Top physics results with ATLAS

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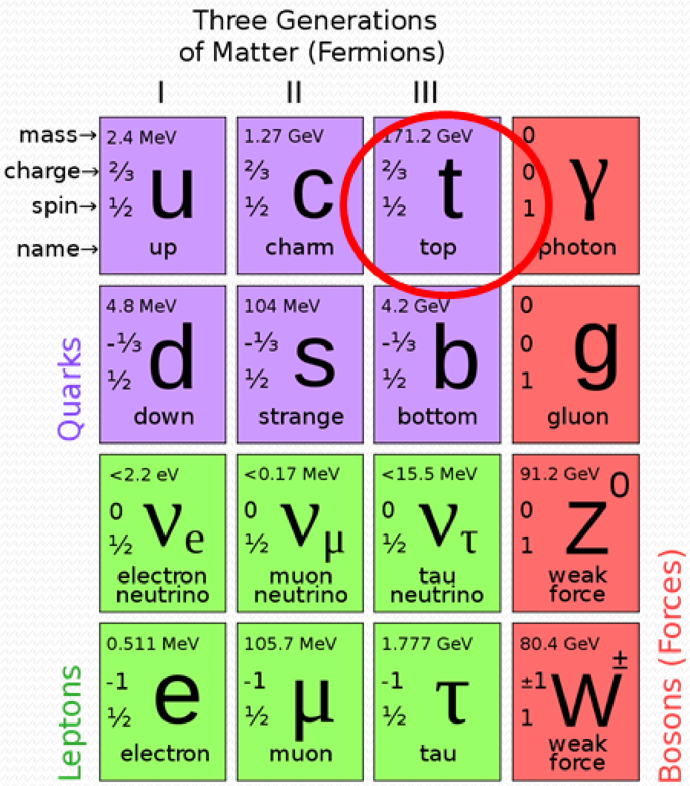
Outline

- Indroduction
- Cross section
  - $t\bar{t}$: inclusive and differential
  - Single top
  - $t\bar{t} + \gamma$ associate production
- Properties
  - Top mass
  - $t\bar{t}$ charge asymmetry
  - $t\bar{t}$ spin correlation
- Summary and conclusions

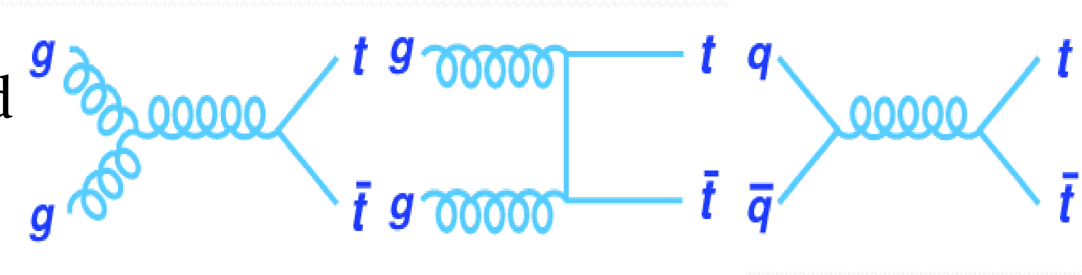
The Top quark

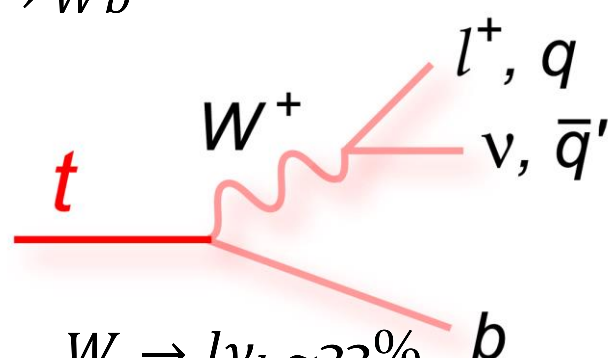


- Large mass: $m_{top} = (173.34 \pm 0.27 \pm 0.71)GeV$ (ATLAS, CDF, CMS, D0 Collaborations, arXiv:1403.4427)
- It decays before hadronization
  - → unique possibility to study a bare quark
- Masses of Top, W and Higgs are bounded:
  - → important consistency test on SM
- Large Yukawa coupling
  - → Special role in electroweak symmetry breaking and in BSM physics scenarios
- Privileged window to search for new physics

Top pair production and decays

- $t\bar{t}$ pairs produced mainly by gg fusions(87% @7TeV) and by $q\bar{q}$ annihilations (13%).
- Almost every top quark decays $t \to Wb$



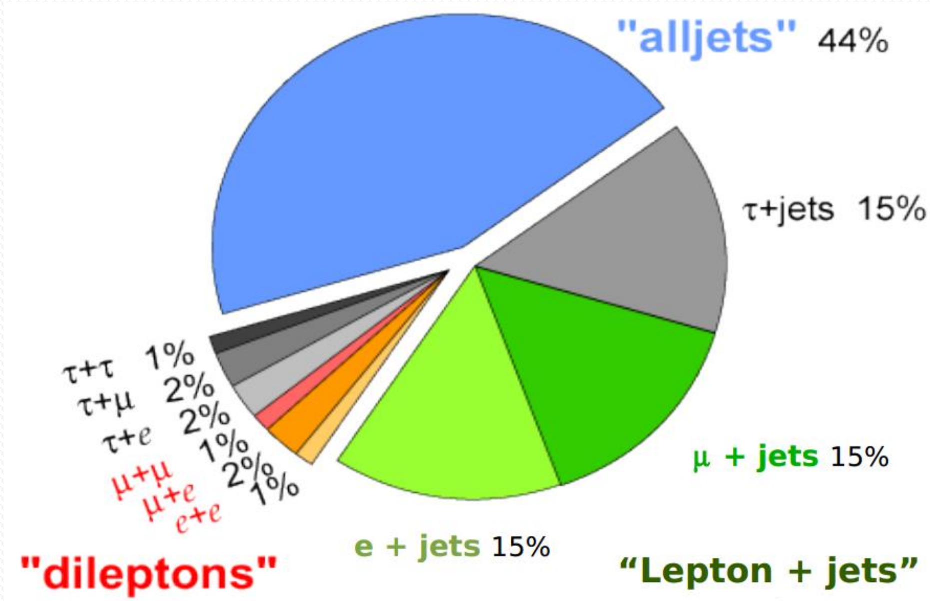


$W \to l\nu_l$ ~33%

$W \to q\bar{q}'$ ~66%

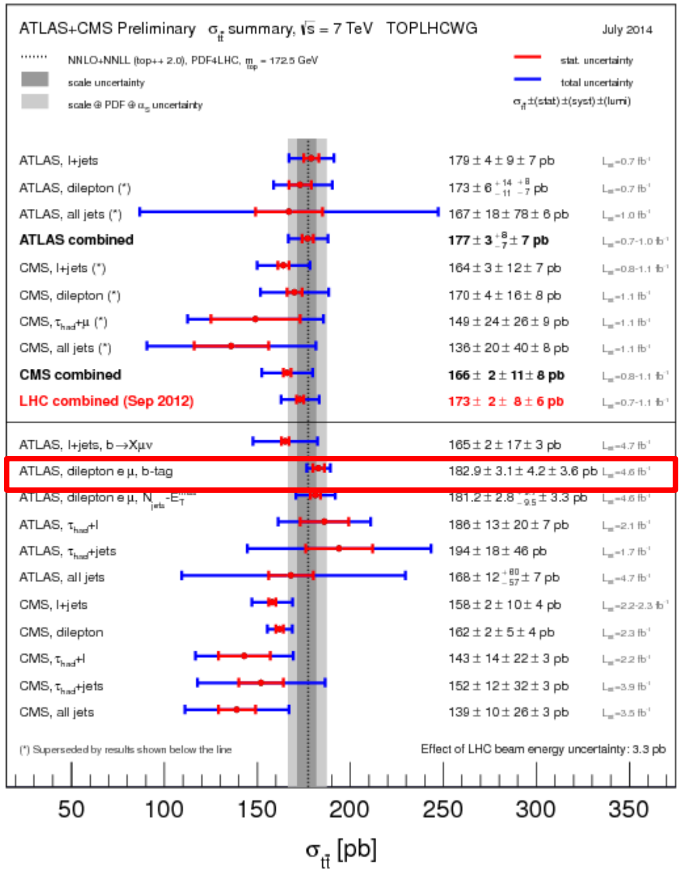
- Hadronic channel, single lepton channel and di-lepton channel

Top pair final states

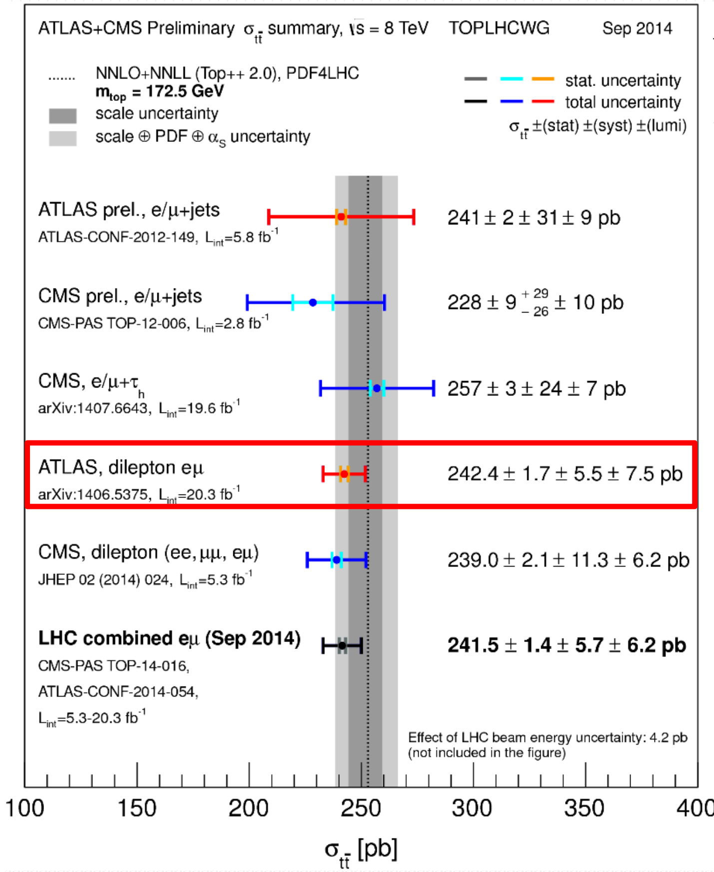


$t\bar{t}$ inclusive cross section: summary

$\sigma(t\bar{t})$ @ $\sqrt{s} = 7$ TeV



$\sigma(t\bar{t})$ @ $\sqrt{s} = 8$ TeV



All measurements are in good agreeement with the Standard Model

The experimental uncertainties (~4%) are better than theoretical ones

The most precise measurement is the one made in dilepton $e\mu$ channel

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/TOP/

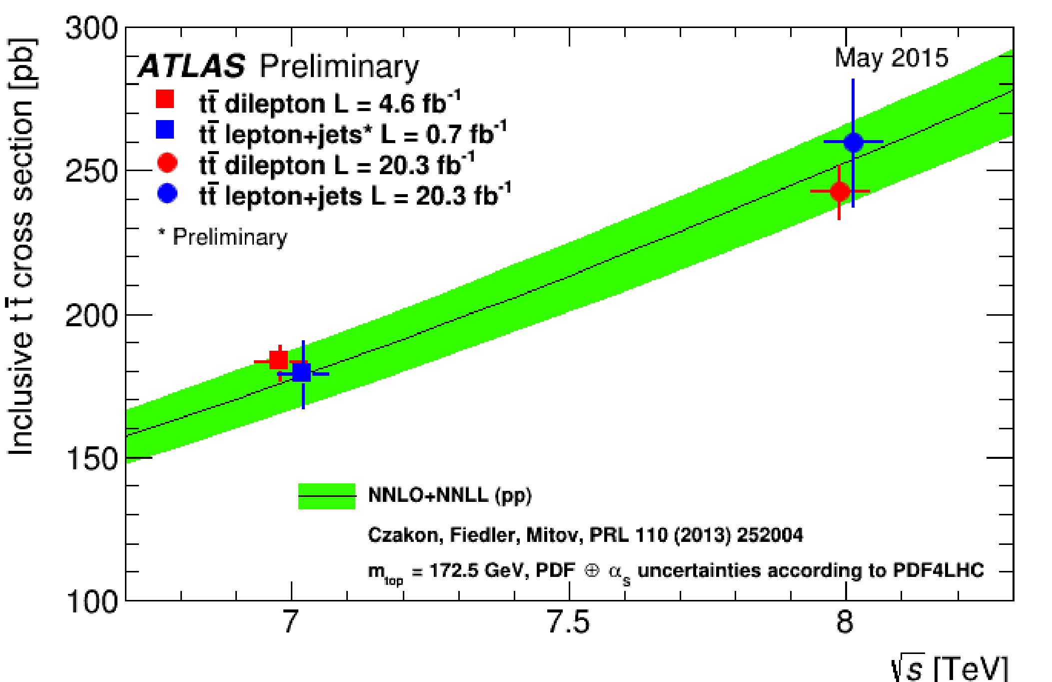
$t\bar{t}$ inclusive cross section

EPJC 74 (2014) 3109

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6$ fb^{-1}
$\sqrt{s} = 8$ TeV, $\int Ldt = 20.3$ fb^{-1}

***eμ* channel, the most sensitive one:**

Extract both total and fiducial $t\bar{t}$ production cross section, b-jet reconstruction and tagging efficiency in *1 btag* and *2 btag* samples, with significant reduction of major (btag) systematics



NNLO+NNLL calculations

7 TeV: $\sigma_{tt}^{th} = 177.3 \pm 9^{+4.6}_{-6.0}$ pb
8 TeV: $\sigma_{tt}^{th} = 252.9 \pm 11.7^{+6.4}_{-6.0}$ pb

Measured total cross section

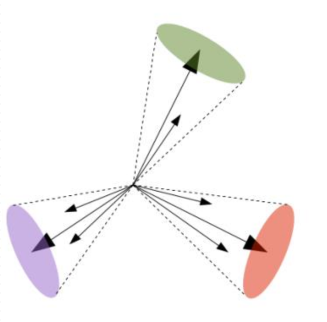
7 TeV: $\boldsymbol{\sigma_{t\bar{t}} = 182.9 \pm 7.1}$ pb (3.9%)
8 TeV: $\boldsymbol{\sigma_{t\bar{t}} = 242.4 \pm 10.3}$ pb (4.3%)

$t\bar{t}$ differential cross section measurements

The high statistics at the LHC allows to perform precision differential $\sigma_{t\bar{t}}$ measurements , which could unveil unexpected features (BSM).

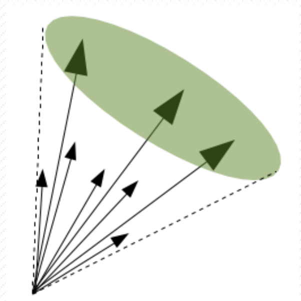
Different strategies are used, depending on the involved energy.

Resolved topology



- Top-quark decay products are well separated and can be recostructed individually.
- Top-antitop kinematic evaluated from the reconstructed decay products.

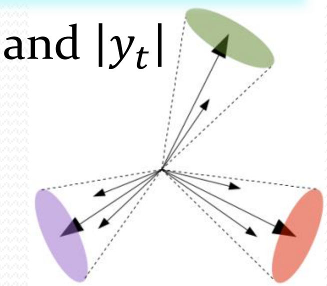
Boosted topology



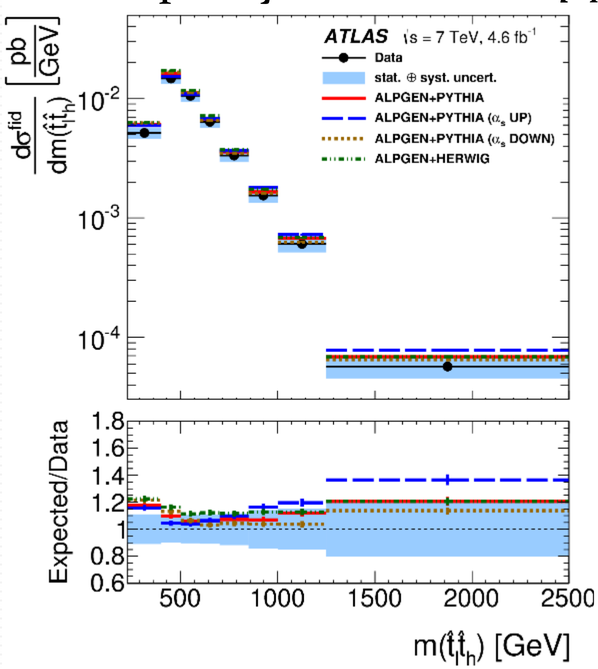
- For high-pt top quarks the decay products tend to become more and more collimated.
- Standard reconstruction becomes less efficient searching three distant objects.
- Hadronically decaying top quark is reconstructed in a single large radius jet.

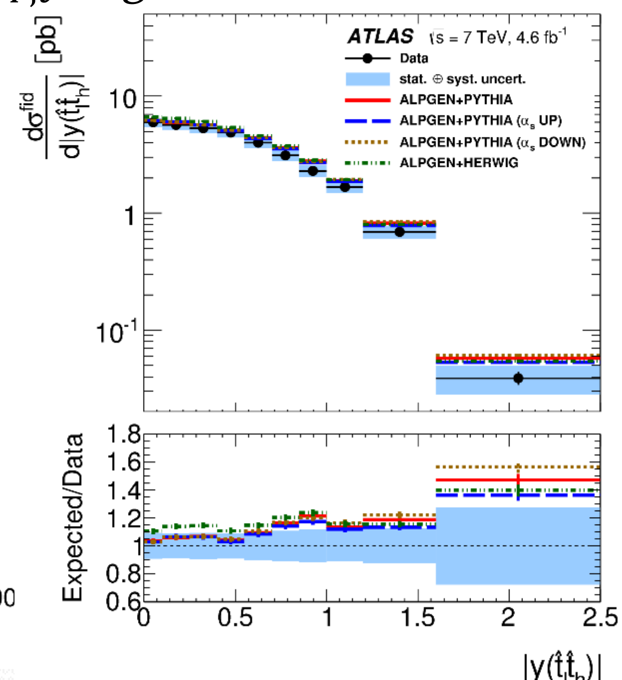
$t\bar{t}$ differential cross section: resolved topology

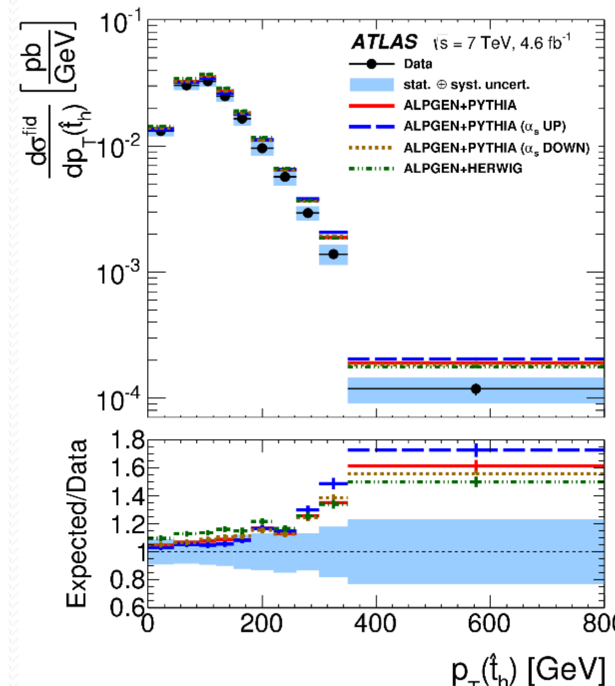
arXiv:1502.05923, Accepted by JHEP
$\sqrt{s} = 7$ TeV, $\int Ldt = 4.06$ fb^{-1}



- Top-antitop differential cross section $\left(\frac{d\sigma}{dX}\right)$ where $X = m_{t\bar{t}}, p_{\mathrm{T},t\bar{t}}, |y_{t\bar{t}}|, p_{T,t}$ and $|y_t|$
- Cut-based analysis in the l+jets channel
- Top quark reconstruction based on particle level objects
- The unfolded data distribution for $p_{T,t}$ is softer than the NLO prediction. Quite large discrepancy observed for $p_{T,t}$ larger than 200 GeV



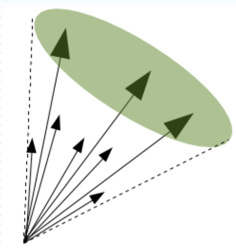




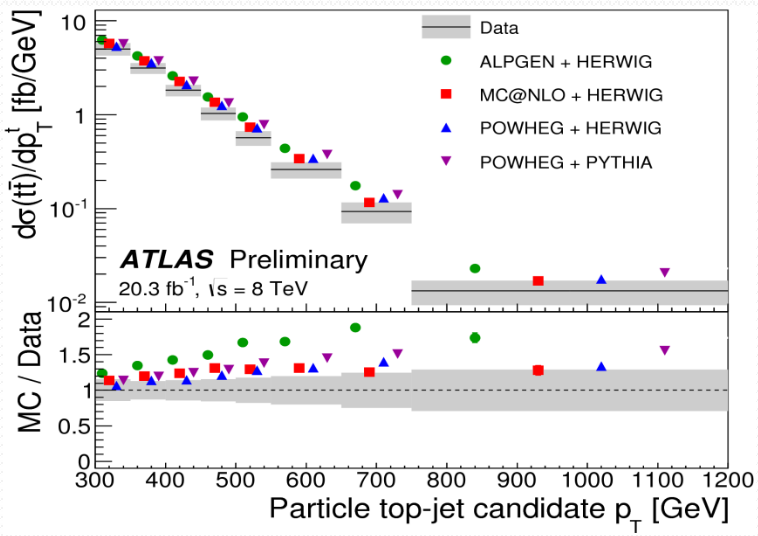
$t\bar{t}$ differential cross section: boosted topology

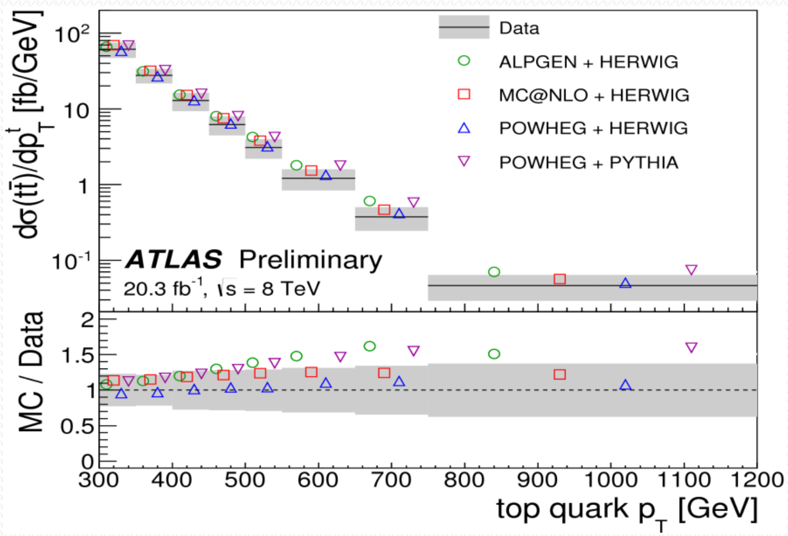
ATLAS-CONF-2014-057

$\sqrt{s} = 8$ TeV, $\int Ldt = 20.3$ fb^{-1}



- High-p_T top cross section measured for the first time
- l+jets channel with $p_T(t_{had}) > 300$ GeV
- Boosted hadronic top defined as a single large-R jet
- Fiducial (boosted top jet) and total (parton tops) phase space measurements





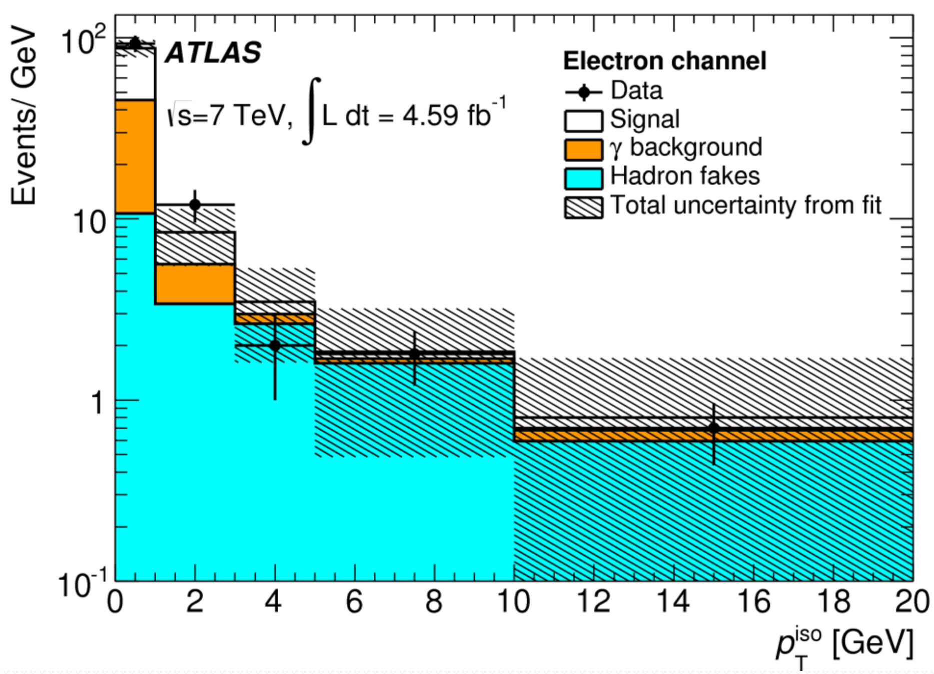
- General tendency of the MC predictions to overestimate the data, especially at high p_T, confirming what seen in resolved topology.

$t\bar{t}+\gamma$ inclusive cross section

Phys. Rev. D 91, 072007 (2015)

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6$ fb^{-1}

- Measurement in the lepton+jet channel: 1 lepton (e/μ), $\geq 4jets(\geq 1btag)$, E_T^{miss}, 1γ
- A binned template likelihood fit is used to extract the *fiducial* cross section
- Template: p_T^{iso} $(\sum p_T^{track}$ with $\Delta R(track,\gamma) < 0.2)$

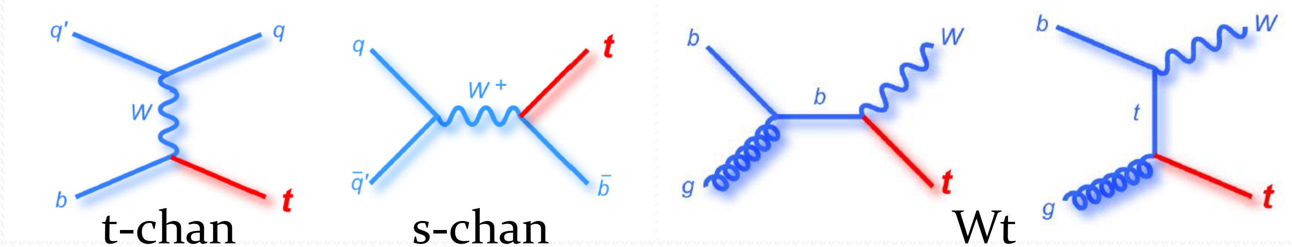


- Templates built for
  - prompt photons (signal & background)
  - background non-prompt photons sources

$\boldsymbol{\sigma_{tt\gamma}(\sqrt{s} = 7\ \text{TeV}) \times BR =}$
$\boldsymbol{63 \pm 8(\text{stat.})^{+17}_{-13}(\text{syst.}) \pm 1(\text{lumi.})\ \text{fb}}$
5σ significance

$\sigma_{tt\gamma}^{th}(\sqrt{s} = 7\ \text{TeV}) = 48 \pm 10$ fb
(Prediction from MadGraph and WHIZARD)

Single top cross section



7 TeV measurements:

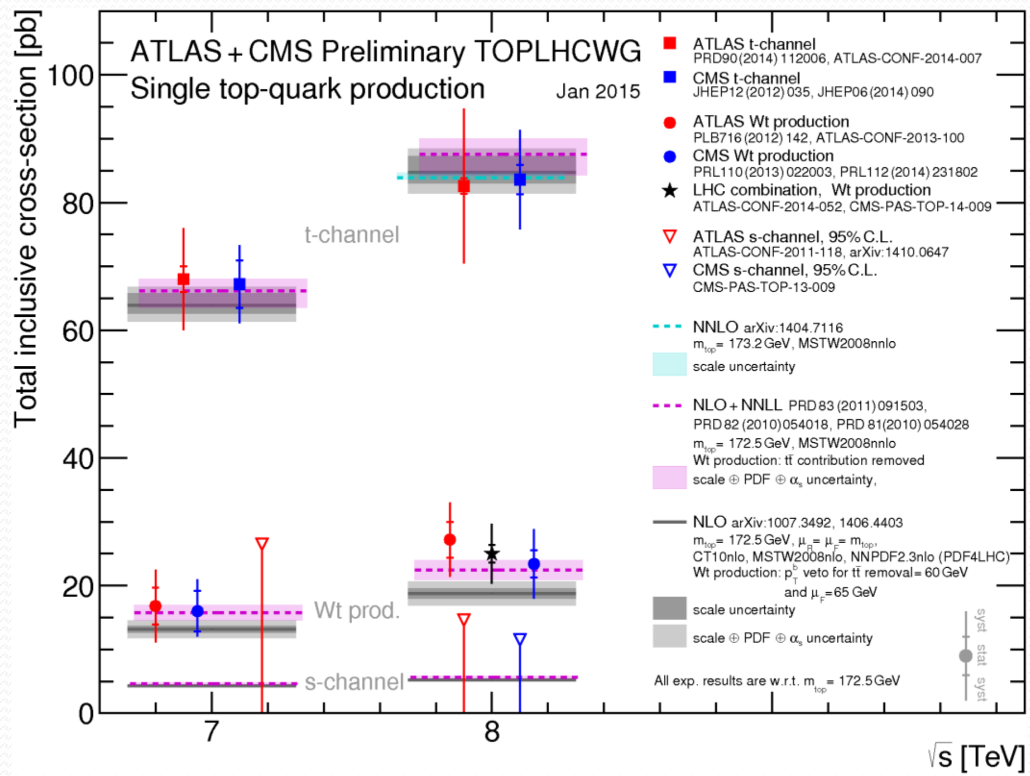
- σ in t- and Wt-channel, Wt measured for the first time

  (> 5σ level)
- Upper limit for the s-channel
- Differential σ measurements.
- Top/antitop t-channel ratio (R_t)

$$R_t = \frac{\sigma_{ub \to td}}{\sigma_{d\bar{b} \to \bar{t}d}}$$

8 TeV measurements:

- σ in t- and Wt-channel
- Upper limit for the s-channel



https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/TOP/

Single top t-channel cross section

ATLAS-CONF-2014-007

$\sqrt{s} = 8$ TeV, $\int Ldt = 20.3$ fb^{-1}

- Lepton + 2 jets channel, 1-btag
- $\boldsymbol{\sigma_{t-chan}}$ calculated through a maximum-likelihood fit of a multivariate Neural Network (NN) discriminant trained with the 14 most-sensitive variables
- **Total phase space measurement:**

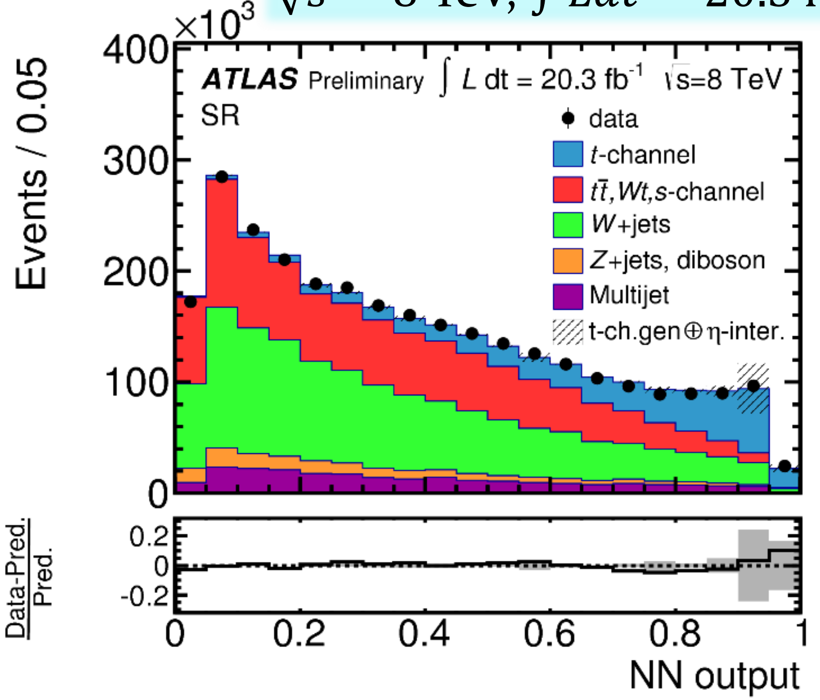
$$\boldsymbol{\sigma_{t-chan}(\sqrt{s} = 8\ \text{TeV}) = 82.6 \pm 1.2(\text{stat}) \pm 11.4(\text{syst}) \pm 3.1(\text{PDF}) \pm 0.09(\text{lumi})\ \text{pb}}$$

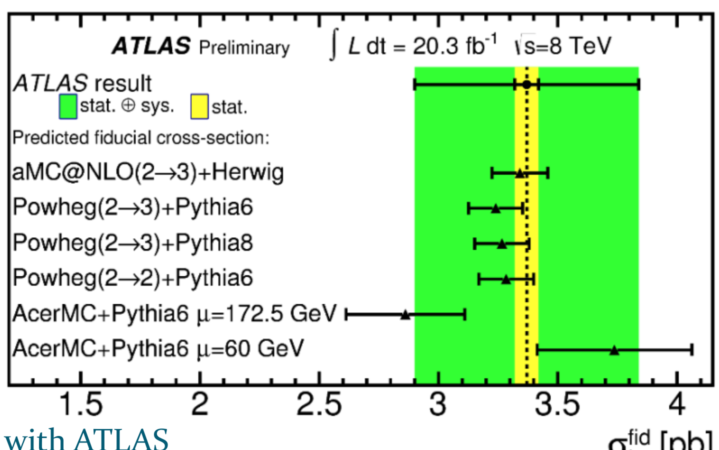
(aMC@NLO)

$$\sigma_{t-chan}^{aNNLO}(\sqrt{s} = 8\ \text{TeV}) = 87.8^{+3.4}_{-1.9}\ \text{pb}$$

- **Fiducial phase space measurement:**

$$\boldsymbol{\sigma_{t-chan}(\sqrt{s} = 8\ \text{TeV}) = 3.37 \pm 0.05(\text{stat}) \pm 0.47(\text{syst}) \pm 0.09(\text{lumi})\ \text{pb}}$$

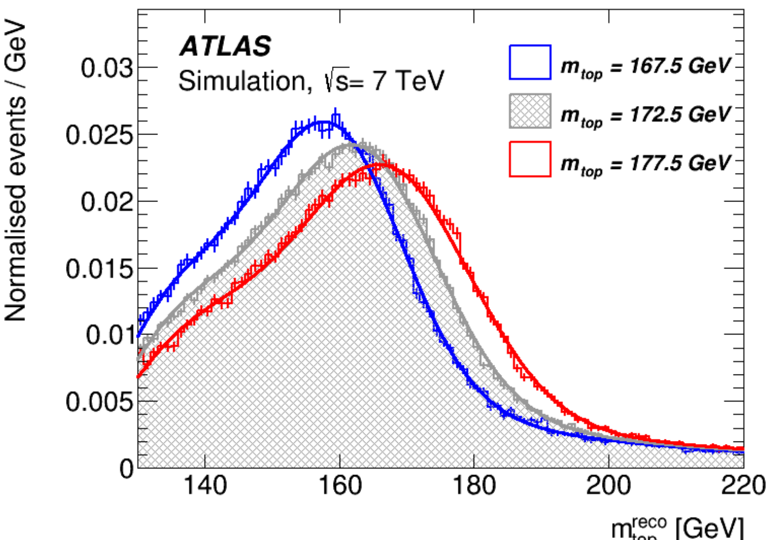




Top quark mass

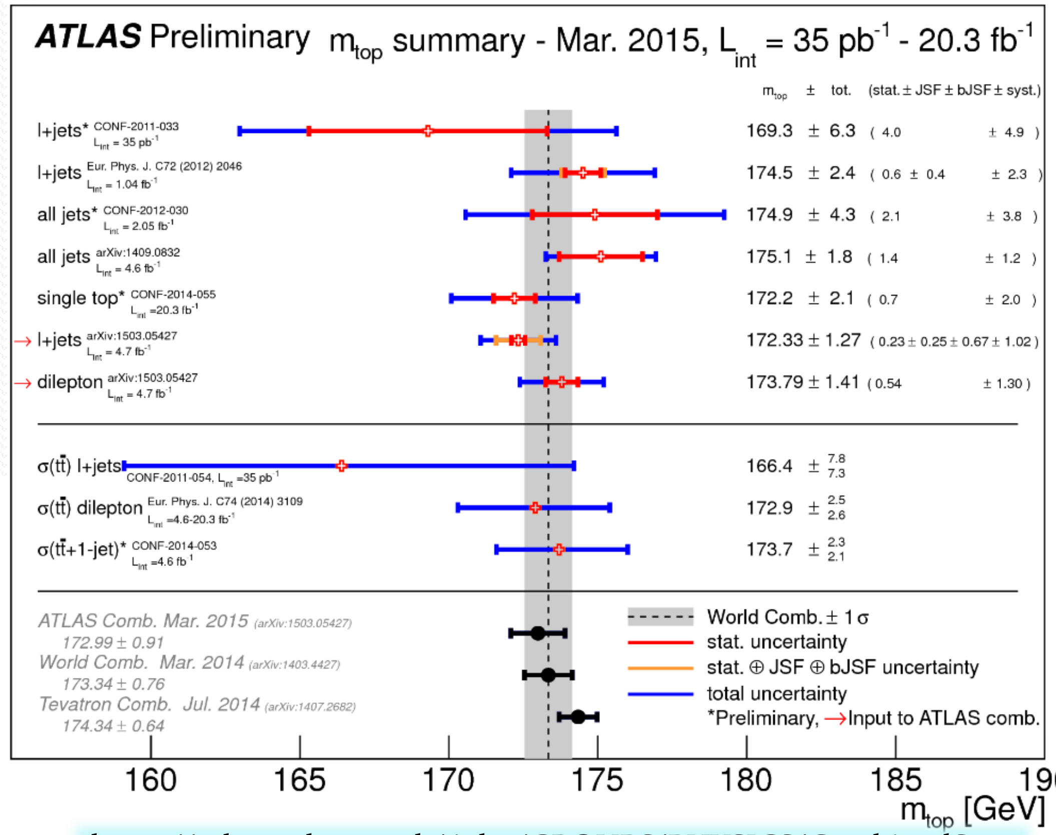
- Measured through a template fit:
  - **Lepton+jets:** *3D template fit* depending on m_t and jet energy scales (JSF, bJSF)
  - **Dilepton:** *1D template fit* depending on m_t
- Templates built by varying the fit parameters in MC simulation:

$m_{t,reco}$, $m_{lb,reco}$, $m_{W,reco}$ and R_{bq}^{reco} (ratio of the sum of the p_T of the bjets from the top and light jets from the W)



arXiv:1503.05427, Submitted to EPJC

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6$ fb^{-1}



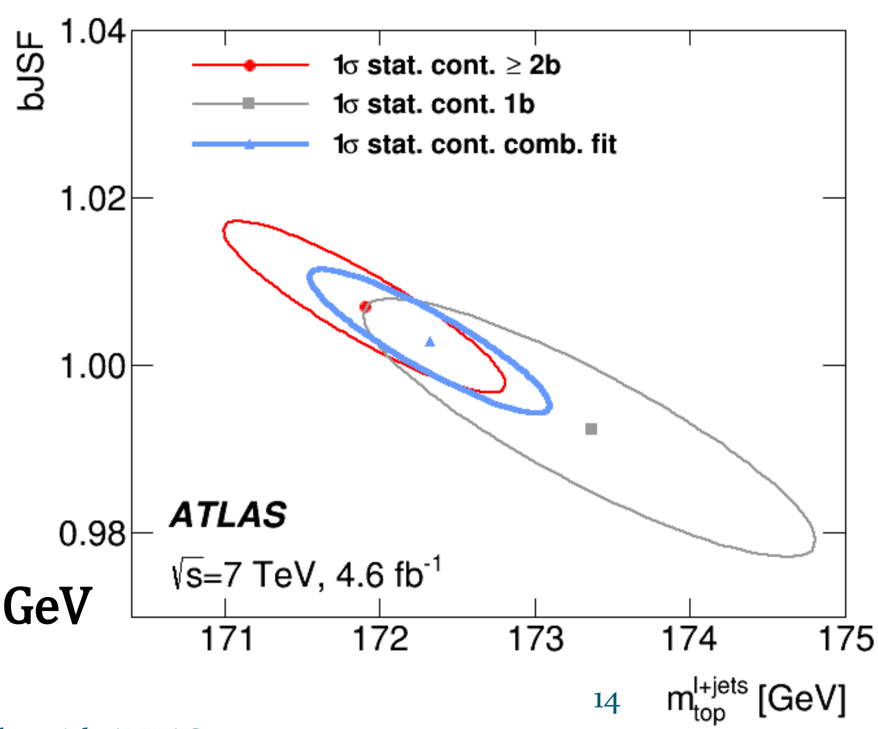
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CombinedSummaryPlots/TOP/

Top quark mass

arXiv:1503.05427, Submitted to EPJC

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6$ fb^{-1}

- A maximum likelihood approach is used to reconstruct $t\bar{t}$ kinematics
- Signal and background PDFs are used in an unbinned likelihood fit separately for *1 btag* and ≥2 *btag* samples:
  - **Lepton+jets:** $L(m_{t,reco}, m_{W,reco}, R_{bq}^{reco} | m_t, JSF, bJSF, n_{bkg})$
  - **Dilepton:** $L(m_{lb,reco} | m_t, n_{bkg})$
- Simultaneous constraint on m_t, JES and bJSF, for the first time
- Good agreement between results obtained with *1 btag* and ≥2 *btag* samples
- Combination of lepton+jets and dilepton results using the *Best Linear Unbiased Estimator (BLUE)*



$$\boldsymbol{m_t^{comb} = 172.99 \pm 0.48(\text{stat}) \pm 0.78(\text{syst})\ \text{GeV}}$$

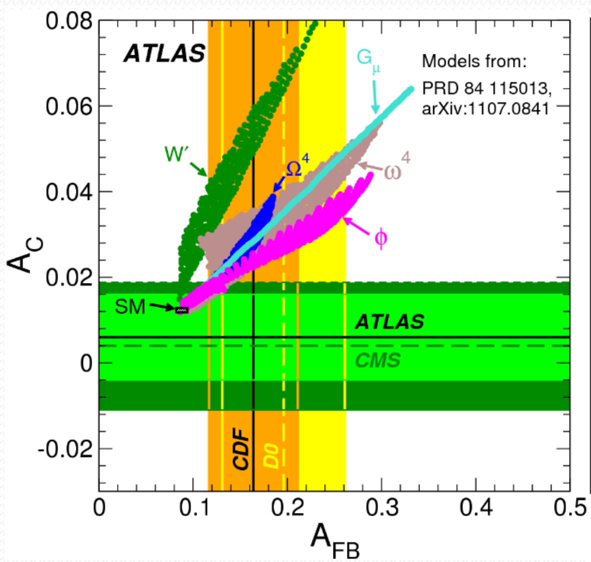
$t\bar{t}$ charge asymmetry in Run I

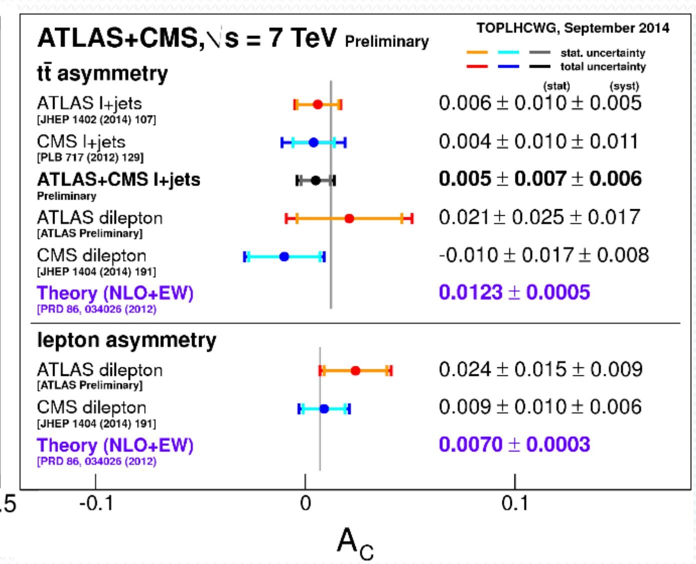
- Tevatron measured a slight discrepancy in forward-backward asymmetry of $t\bar{t}$ with respect to SM:

$$A_{FB} = \frac{N(\Delta y > 0) - N(\Delta y < 0)}{N(\Delta y > 0) + N(\Delta y < 0)} \qquad \Delta y = y_t - y_{\bar{t}}$$

- Because of the different colliding beams and top production mechanism at LHC, A_{FB} is not possible to measure. Instead, different asymmetries can be considered and have been measured at 7 TeV.

$$A_C = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)} \qquad \begin{array}{l} \Delta|y| = |y_t| - |y_{\bar{t}}| \\ \Delta|y| = |y_{l^+}| - |y_{l^-}| \end{array}$$





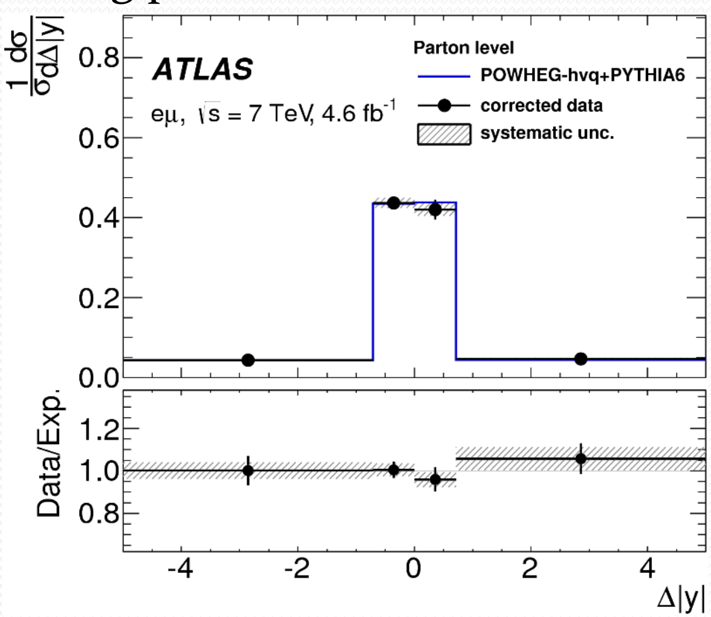
- **Dilepton: $A_C(tt)$ and $A_C(ll)$ (JHEP 05 (2015) 061)**
- **Single lepton: (JHEP02(2014)107)**
- **Combination with CMS: (ATLAS-CONF-2014-012)**

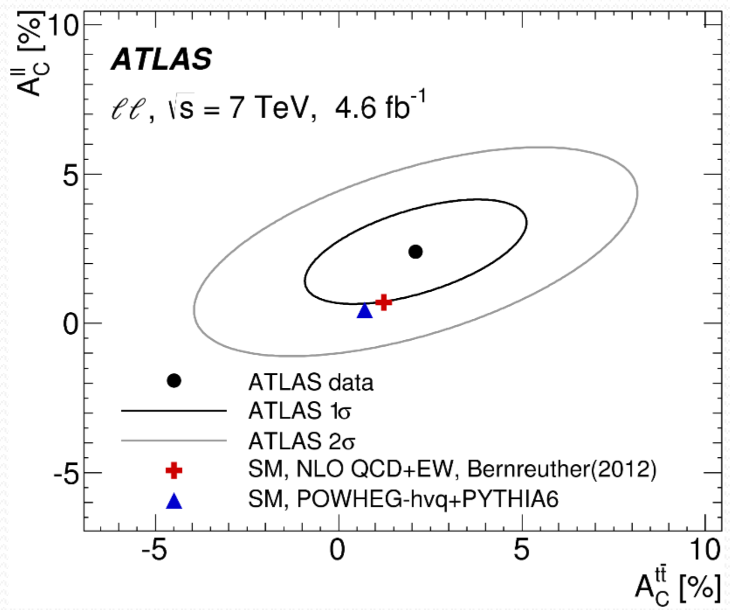
$t\bar{t}$ charge asymmetry in l^+l^- channel

JHEP 05 (2015) 061

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6$ fb^{-1}

- Dilepton channel allows lepton-based asymmetry, to remove any dependence on the algorythm used for top reconstruction.
- Reconstructed $\Delta|y|$ spectra are corrected for detector response and acceptance by unfolding procedures.





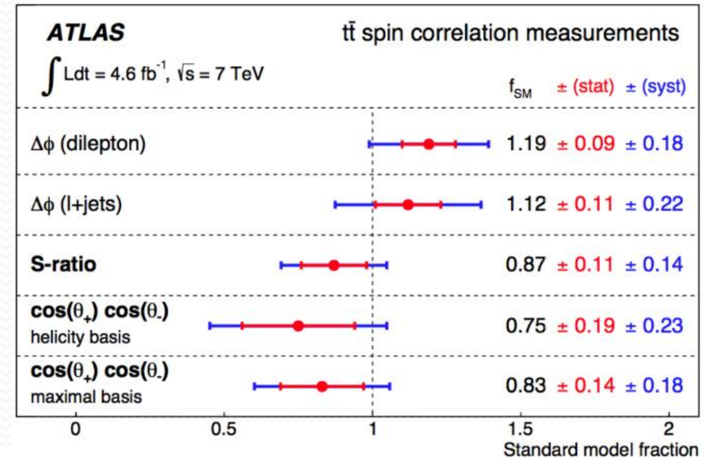
$$A_C^{ll} = \mathbf{0.024 \pm 0.015}(\text{stat}) \pm \mathbf{0.009}(\text{sist})$$
$$A_C^{tt} = \mathbf{0.021 \pm 0.025}(\text{stat}) \pm \mathbf{0.017}(\text{sist})$$

Spin correlation measurements

$$A = \frac{N(\uparrow\uparrow)+N(\downarrow\downarrow)-N(\uparrow\downarrow)-N(\downarrow\uparrow)}{N(\uparrow\uparrow)+N(\downarrow\downarrow)+N(\uparrow\downarrow)+N(\downarrow\uparrow)} \quad A^{SM}_{helicity} = 0.318 \pm 0.005$$

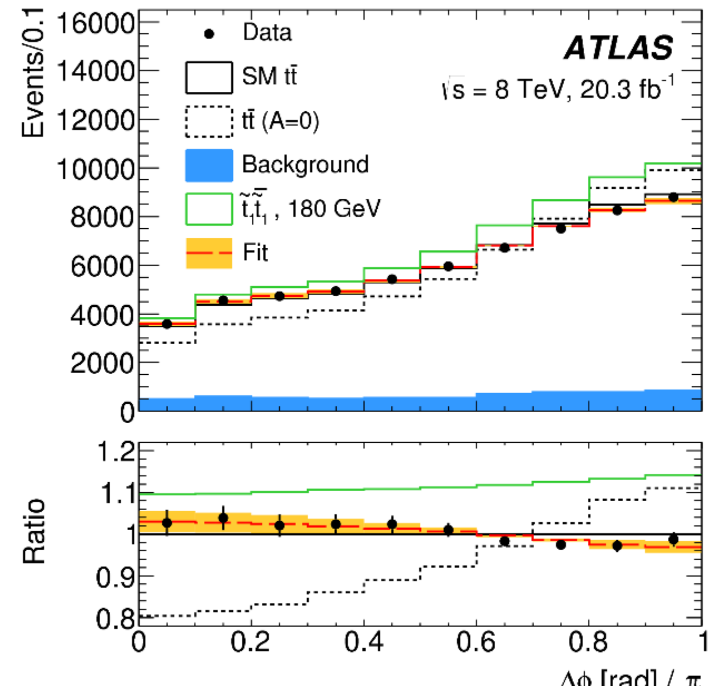
- **7 TeV analysis: Phys. Rev. D. 90, 112016 (2014)**
  - The spin correlation is extracted through four observables in a binned likelihood fit of f_{SM} where

    $$A_{measured} = f_{SM} A^{th}_{SM}$$
  - $\Delta\phi(ll)$ shows highest sensitivity



- **8 TeV analysis: Phys. Rev. Lett. 114, 142001 (2015)**
  - The spin correlation is extracted through a template fit on $\Delta\phi(ll)$ distribution

    $$f_{SM} = 1.20 \pm 0.05(\text{stat}) \pm 0.13(\text{syst})$$
    $$A_{helicity} = 0.38 \pm 0.04$$
  - It is the most precise measurement by now.
  - Limits on stop production can be set exploiting the sensitivity of $t\bar{t}$ spin correlation to SUSY processes $\tilde{t}\bar{\tilde{t}} \rightarrow t\bar{t}\tilde{\chi}^0\tilde{\chi}^0$



Summary and conclusions

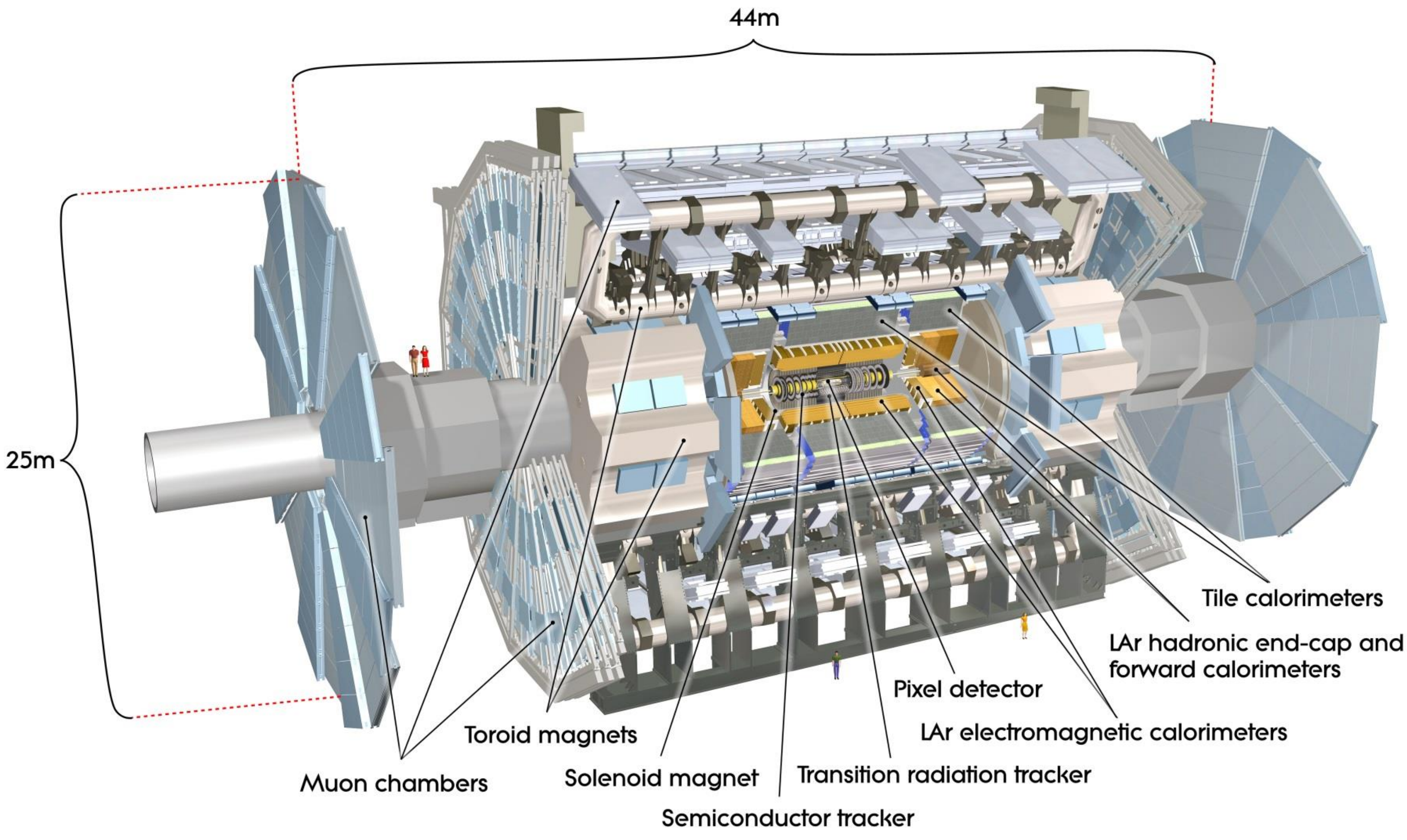
- During Run I ATLAS has provided several top quark measurements to make stringent tests on SM.
  - Top pair and single top cross section
  - Top-quark mass measurement
  - Top-antitop charge asymmetry
  - Top-antitop spin correlation
- Even if most of the measurements are limited by systematic uncertainties, almost all results agree with the Standard Model.
- In the $t\bar{t}$ differential cross section the data distribution for $p_{T,t}$ is slightly softer then the theoretical prediction, especially at high p_T.
- Prospects for RunII
  - The expected higher statistics will allow to refine all these results.
  - New analyses will start, especially regarding the boosted topologies.

- Additional information can be found at the ATLAS Top public results page:

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TopPublicResults

Backup

ATLAS (A Toroidal LHC ApparatuS)



Common object definitions

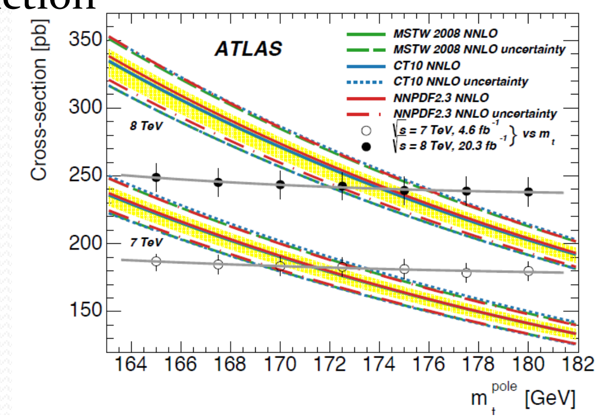
- Details can vary among the different analyses
- Jets:
  - Reconstructed from topological clusters using the anti-kt algorithm ($R = 0.4$)
  - p_{T}> 25 GeV, $|\eta|$ <2.5
- B-tagging via a Neural network based algorithm (MV1) with average efficiency of 70% and light jet rejection factor ~140
- Electrons:
  - EM cluster with track matched
  - Isolation in tracker and calorimeter
  - E_{T} > 25 GeV, $|\eta|$<1.37 or 1.52 < $|\eta|$ <2.47
- Muons:
  - Tracks in inner detector and muon spectrometer
  - Isolation in tracker and calorimeter
  - $p_{\mathrm{T}} > 20$ GeV, $|\eta|$ <2.5
- Missing transverse energy
  - Vector sum of energy deposits in calorimeters, with corrections based on the associated reconstructed object

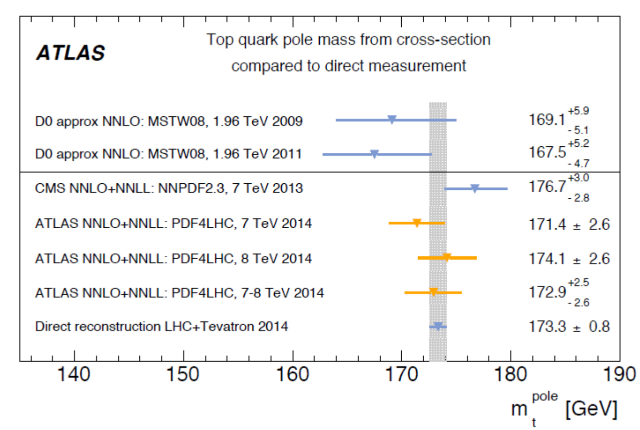
$t\bar{t}$ inclusive cross section $e\mu$ channel

EPJC 74 (2014) 3109

Strong dependence of σ_{tt} on top mass

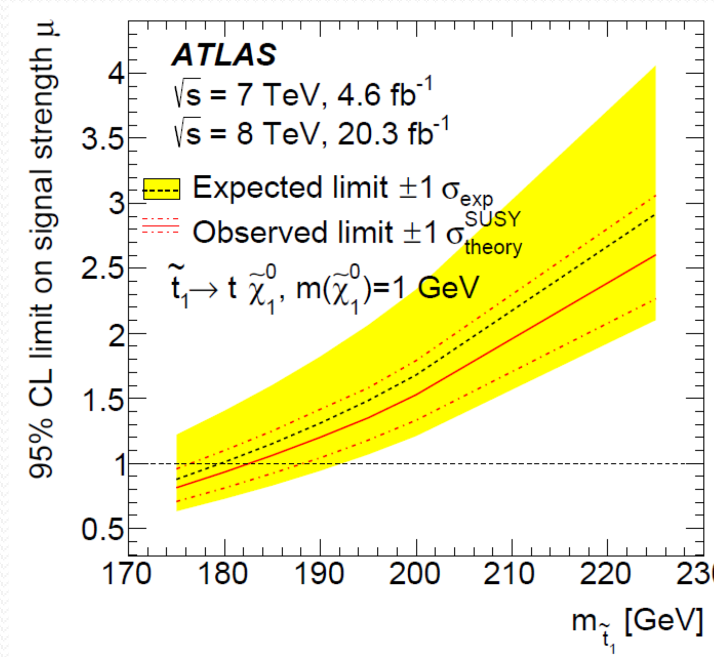
- Extraction of top mass via the maximization of a Baysian likelihood function





Constraints on stop pair production

- R-parity conserving SUSY extension of SM with $\tilde{t}_1 \to t\tilde{\chi}_1^0$ (BR = 100%)
- Fit $\sigma_{\tilde{t}_1\tilde{t}_2}$ to the $\sigma_{tt}^{meas} - \sigma_{tt}^{th}$ difference
- 95% CL exclusion of stop with $m_t < m_{\tilde{t}_1} < 177$ GeV



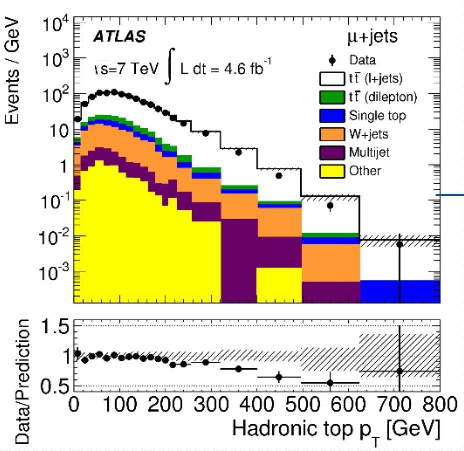
Top pair differential cross section

Phys. Rev. D 90, 072004

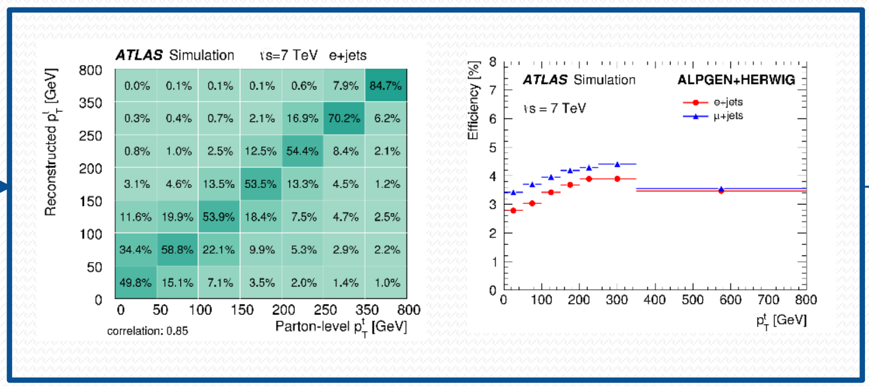
$\sqrt{s} = 7\ \text{TeV}, \int L dt = 4.06\ \text{fb}^{-1}$

- Total $\sigma_{t\bar{t}}$ measurements show very good agreement with the SM
  - New physics phenomena can still affect the *shape* of $\sigma_{t\bar{t}}$
- Top-antitop relative differential cross section $\left(\frac{1}{\sigma}\frac{d\sigma}{dX}\right)$ where $X = m_{t\bar{t}}, p_{\mathrm{T},t\bar{t}}, |Y_{t\bar{t}}|$ and $p_{T,t}$
  - *Relative* measurement more precise than the *absolute* →cancellation of correlated systematics
- Cut-based analysis in the *l*+jets channel
- $t\bar{t}$ system reconstructed via a kinematic likelihood fit.
- Final parton level measurement extracted via unfolding methods

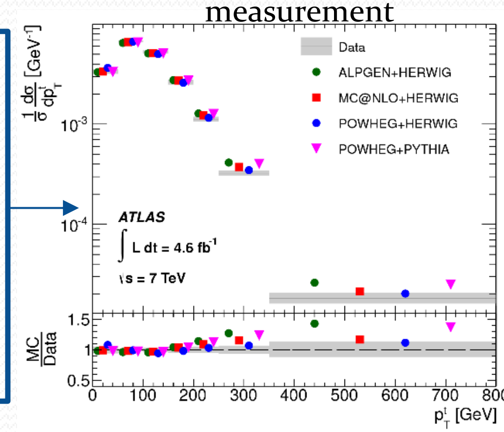
Reco spectrum



Resolution & efficiency corrections



Parton level measurement



Results: comparison with generators

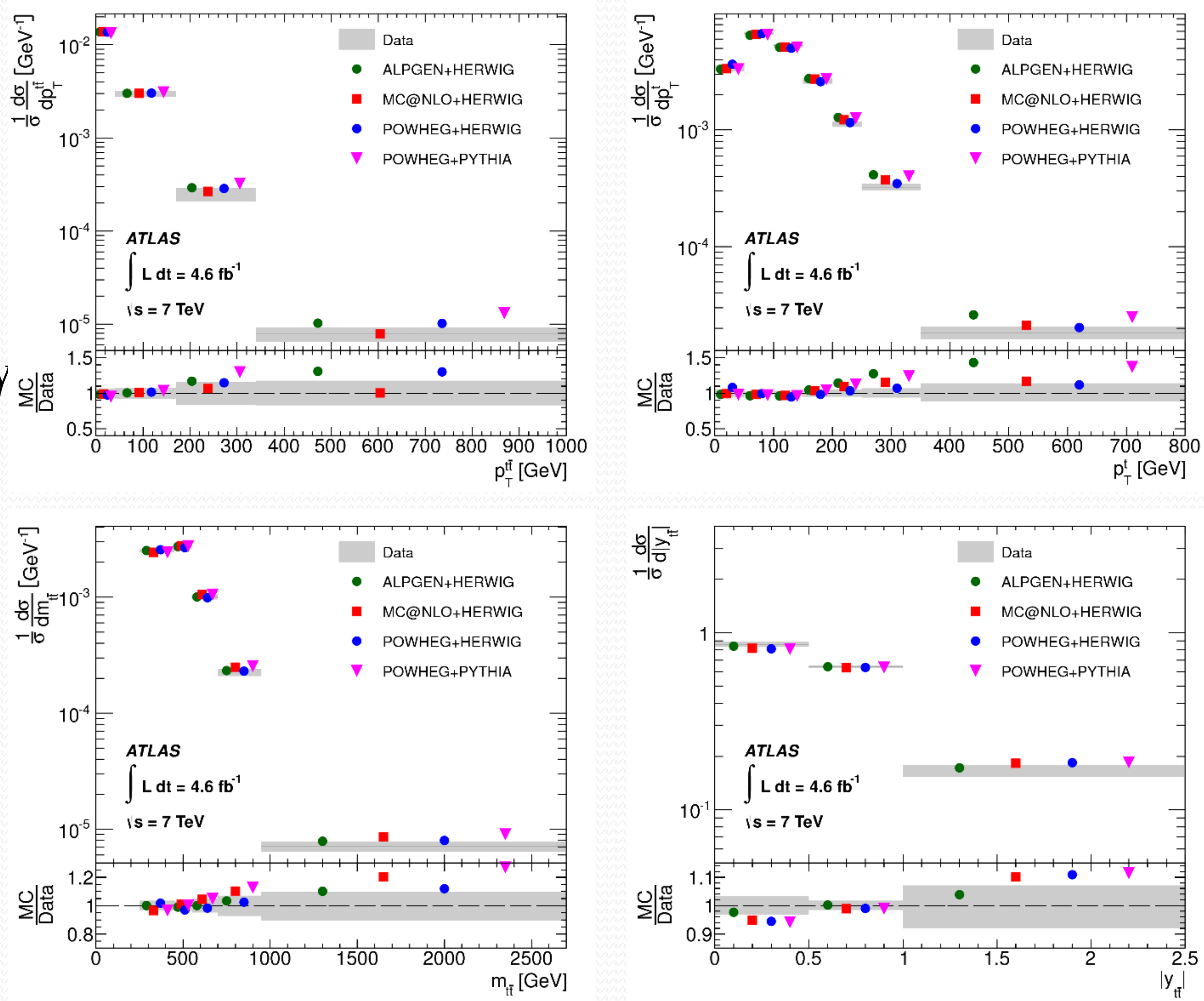
Phys. Rev. D 90, 072004

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.06$ fb^{-1}

Electron and muon channel combination via the Asymmetric Iterative BLUE (AIB)

MC generators: Alpgen, PowHeg and Mc@Nlo interfaced with Herwig+Jimmy and PowHeg+Pythia

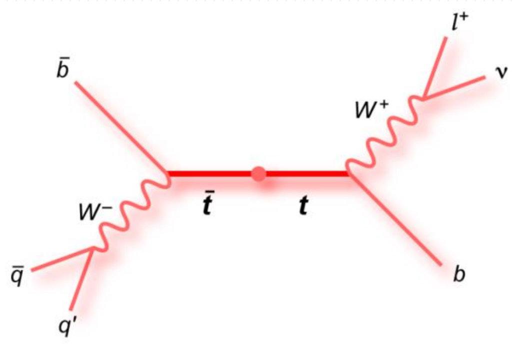
- General trend of data being softer in $p_{T,t}$ above 200 GeV
- All four MC generators well describe the shape of $m_{t\bar{t}}$ and $p_{T,t\bar{t}}$
- Alpgen gives the best prediction of the $|y_{t\bar{t}}|$



Reconstruction of the tt system via kinematic likelihood fit

- The tt system reconstruction is performed trough a kinematic fit using a maximum likelihood approach

$$
\begin{aligned}
\mathcal{L} \; = \; & \mathcal{B}\left(\widetilde{E}_{p,1}, \widetilde{E}_{p,2} | m_W, \Gamma_W\right) \cdot \mathcal{B}\left(\widetilde{E}_{l}, \widetilde{E}_{\nu} | m_W, \Gamma_W\right) \cdot \\
\cdot \; & \mathcal{B}\left(\widetilde{E}_{p,1}, \widetilde{E}_{p,2}, \widetilde{E}_{p,3} | m_t, \Gamma_t\right) \cdot \mathcal{B}\left(\widetilde{E}_{l}, \widetilde{E}_{\nu}, \widetilde{E}_{p,4} | m_t, \Gamma_t\right) \cdot \\
\cdot \; & \mathcal{W}\left(\widehat{E}_x^{miss} | \tilde{p}_{x,\nu}\right) \cdot \mathcal{W}\left(\widehat{E}_y^{miss} | \tilde{p}_{y,\nu}\right) \cdot \mathcal{W}\left(\widehat{E}_{lep} | \widetilde{E}_{lep}\right) \cdot \\
\cdot \; & \prod_{i=1}^{4} \mathcal{W}\left(\widehat{E}_{jet,i} | \widetilde{E}_{p,i}\right) \cdot P\left(b \text{ tag} \mid \text{quark}\right),
\end{aligned}
$$



- The likelihood assesses the compatibility of the event with a typical ttbar pair
- The algorithm is fed with the 4 or 5 reconstructed highest-pt jets (and their b-tag info), the lepton and the E_T^{miss}
- The output is the permutation of the four jets, lepton and E_T^{miss} that maximizes the likelihood

From the detector-level spectra to the cross section measurement

The 'detector-level' spectra are linked to the 'parton level'cross section σ_j via

$$N_i = \sum_j M_{ij} \epsilon_j \sigma_j \beta L + B_i$$

Where

- N_i is the number of observed data events in the bin j.
- L is the luminosity
- B_i is the number of background events in the bin i.
- β is the branching ratio
- M_{ij} is the 'migration matrix'
- ϵ_j is the efficiency of the selection

$t\bar{t}$ + jets differential cross section

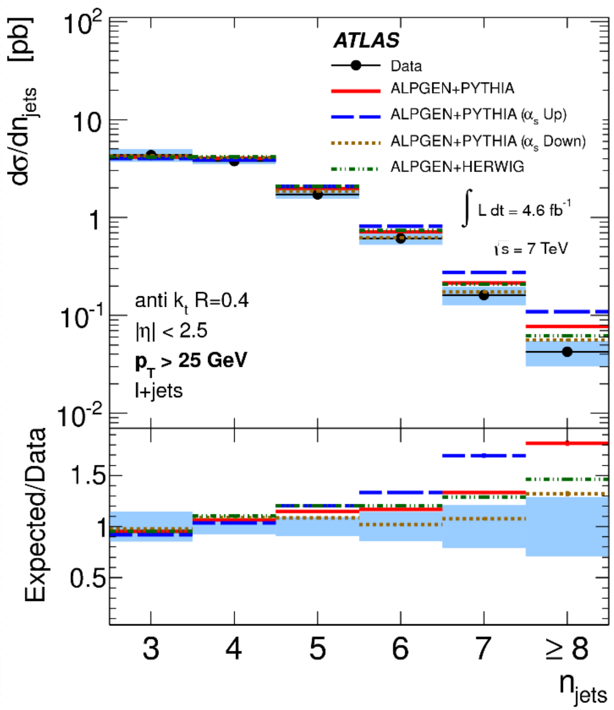
- Cut-based analysis in the *l*+jets channel
- *Particle level* measurement
- Limited by systematic uncertainties, background modelling (for $n_{jets} < 4$) and jet energy scale ($n_{jets} \geq 4$)

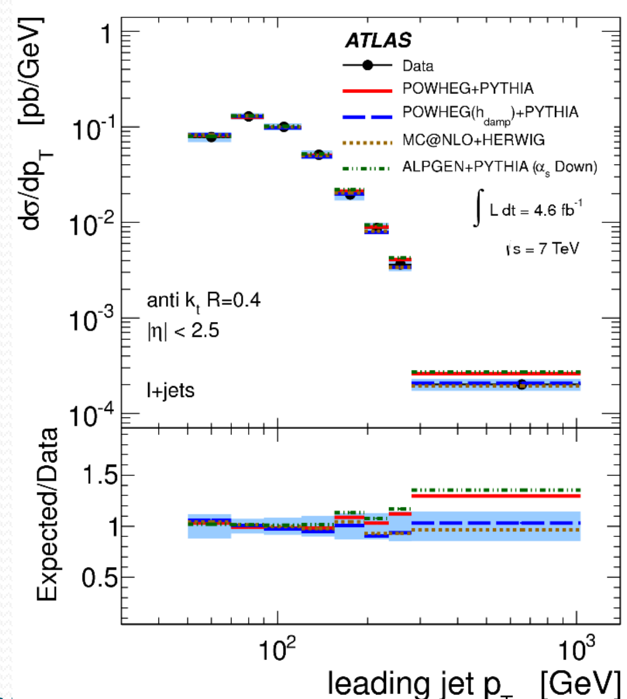
JHEP 01(2015)020

$\sqrt{s} = 7$ TeV, $\int Ldt = 4.6\text{fb}^{-1}$

$\frac{d\sigma_{tt}}{dN_{jets}}$: sensitive to hard emissions in QCD bremsstrahlung processes.

$\frac{d\sigma_{tt}}{dp_{t,jet}}$: sensitive to the modelling of higher-order QCD effects in MC

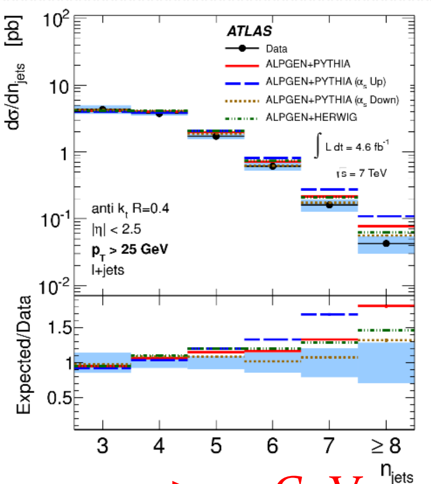




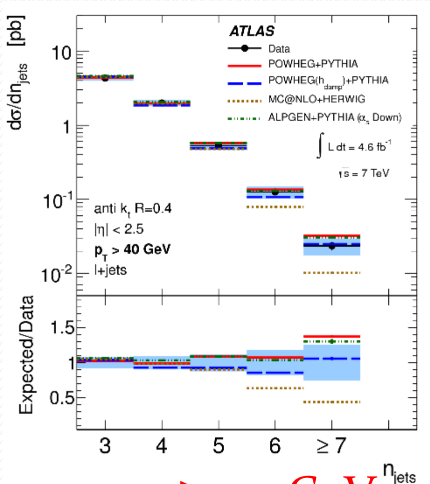
Jet multiplicity in top–anti-top final states

- Useful to constrain models of initial and final state radiation (ISR/FSR)
- Provides a test of perturbative QCD
- Single-lepton channel
  - Four jet p_T thresholds: (25, 40, 60, and 80 GeV)
- Results are corrected for all detector effects through unfolding
  - Reconstructed level → particle level
- Measurement is limited by systematic uncertainties,
  - background modelling (at lower jet multiplicities)
  - jet energy scale (at higher jet multiplicities)

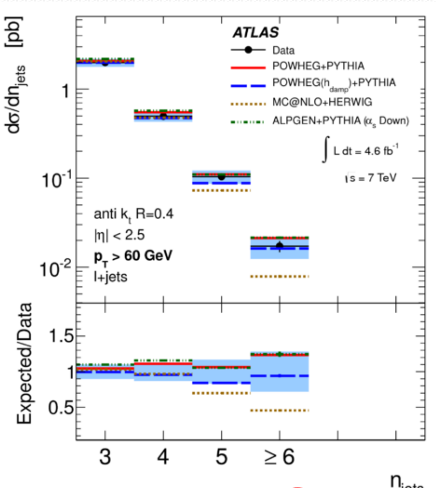
Jet multiplicity in top–anti-top final states



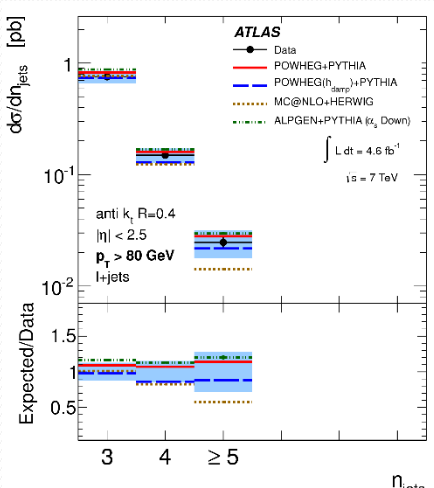
$p_T > 25$ GeV



$p_T > 40$ GeV



$p_T > 60$ GeV



$p_T > 80$ GeV

- MC@NLO modelling predicts a lower jet multiplicity spectrum and softer jets
- Predictions from ALPGEN + HERWIG or PYTHIA and POWHEG + PYTHIA are consistent with the data

Single top/antitop t-chan ratio

$$R_t = \frac{\sigma_{ub \to td}}{\sigma_{d\bar{b} \to \bar{t}d}}$$

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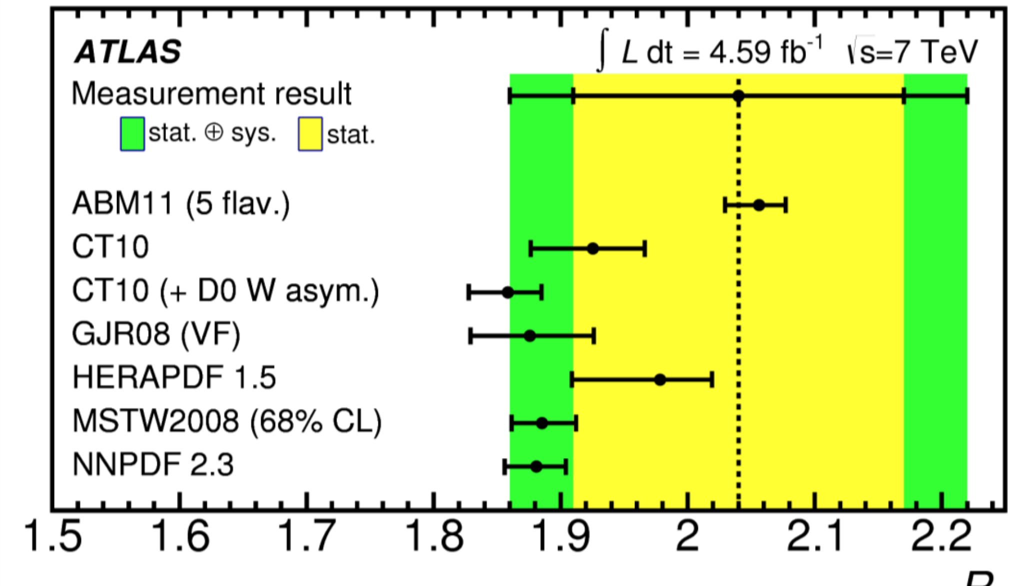
$\sqrt{s} = 7$ TeV, $\int Ldt = 4.7\ \text{fb}^{-1}$

- Very sensitive to the ratio of the PDF of the valence quark in the high x regime
  - Smaller uncertainties because of error cancelations
- Sensitive to new physics effects
- Same analysis technique used in the σ_{tchan} measurement



The measurement is in agreement with the predictions from different PDF sets and is dominated by systematic uncertainties

Top quark mass

Most precise measurement in ATLAS

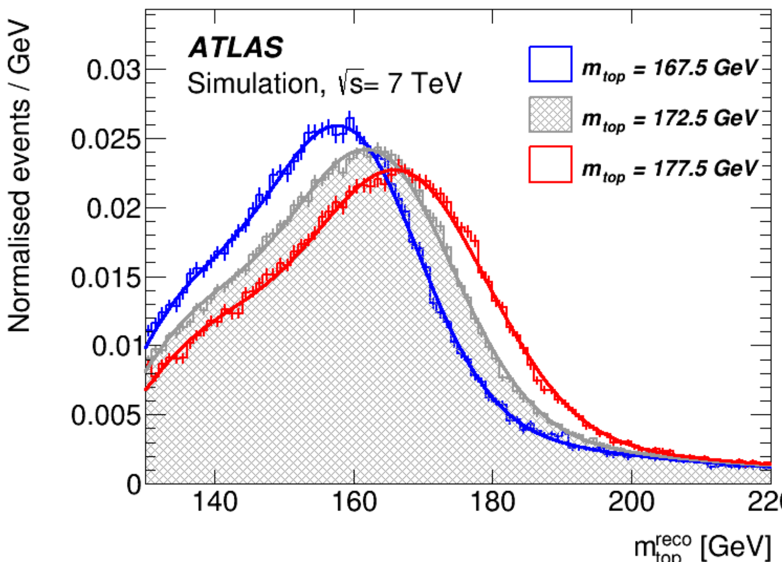
arXiv:1503.05427, Submitted to EPJC

$\sqrt{s} = 7\ \text{TeV}, \int Ldt = 4.6\ \text{fb}^{-1}$

- *3D template fit* in the lepton+jets channel
  - m_t, global jet energy scale factor (JSF) and bJet energy scale factor (bJSF)
- 1D template fit in dilepton channel
- Templates: $m_{t,reco}$, $m_{lb,reco}$, $m_{W,reco}$ and R_{lb}^{reco} (ratio of the sum of the p_T of the bjets from the top and light jets from the W)
  - Templates built by varying the fit parameters in Monte Carlo

☑= linear dependency for signal and bg
☑= linear dependency but not fitted
✓= linear dependency for signal only

	m_t	JSF	bJSF
$m_{t,reco}$	✓	☑	☑
$m_{W,reco}$		☑	
R_{lb}^{reco}	✓		☑
$m_{lb,reco}$	✓	☑	☑



- Probability density functions for each parameter evaluated by fitting each template distribution for signal and background

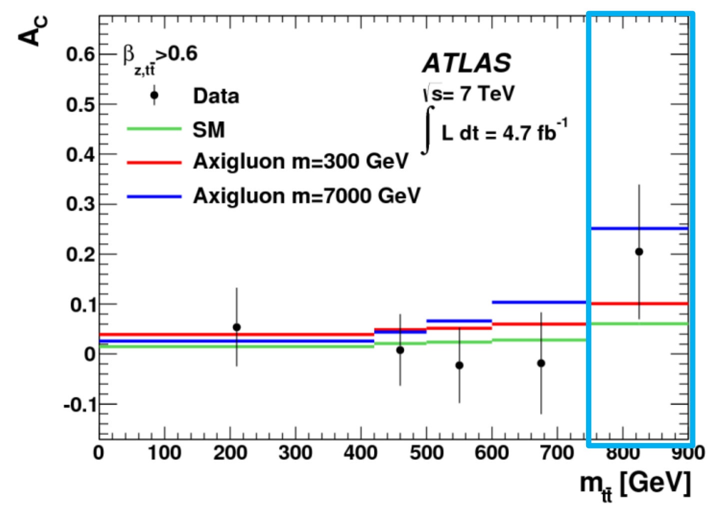
Tt charge asymmetry in Run II

- Interest shown for boosted analyses
  - Combinations with resolved analyses could improve the precision
- A_C at high m_{tt} particularly sensitive to new physics
- Run II ideal environment for boosted analyses
  - Expected 7x more boosted tops (m_{tt}>1TeV) with 5/fb

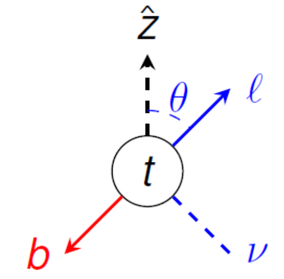
Interest shown also for $A_C(tl)$ with a high p_T hadronically decaying top (arXiv:1401.2443)

$$A_C^{tl} = \frac{N(\Delta|y|^{tl} > 0) - N(\Delta|y|^{tl} < 0)}{N(\Delta|y|^{tl} > 0) + N(\Delta|y|^{tl} < 0)}$$

No ambiguity due to the z-component of the neutrino



Spin correlation observables

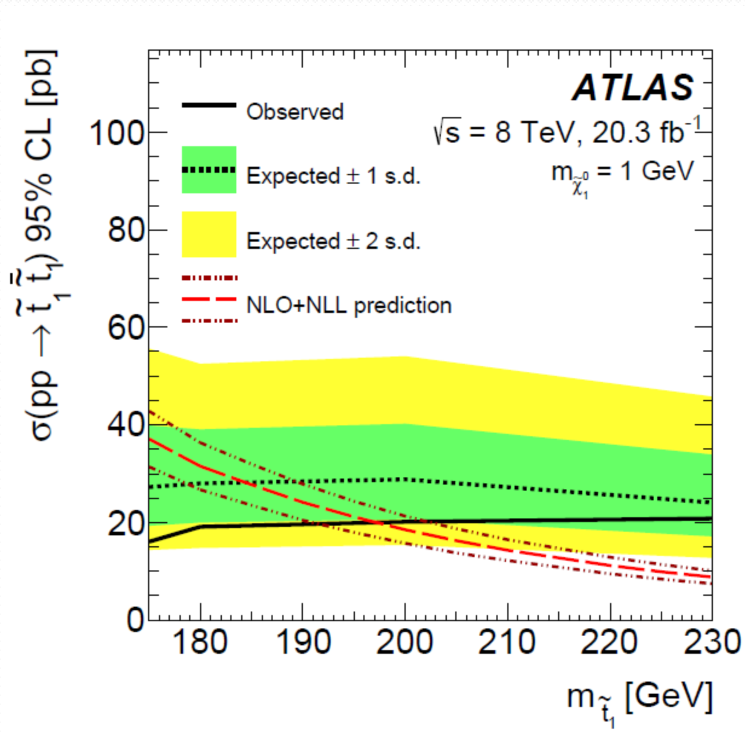


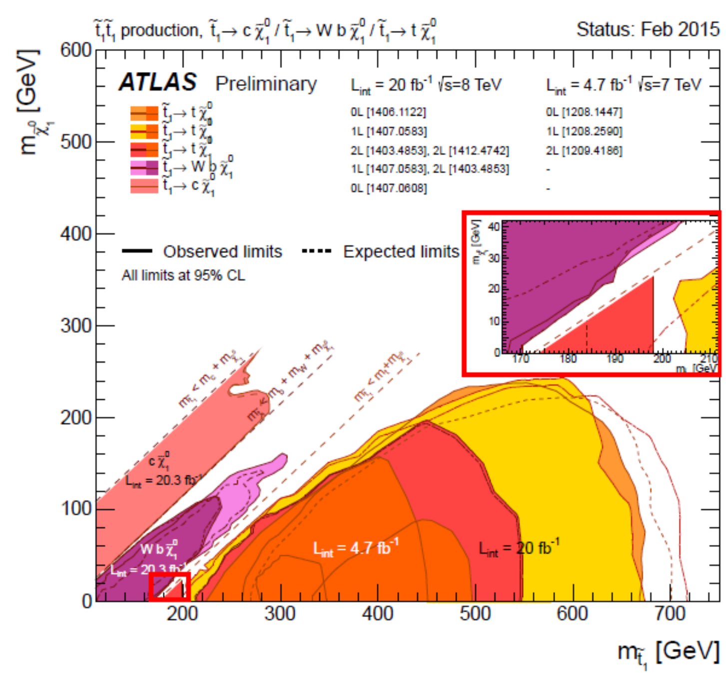
- Angular distributions of daughter pairs
  - $\frac{d\sigma}{d\cos\theta_1 d\cos\theta_2} \sim 1 - \boldsymbol{A}\alpha_1\alpha_2 cos\theta_1 cos\theta_2$
  - Elicity basis: top rest frame
  - Maximal basis: event-by-event axis that maximize correlation for *gg* fusion
- S-ratio
  - Ratio of matrix elements of like-helicity gluon fusion with spin correlation to without correlation

$$S = \frac{(|M|^2_{RR} + |M|^2_{LL})_{corr}}{(|M|^2_{RR} + |M|^2_{LL})_{uncorr}} = \frac{m_t^2[(t \cdot l^+)(t \cdot l^-) + (\bar{t} \cdot l^+) - m_t^2(l^+ \cdot l^-)]}{(t \cdot l^+)(\bar{t} \cdot l^-)(t \cdot \bar{t})}$$

Spin correlation: stop exclusion

- $t\bar{t}$ spin correlation is sensitive to SUSY processes $\tilde{t}\bar{\tilde{t}} \to t\bar{t}\tilde{\chi}^0\tilde{\chi}^0$
- Limits on stop production can be set by measuring $t\bar{t}$ spin correlation



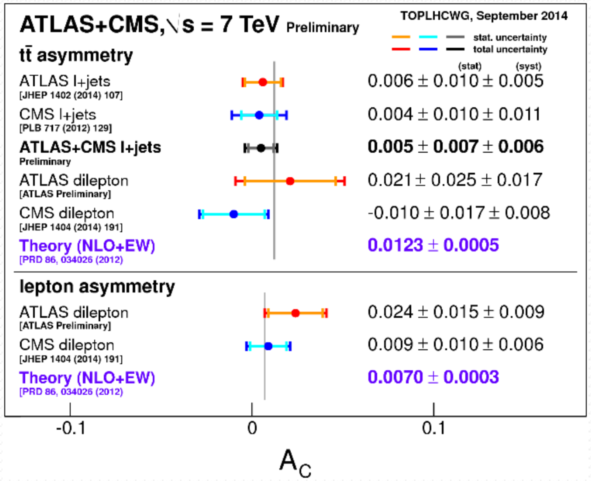


ATLAS SUSY summary plot on atlas.web.cern.ch

$t\bar{t}$ charge asymmetry in Run I

$$A_C^{tt} = \frac{N(\Delta|y|>0) - N(\Delta|y|<0)}{N(\Delta|y|>0) + N(\Delta|y|<0)} \qquad \Delta|y| = |y_t| - |y_{\bar{t}}|$$

$$A_C^{ll} = \frac{N(\Delta|y|>0) - N(\Delta|y|<0)}{N(\Delta|y|>0) + N(\Delta|y|<0)} \qquad \Delta|y| = |y_{l^+}| - |y_{l^-}|$$



- Extensively measured @ 7 TeV
- All results obtained after unfolding to parton level
  - Dilepton channel (submitted to JHEP)
    - Simultaneous measurement of $A_C(tt)$ and $A_C(ll)$
  - Single lepton channel (JHEP02(2014)107)
  - Combination with CMS (ATLAS-CONF-2014-012)
- Results in agreement with SM predictions
  - To understand the discrepancies in A_{FB} @ Tevatron