.0, 0.8, 5.0]
	500–2000 GeV	[0.0, 1.4, 5.0]
$\beta_{t\bar{t}}$	0–0.6	[0.0, 0.8, 5.0]
	0.6–1.0	[0.0, 1.2, 5.0]
$p_T^{t\bar{t}}$	0–30 GeV	[0.0, 0.7, 5.0]
	30–1000 GeV	[0.0, 0.7, 5.0]

Binning Correlation

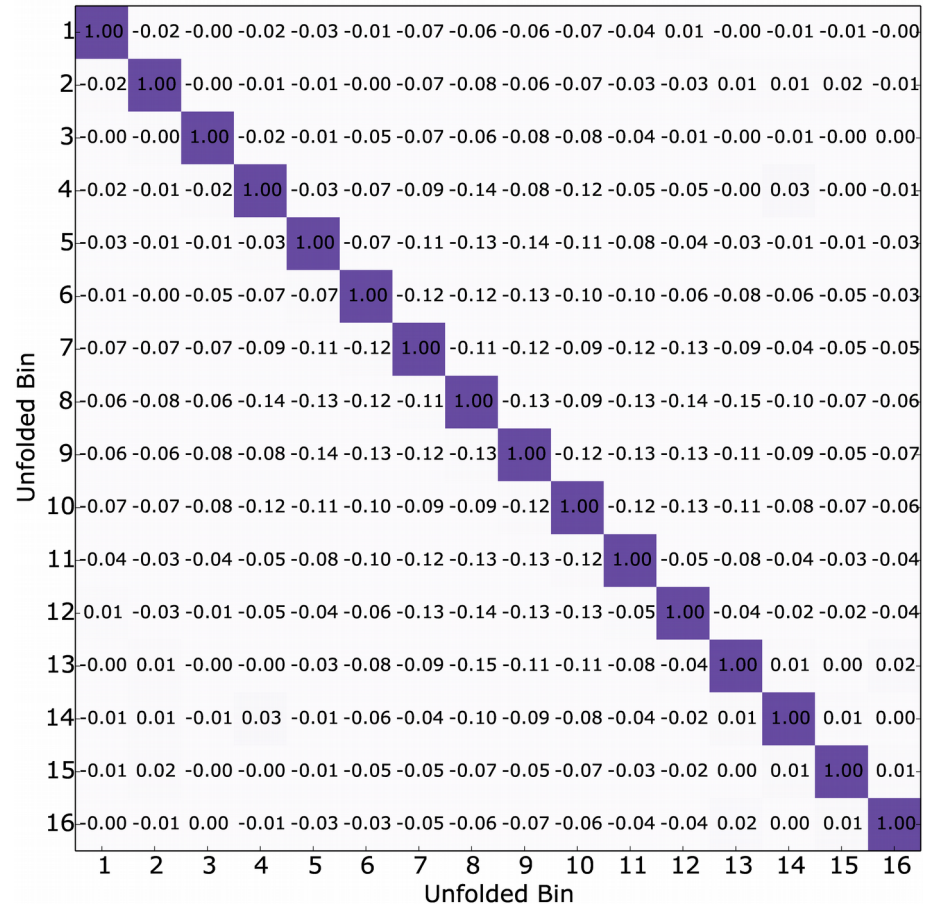
Top Asymmetry

Leptonic Asymmetry

ATLAS $\sqrt{s} = 8 \text{ TeV}$, 20.3 fb^{-1}



ATLAS $\sqrt{s} = 8 \text{ TeV}$, 20.3 fb^{-1}



Response Matrices

