TOP-ANTITOP ENERGY ASYMMETRY IN JET-ASSOCIATED TOP-QUARK PAIR PRODUCTION AT ATLAS

Introduction and Motivation

- Measurement of the top-antitop energy asymmetry in the semileptonic $t\bar{t}$ decay channel in the boosted phase space using 139 fb^{-1} of pp collision data collected by the ATLAS detector at the LHC at $\sqrt{s} = 13$ TeV
- The energy asymmetry is sensitive to the top-quark chirality in four-quark operators and thus a valuable new observable in global SMEFT fits

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Top energy asymmetry observable

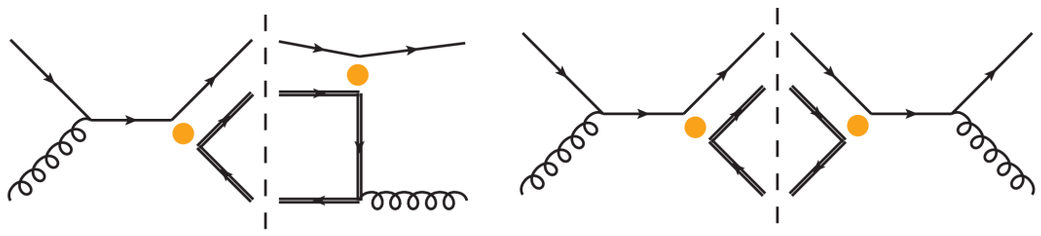
- Energy asymmetry A_E in $t\bar{t}j$ production

$$A_E(\theta_j) = \frac{\sigma^{opt}(\theta_j|\Delta E > 0) - \sigma^{opt}(\theta_j|\Delta E < 0)}{\sigma^{opt}(\theta_j|\Delta E > 0) + \sigma^{opt}(\theta_j|\Delta E < 0)}$$

$$\sigma^{opt}(\theta_j) = \sigma(\theta_j|y_{ttj} > 0) + \sigma(\pi - \theta_j|y_{ttj} < 0)$$

where both $\Delta E = E_t - E_{\bar{t}}$ and the jet scattering angle θ_j are defined in the $t\bar{t}j$ rest frame

- Final state $t\bar{t}j$ tends to be boosted into the direction of the incoming quark, which can thus be 'guessed' via y_{ttj}

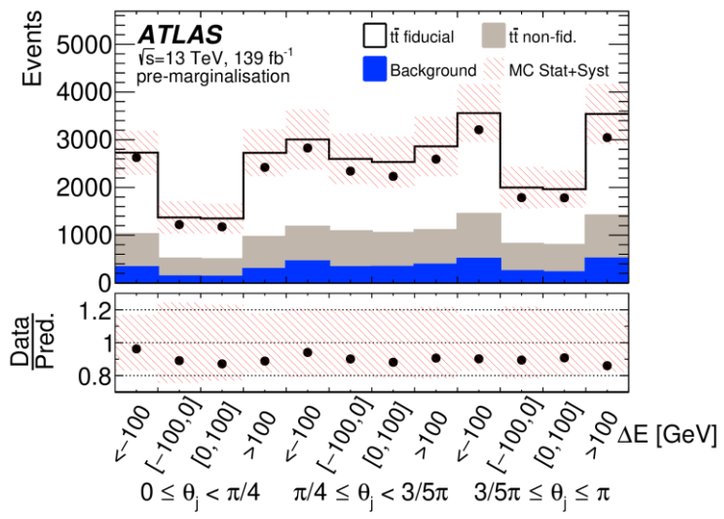


- A_E is generated in qg-production, which is much more abundant than $q\bar{q}$ production
- A_E increases with the associated jet p_T

Measurement strategy

- Fully Bayesian Unfolding from detector to particle level to correct for detector resolution and acceptance effects:

$$P(T|D,M) \propto \mathcal{L}(D|T,M)\pi(T)$$

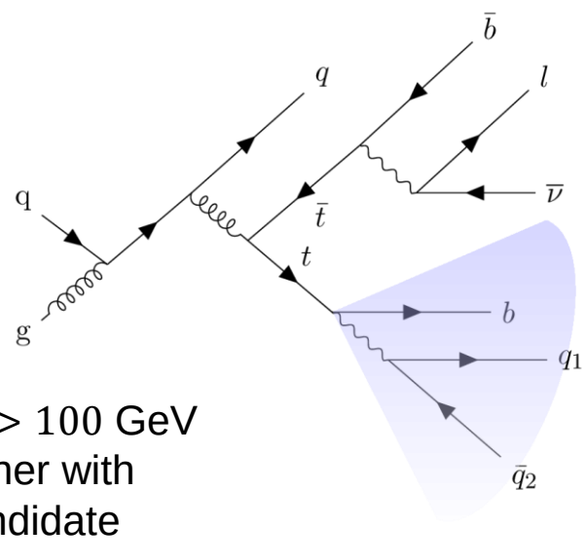


- MC simulations for response matrix and estimation of background processes with prompt leptons
- Data-driven matrix method for background processes with fake or non-prompt leptons
- Nuisance parameters for systematic uncertainties

Event selection and reconstruction

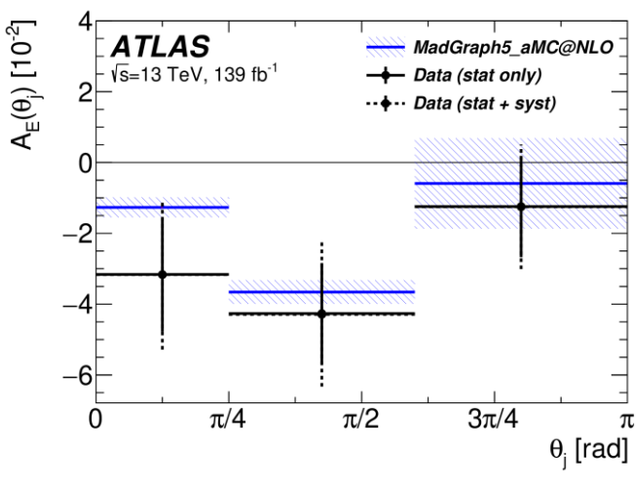
- Boosted topology enhances the asymmetry and eases the reconstruction due to less combinatorial possibilities
- Semileptonic decay to infer the top-quark charge from the lepton

- Hadronic top candidate:
  Large-R jet with $p_T > 350$ GeV identified with a DNN
- Leptonic top candidate:
  1 lepton (electron or muon)
  1 neutrino
  1 small-R jet
- Associated small-R jet with $p_T > 100$ GeV
- ≥ 1 b-tagged jet associated either with the hadronic or leptonic top candidate



Measurement results

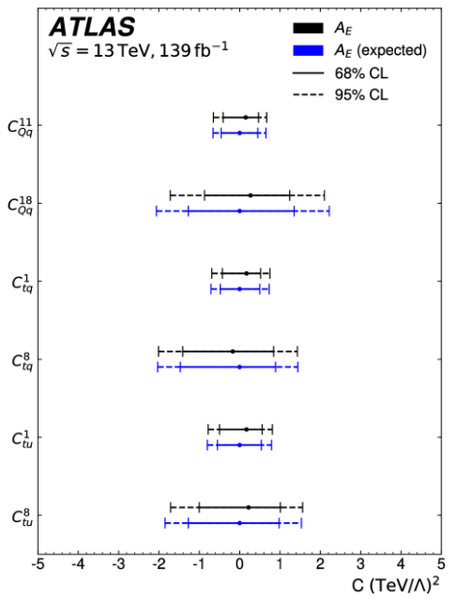
- Agreement with the SM prediction at NLO in QCD
- Data statistical uncertainty dominates
- $t\bar{t}$ modelling and jet energy resolution are the largest systematic uncertainties



$A_E \pm \Delta A_E\ [10^{-2}]$

	$0 \leq \theta_j \leq \pi/4$	$\pi/4 \leq \theta_j < 3\pi/5$	$3\pi/5 \leq \theta_j < \pi$
Data	-3.2 ± 2.1	-4.3 ± 2.0	-1.3 ± 1.8
SM	-1.3 ± 0.3	-3.7 ± 0.3	-0.6 ± 1.3

SMEFT interpretation

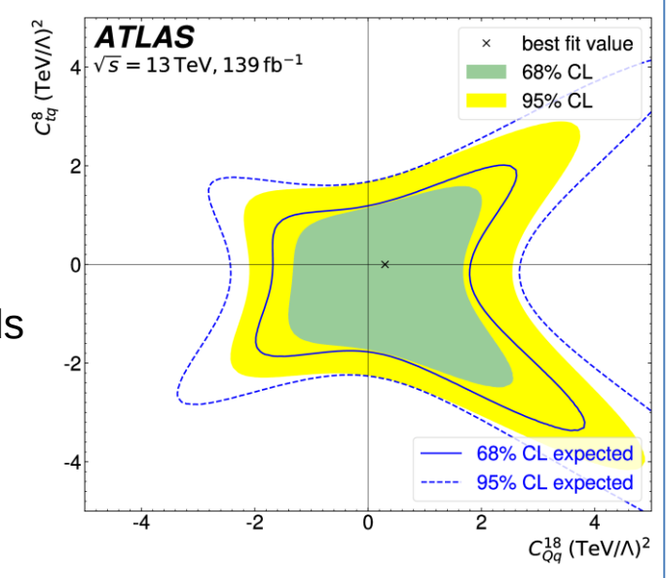


- Standard Model Effective Field Theory (SMEFT)

$$\mathcal{L}_{SMEFT} = \mathcal{L}_{SM} + \sum_k \frac{C_k}{\Lambda^2} O_k + \ ...$$

- Focus on six dimension-six operators with different chiral (LL,RR,LR) and colour structures (singlet, octet)
- χ^2 fits of the asymmetry for one- and two-dimensional confidence bounds

- Sensitivity similar to other observables in the top sector
- A_E probes new directions in the parameter space of Wilson coefficients



Alexander Basan, on behalf of the ATLAS Collaboration

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