

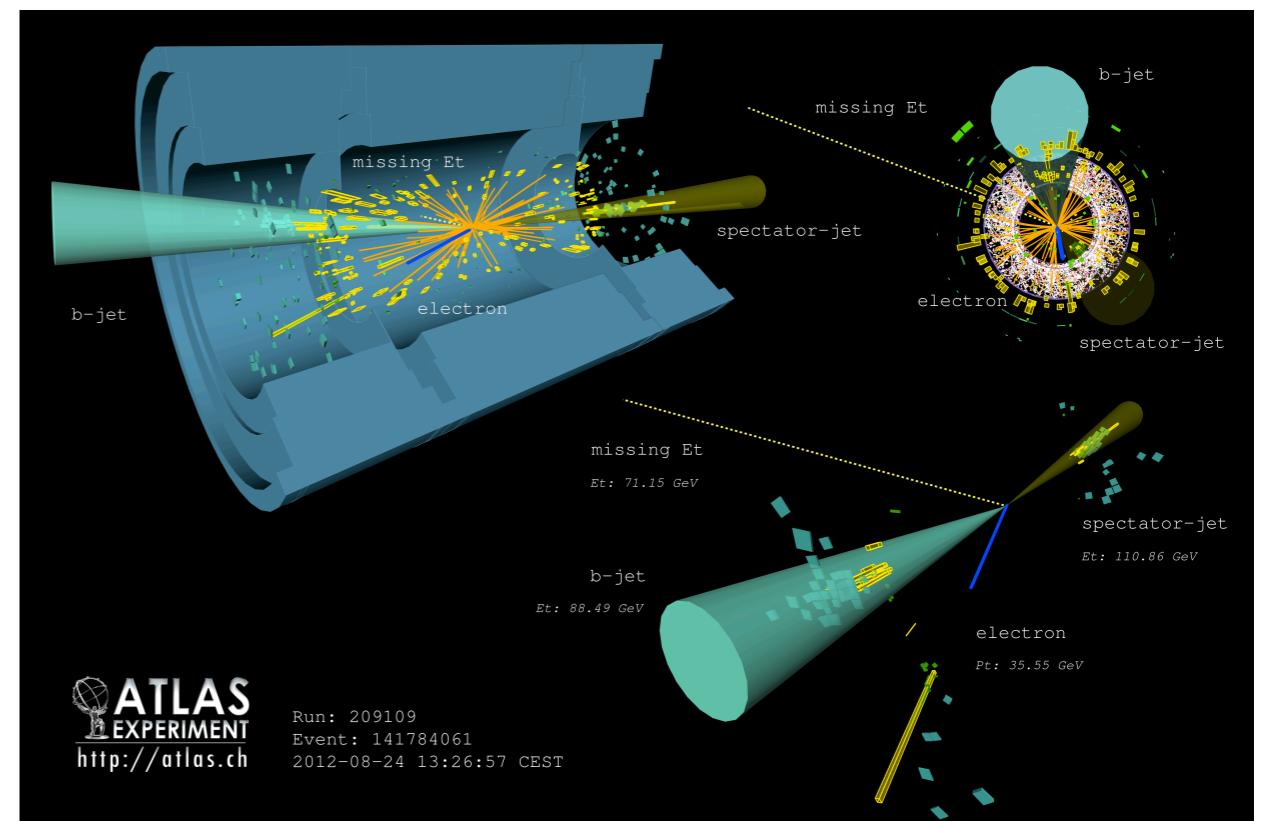
# Measurement of the $t$ -channel single top-quark and top-antiquark differential cross-sections in $pp$ collisions at 8 TeV with the ATLAS detector

[Paper in preparation]

**Top2016**

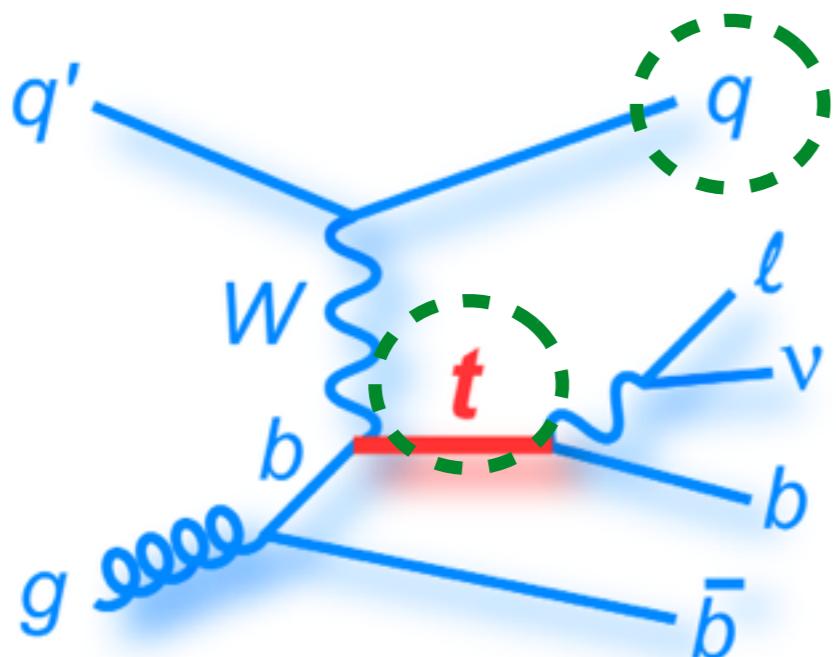
Olomouc, 20/09/2016

**Pienpen Seema**  
on behalf of the ATLAS collaboration



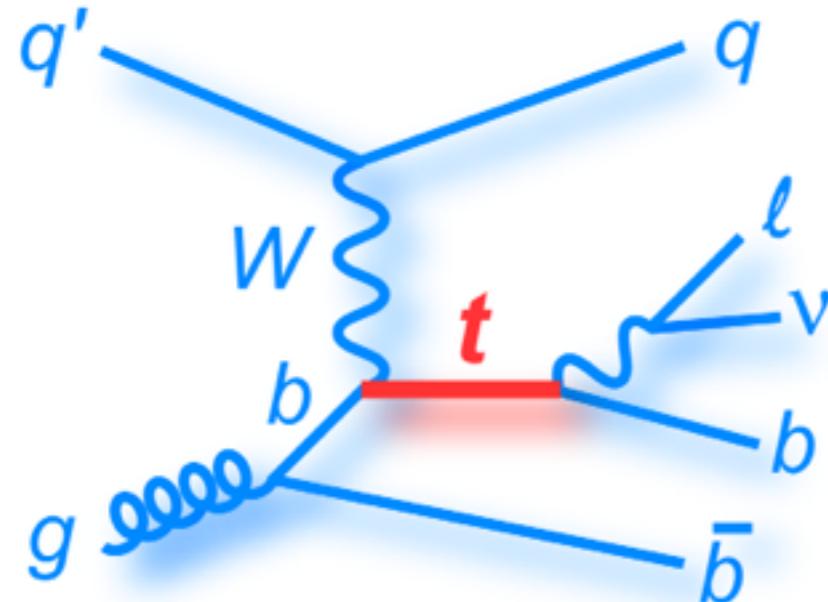
# Introduction

- t-channel single top quarks...
  - dominant single top-quark cross-section at LHC
  - this measurement:
    - focus on accessing kinematics ( $p_T$  and  $|y|$ ) of the (pseudo-) top (anti)quarks and the untagged jets
    - extract absolute and normalised differential cross-sections
    - neural network used to define signal enriched region
    - exploit unfolding technique



- Why differential distributions?
  - input for Monte Carlo tuning
  - test theory and models
  - search for effects of new physics

# Selection & reconstruction



## Pseudo-top-quarks

- top quarks at particle level
- reconstruct from stable particles (lifetime  $> 30$  ps)
- close to parton-level and reconstruction-level top quarks

## Lepton+jets event selection

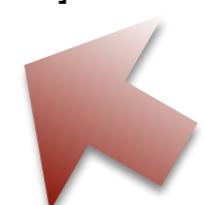
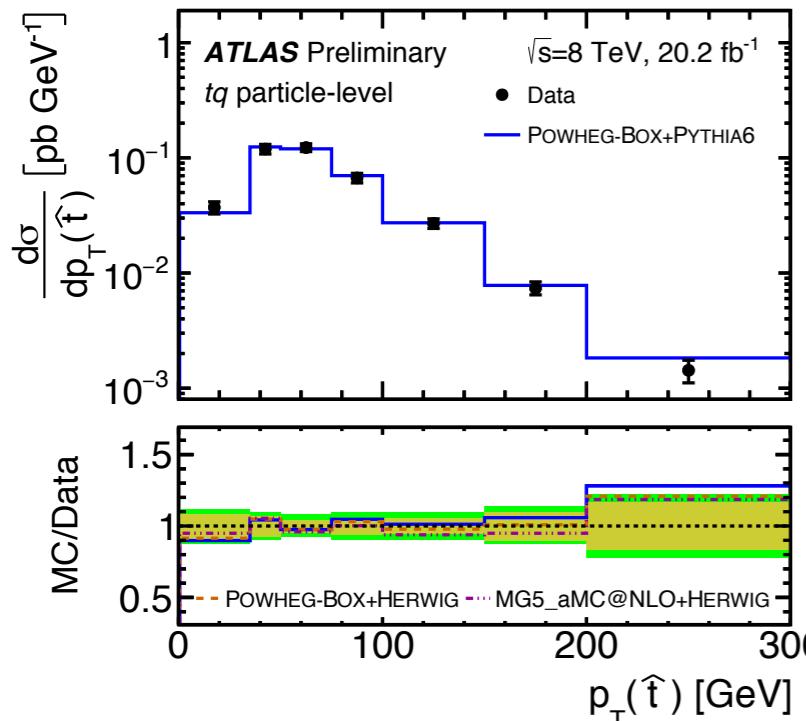
- 1 charged lepton
  - $p_T > 25\text{GeV}$ ,  $|\eta| < 2.5$
- 2 jets
  - 1 b-tagged jet, 1 untagged jet
  - $p_T > 30\text{GeV}$ ,  $|\eta| < 4.5$
- multijet suppression:
  - $E_T^{\text{miss}} > 30\text{GeV}$
  - $m_T(l, E_T^{\text{miss}}) > 50\text{GeV}$
  - $p_T(l) > \max(25\text{GeV}, 40\text{GeV} \cdot (1 - \frac{\pi - |\Delta\phi(j,l)|}{\pi - 1}))$

# Analysis strategy

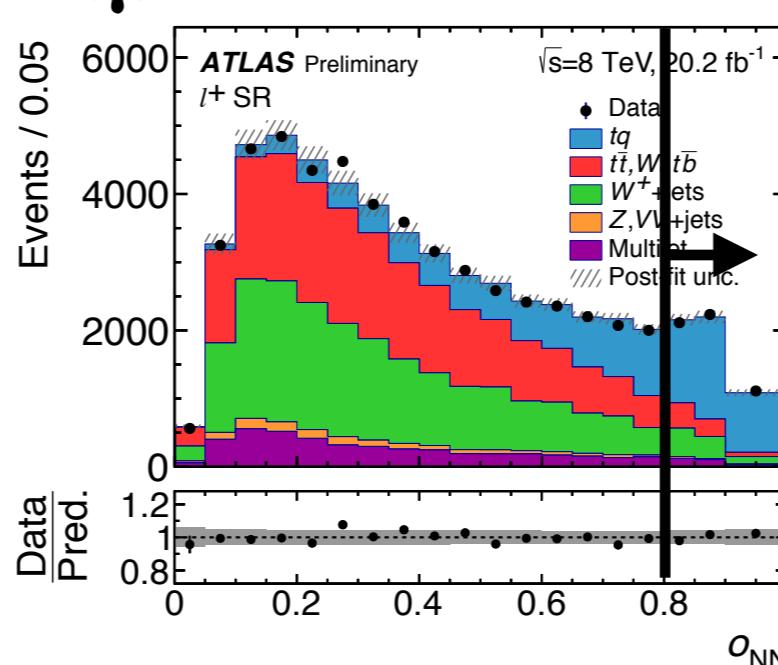
1) Fiducial XS measurement  
→ See D. Hirschbühl's talk



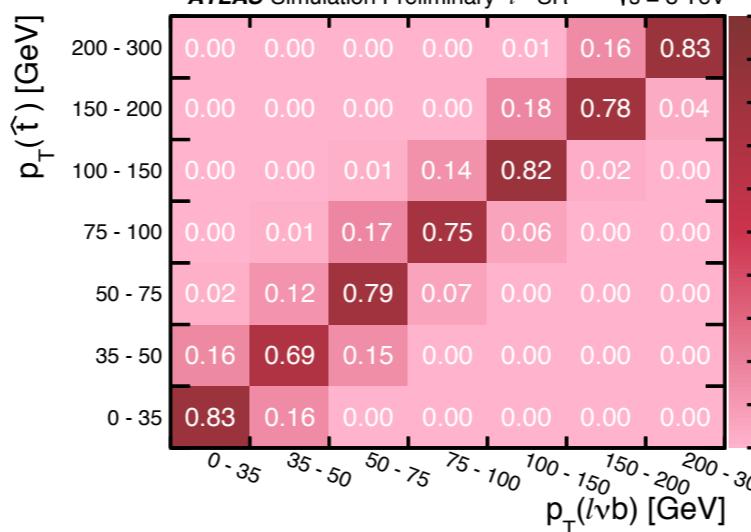
5) Final result  
— after correcting to —  
full/fiducial phase space



2) Cut on NN output of 0.8  
— NN wo  $|\eta(j)|$  used for —  
unfolding  $|y(j)|$



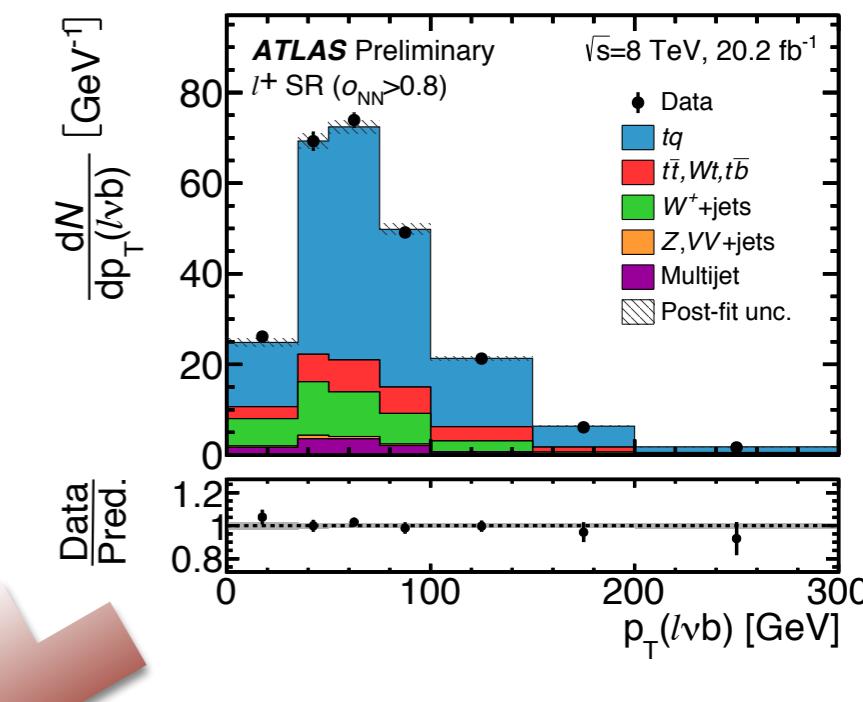
4) Calculate migration matrix  
for unfolding procedure



Order	Variable
1	$m(jb)$
2	$ \eta(j) $
3	$m(\Lambda b)$
4	$m_T(W)$
5	$\Delta\eta(\Lambda, b)$
6	$m(b)$
7	$\cos\theta^*(l, j)$

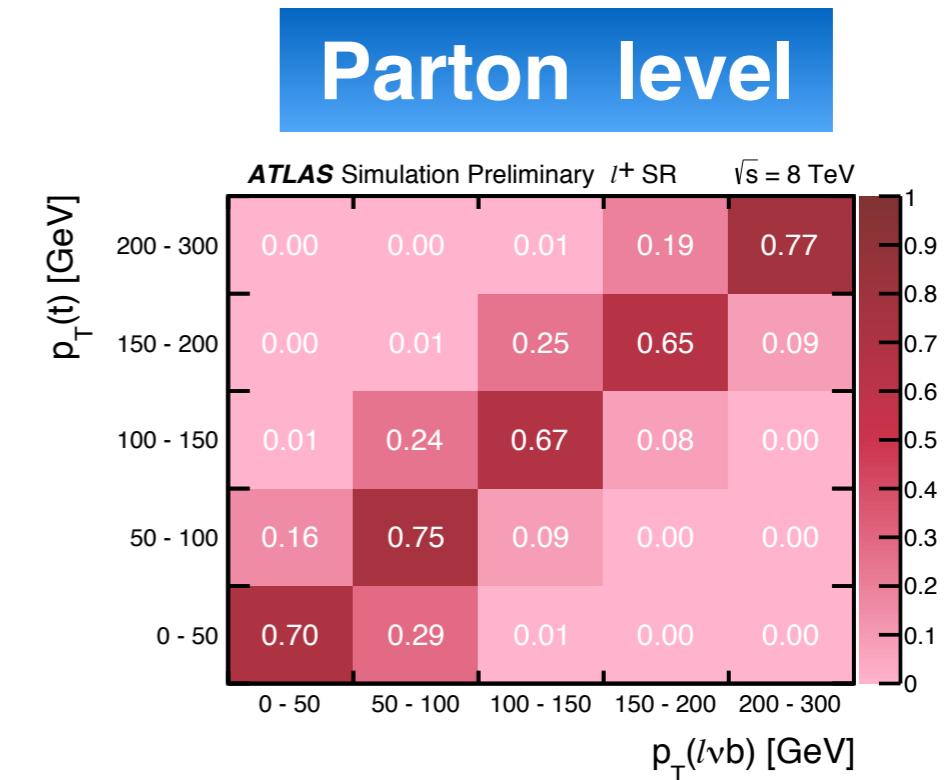
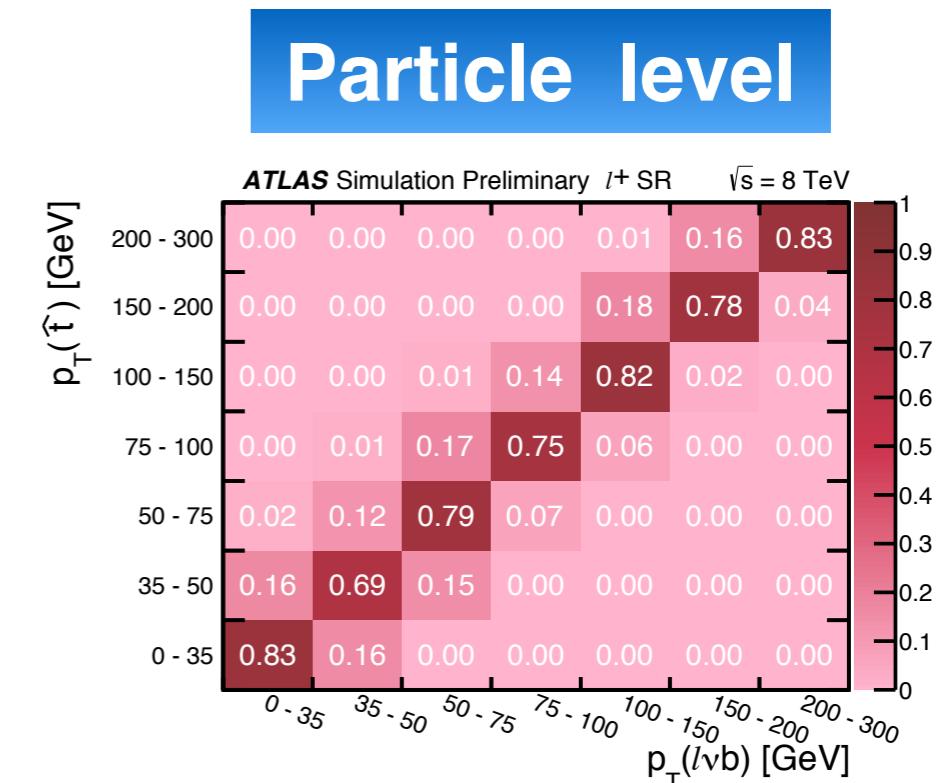


3) Subtract background



# Unfolding procedure

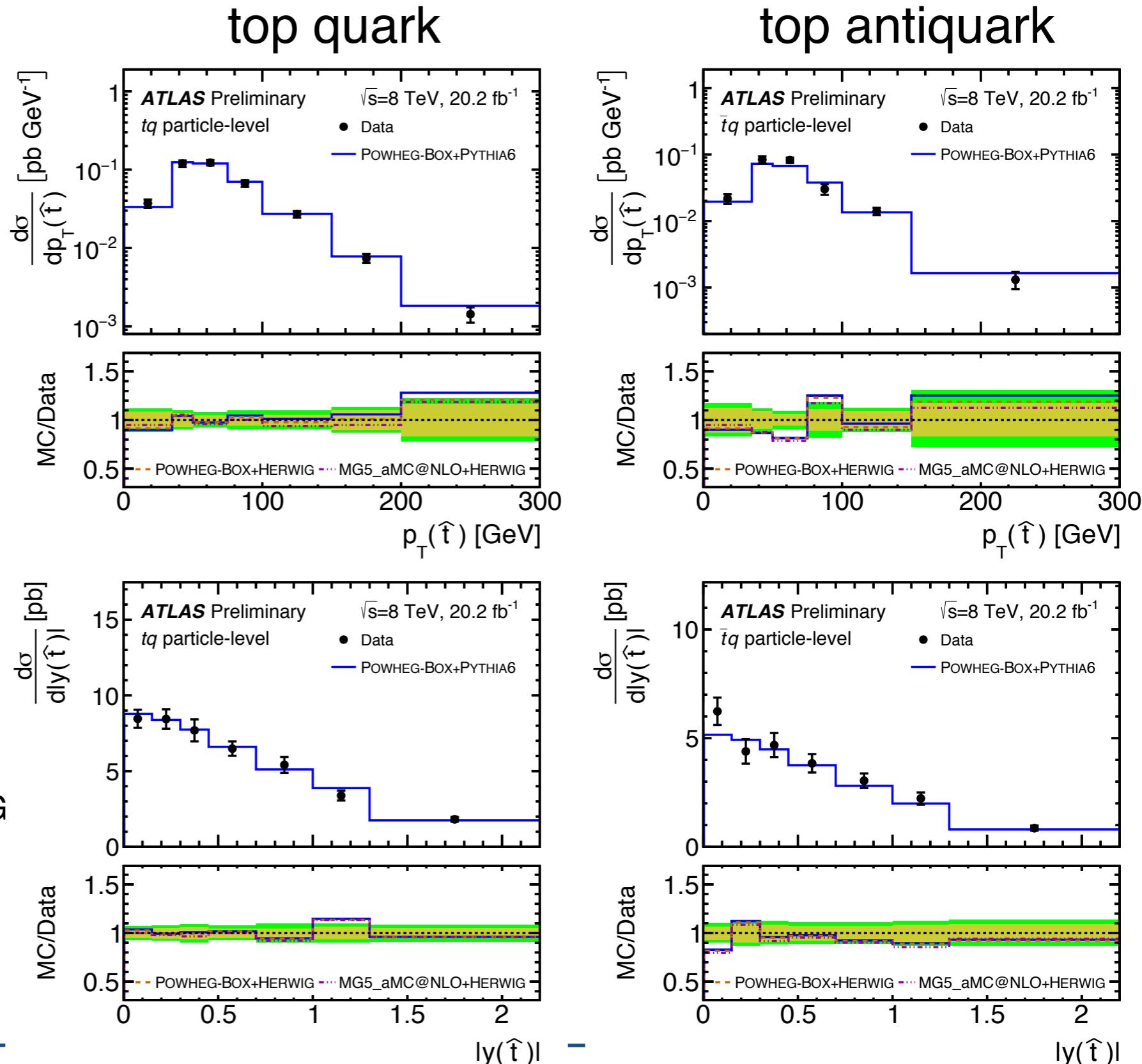
- Correct for detector effects:
  - resolution, acceptance
- Direct comparison to theoretical predictions and measurements from different experiments
- Use iterative Bayesian unfolding
  - stable with > 60% along diagonal
- Unfold to particle level and parton level
  - more bins for particle-level cross-sections due to better resolution



# Results

New!

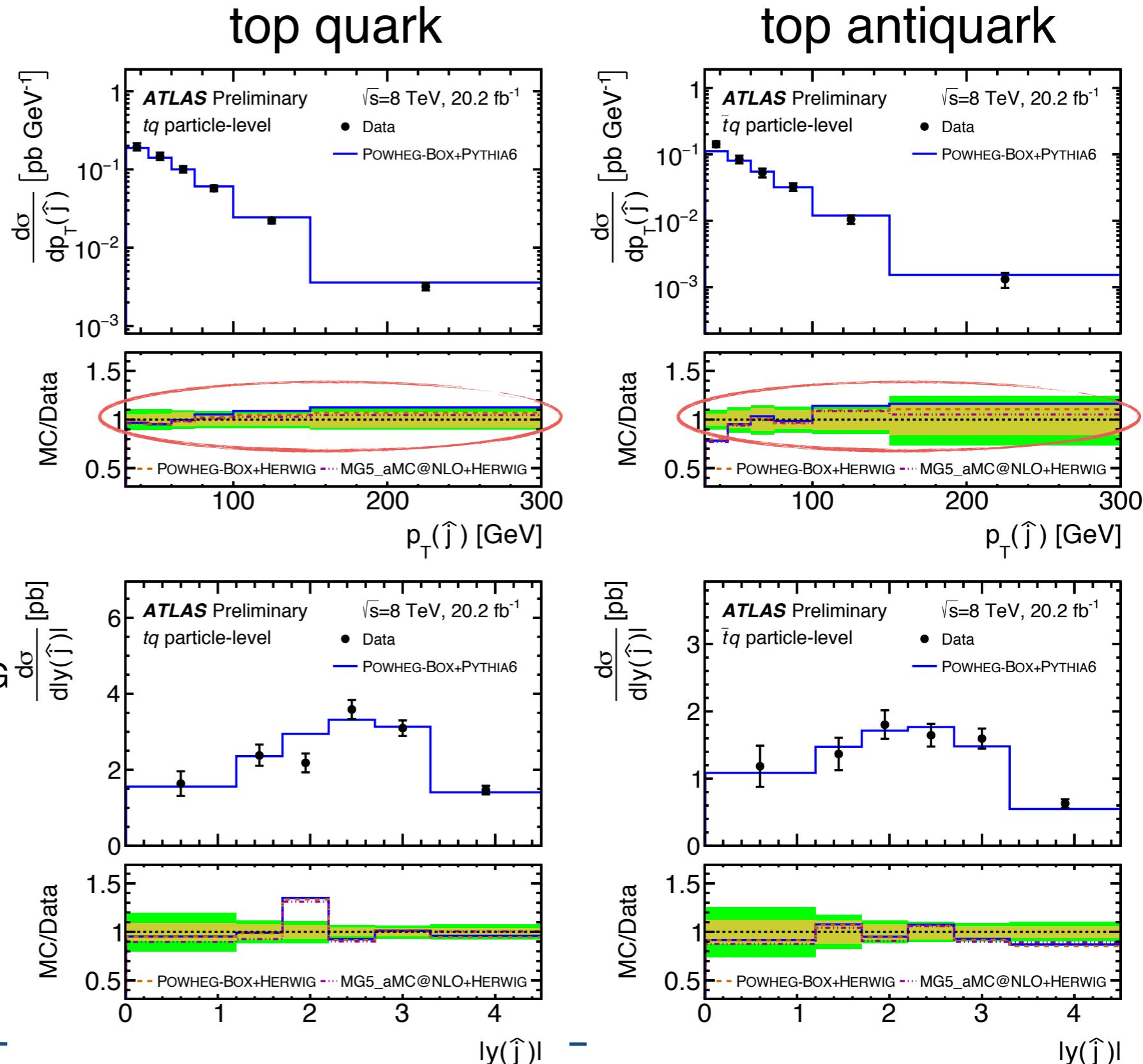
- $p_T$  and  $|y|$  of pseudo top (anti)quarks at particle level
- Typically 5-10% precision per bin
- Consistent with MC predictions:
  - POWHEG-Box+PYTHIA6
  - POWHEG-Box+HERWIG
  - MG5\_aMC@NLO+HERWIG



# Results

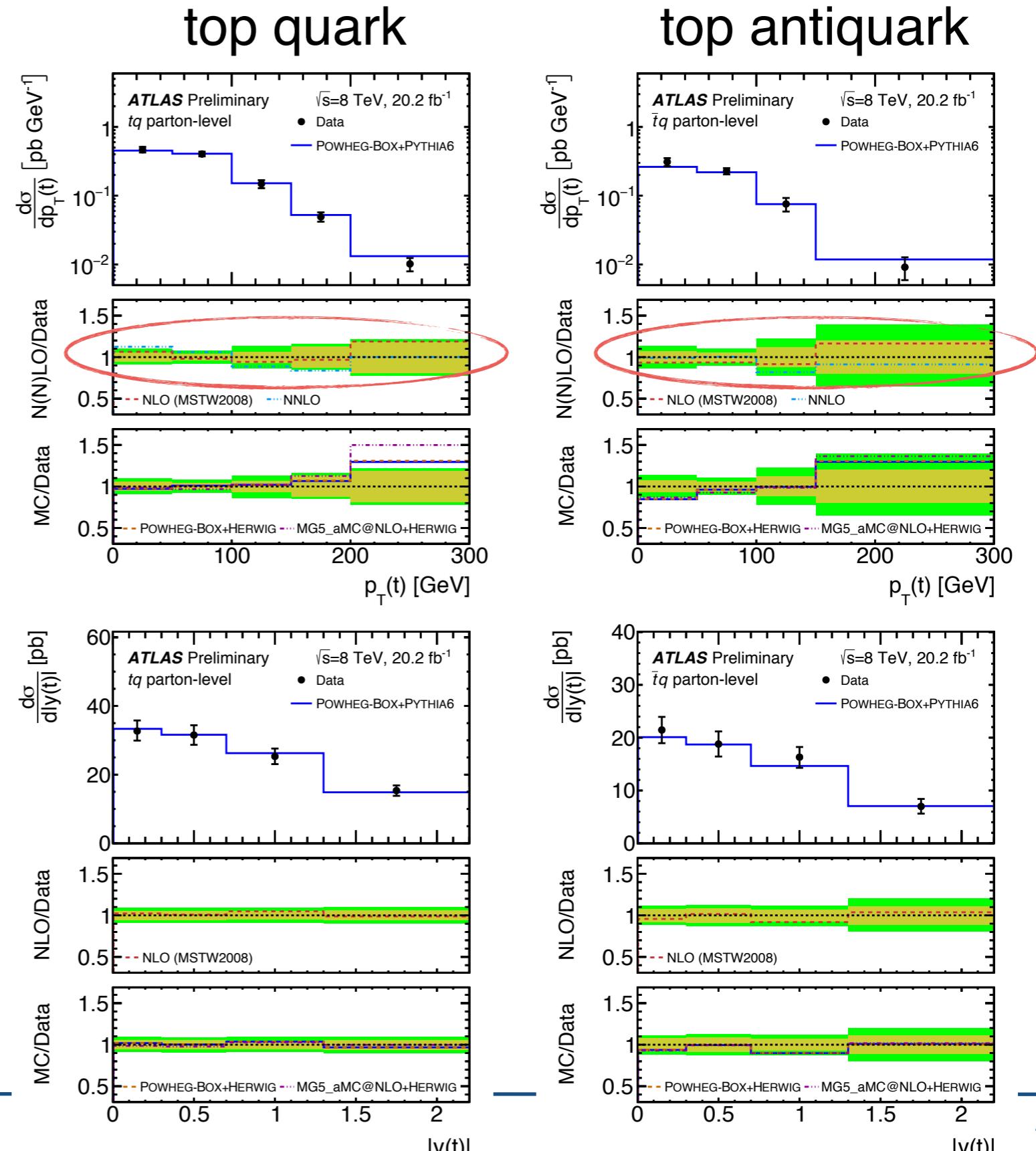
New!

- $p_T$  and  $|y|$  of untagged jets at particle level
- Typically 5-10% precision per bin
- Consistent with MC predictions:
  - POWHEG-Box+PYTHIA6
  - POWHEG-Box+HERWIG
  - MG5\_aMC@NLO+HERWIG
- Predicted spectra are slightly harder than data for  $p_T(\hat{j})$



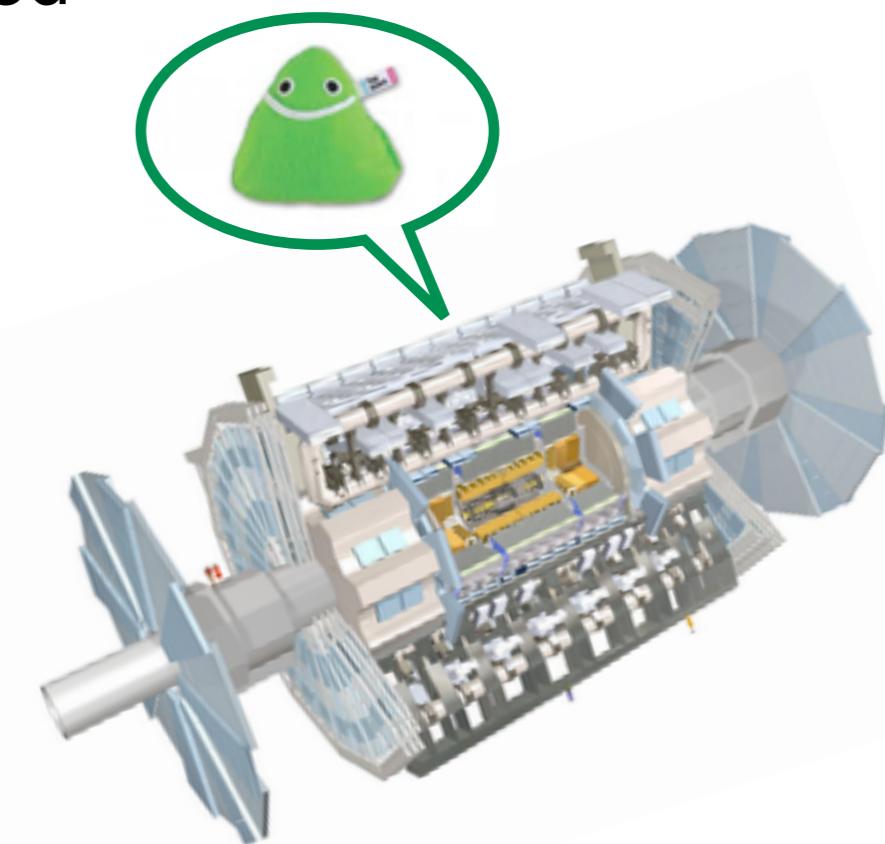
# Results

- $p_T$  and  $|y|$  of top (anti)quarks at parton level
- Typically 5-10% precision per bin
- Consistent with MC & N(N)LO predictions:
  - POWHEG-Box+PYTHIA6
  - POWHEG-Box+HERWIG
  - MG5\_aMC@NLO+HERWIG
  - NLO (MCFM)
  - NNLO (Kidonakis) for  $p_T$  only
- NNLO describes the data better than MC for  $p_T(t)$



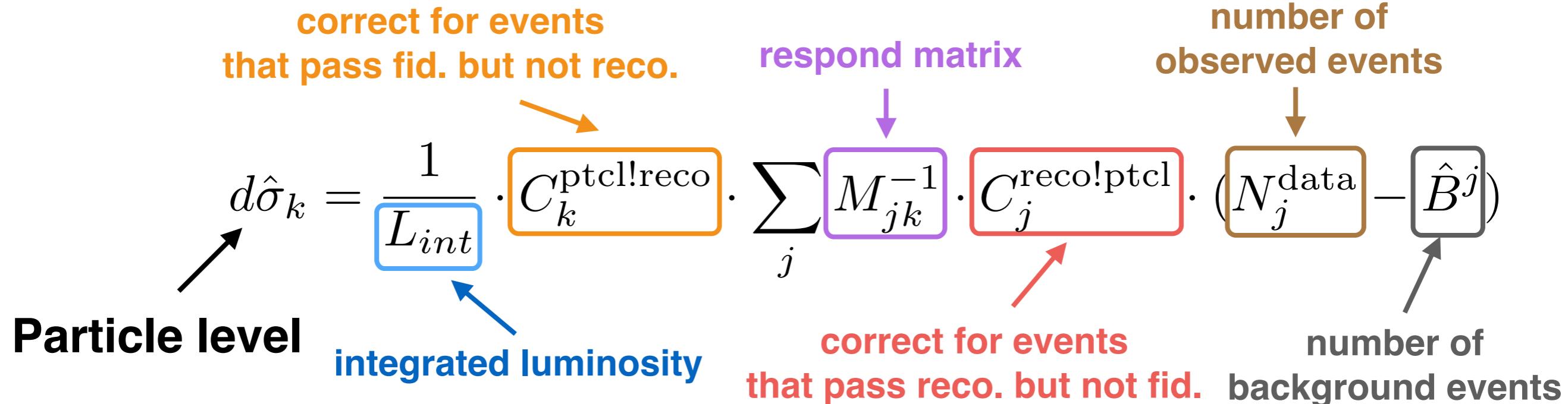
# Conclusions

- ATLAS has performed measurements of  $t$ -channel top-(anti)quark differential cross-sections at 8 TeV
  - both absolute and normalised cross-sections
  - at parton level and the first time at particle level
- Typically 5-10% precision per bin achieved
- The most precise measurements are normalised cross-sections at particle level
- Good agreement between data and MC predictions (and fixed-order QCD calculations)
  - NNLO describes the data better than MC for  $p_T(t)$
  - Tendency for MC to be harder than the data for  $p_T(\hat{j})$



# Backup

# Differential cross sections



**For parton-level cross sections:**

$$C_k^{\text{ptcl!reco}} = \frac{1}{\epsilon_k} \quad \& \& \quad C_j^{\text{reco!ptcl}} = 1$$

**Normalised cross sections =**

$$\frac{1}{\hat{\sigma}} d\hat{\sigma}_k$$