

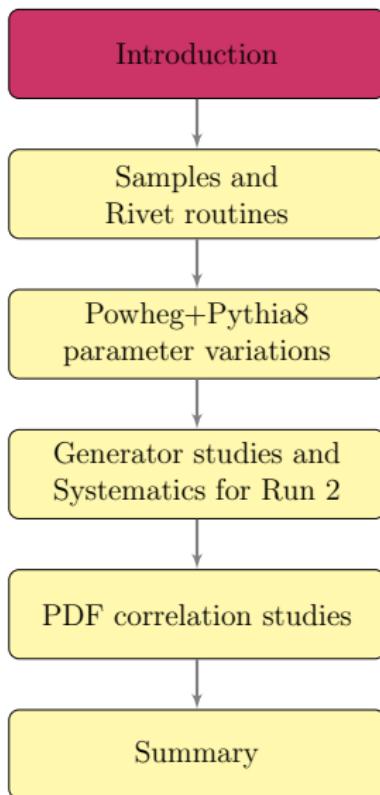
# ATLAS Monte Carlo plans for Run II

**Andrea Knue** on behalf of the ATLAS Top group

– Top LHC WG meeting, May 2015 –

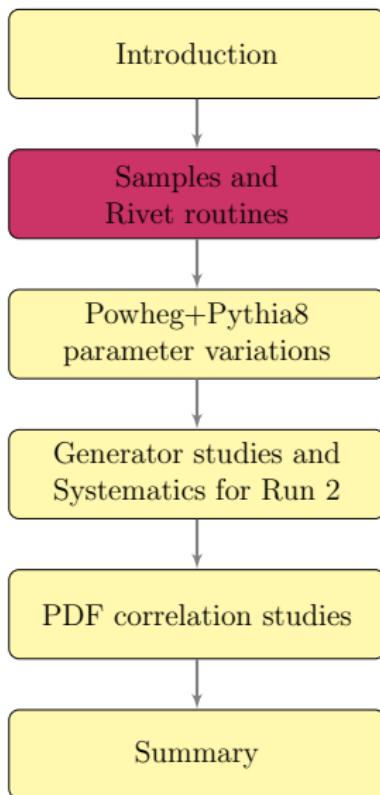
21st May, 2015





# Introduction

- present top modelling studies in preparation for Run II
  - ↪ Powheg+Pythia8 with  $h_{\text{damp}}$  variations
  - ↪ compare different NLO+PS setups and NLO multileg generators
  - ↪ results published in PUB note [ATL-PHYS-PUB-2015-011](#)
- discuss initial default generator and setups for systematics in Run II
- study correlation of PDF uncertainties between  $t\bar{t}$  and  $Wt$  channel
  - ↪ has been published in PUB note [ATL-PHYS-PUB-2015-010](#)



## Rivet routines used in these studies

→ We compare our  $t\bar{t}$  samples after showering to the unfolded 7 TeV data using different Rivet routines

$t\bar{t}$  production with a veto on additional jet activity

Eur.Phys.J. C72 (2012) 2043

Use the 'gap fraction'  $f(Q_0)$  and  $f(Q_{\text{sum}})$  variables to quantify additional jet activity:

$$f(Q_0) = \frac{n(Q_0)}{N}, \quad f(Q_{\text{sum}}) = \frac{n(Q_{\text{sum}})}{N}$$

- dilepton channel
- exactly two leptons and at least two  $b$ -jets
  - ↪ allows to identify the additional jets
- jets: antiKt 0.4,  $p_T > 25$  GeV,  $|\eta| < 2.4$

## Rivet routines used in these studies II

$t\bar{t}$  xsec as function of  $N_{\text{jets}}$  and  $p_T$

► JHEP 01 (2015) 020

- lepton+jets channel
- exactly one lepton,  $\geq 4$  jets (1  $b$ -jet)
- jets: antiKt 0.4,  $p_T > 25$  GeV,  $|\eta| < 2.5$
- $N_{\text{jets}}$  with  $p_T > 25, 40, 60$  and  $80$  GeV
- $p_T$  for the 1st, 2nd, 3rd, 4th and 5th jet

Normalised differential xsec (unf. to parton level)

► Phys.Rev. D90 (2014) 072004

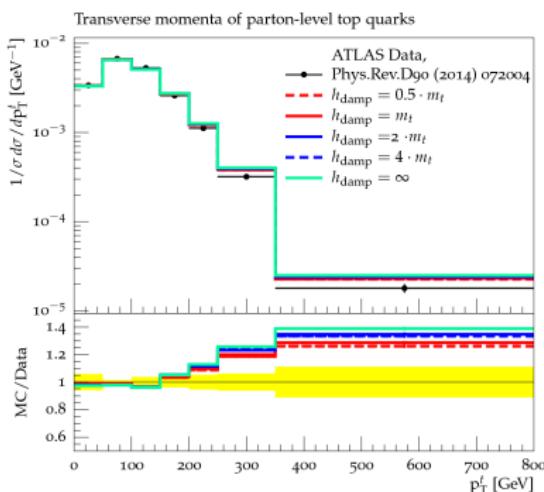
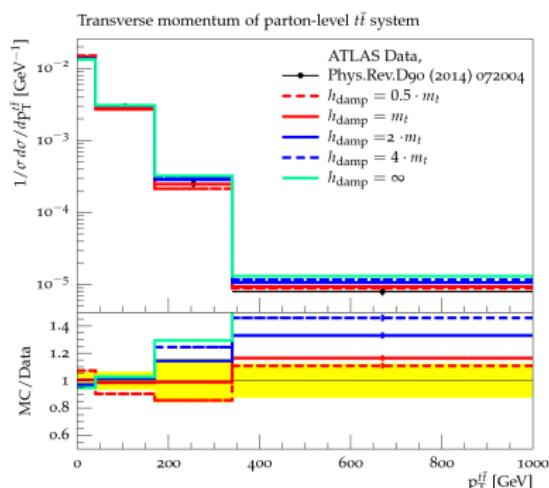
- lepton+jets channel with selection as above
- xsec as function of top quark  $p_T$
- xsec as function of mass,  $p_T$  and  $|\eta|$  of the  $t\bar{t}$ -system

# Resummation damping

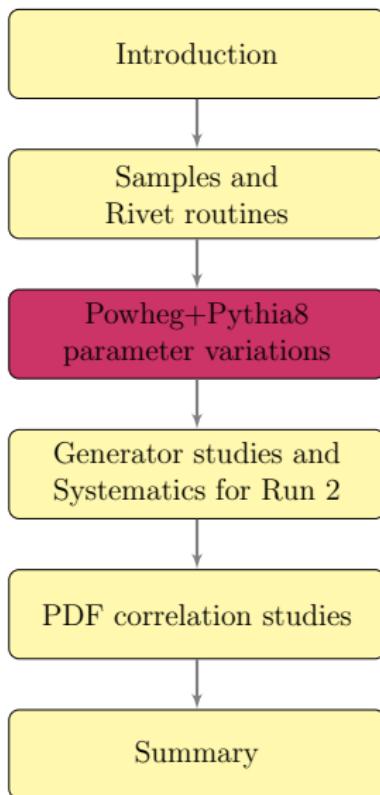
- new baseline:  $h_{\text{damp}} = m_{\text{top}}$
- before was set to infinity as default
- $h_{\text{damp}}$  controls hardness of hardest emission:
  - ↪ gluon that recoils against the  $t\bar{t}$ -system
  - ↪ expect therefore an effect on the  $p_T$  spectra
- will test different  $h_{\text{damp}}$  variations to study effect on the data/MC agreement of the unfolded spectra

# Powheg+Pythia6 studies (Run I)

- Powheg(CT10)+Pythia6
- Perugia2011C tune with CTEQ6L1
- $h_{\text{damp}} = m_{\text{top}}$   
 $\hookrightarrow$  switch from infinity to  $m_{\text{top}}$   
 improves  $t\bar{t} p_T$  but NOT top  $p_T$



- studies published in [▶ ATL-PHYS-PUB-2015-002](#)
- will compare to new generator setups published in [▶ ATL-PHYS-PUB-2015-XXX](#)

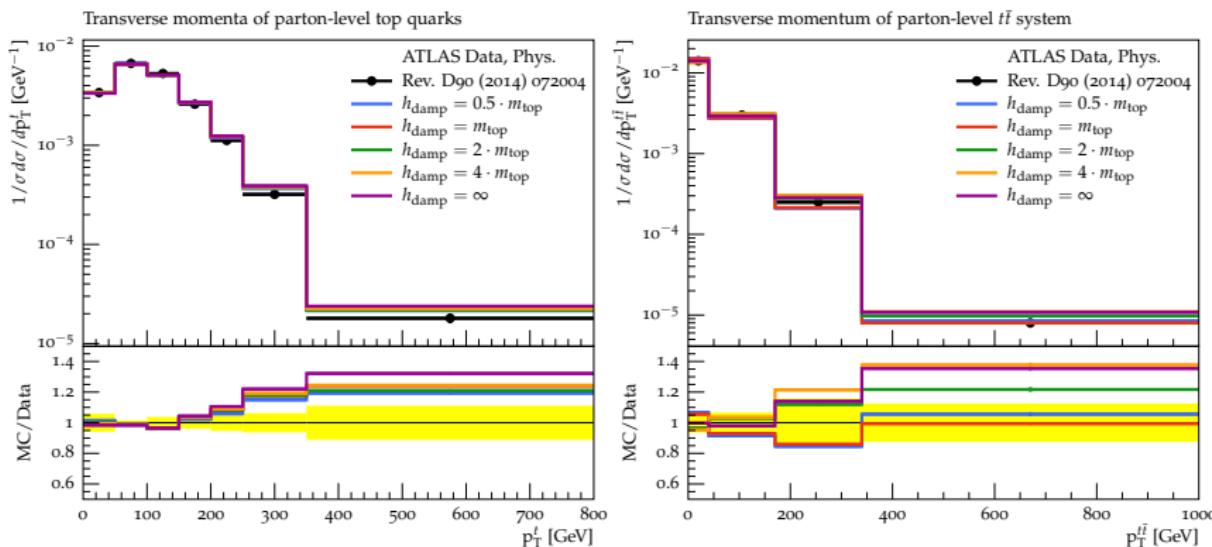


# Generator setups in comparisons

Sample	POWHEG+PYTHIA6	POWHEG+PYTHIA8	POWHEG+ HERWIG++	SHERPA
ME gen.	POWHEG(r2330.3)	POWHEG(r2330.3)	POWHEG(r2330.3)	SHERPA(v2.1.1)
PS/UE gen.	PYTHIA6(v6.427)	PYTHIA8(v8.183)	HERWIG++(v2.7.1)	SHERPA(v2.1.1)
ME & PS/UE PDF	CT10 & CTEQ6L1	CT10 & CTEQ6L1	CT10 & CTEQ6L1	CT10
PS tune	Perugia 2011C	A14	UEEE5	Default

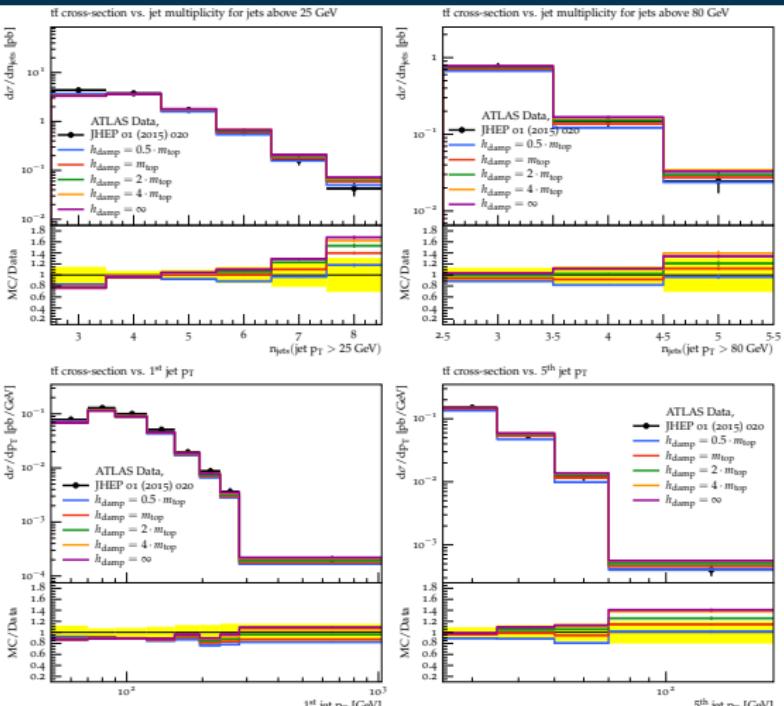
- lepton+jets and dilepton samples at  $\sqrt{s} = 7 \text{ TeV}$
- $m_{top} = 172.5 \text{ GeV}$
- based on Powheg+Pythia8 with A14 tune:
  - ↪ vary  $h_{damp}$  from  $0.5 \cdot m_{top} - \infty$
  - ↪ vary the NLO PDF in the matrix element
- Sherpa:  $t\bar{t} + 0,1 \text{ parton} @ \text{NLO and } 2,3,4 @ \text{LO}$

# $h_{\text{damp}}$ variations in Powheg+Pythia8 setup



→  $h_{\text{damp}} = m_{\text{top}}$ : improves the  $t\bar{t}$ - $p_T$ , less sensitive to the top  $p_T$

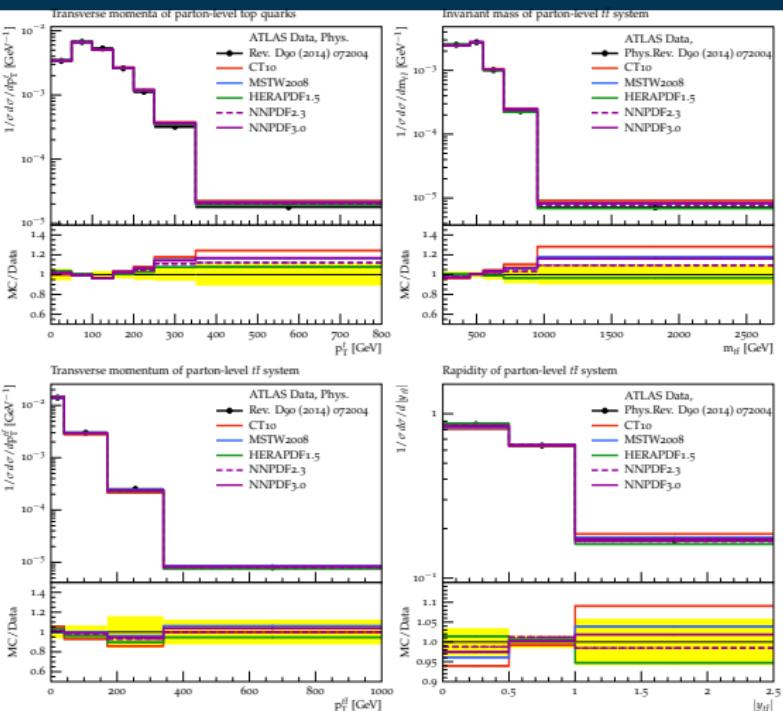
# $h_{\text{damp}}$ variations in Powheg+Pythia8 setup



→ best agreement for low  $h_{\text{damp}}$  values

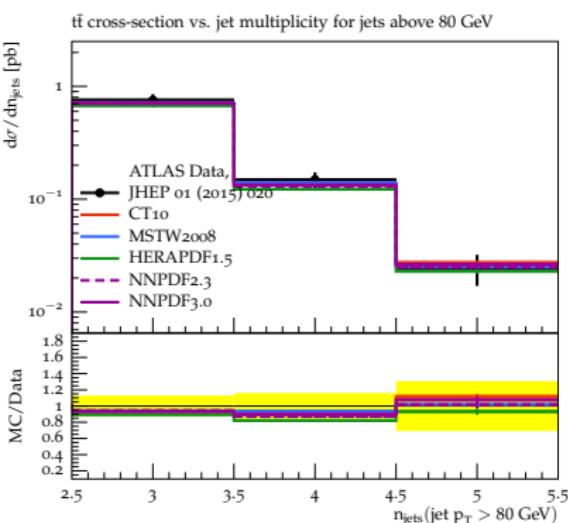
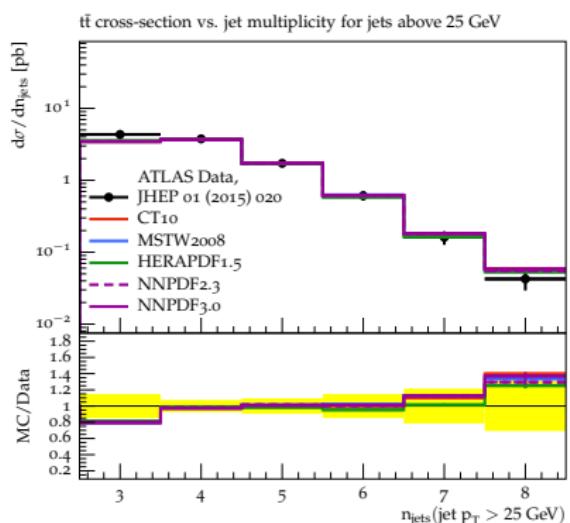
→ consistent with findings for Powheg+Pythia 6

# PDF variations in Powheg+Pythia8 setup

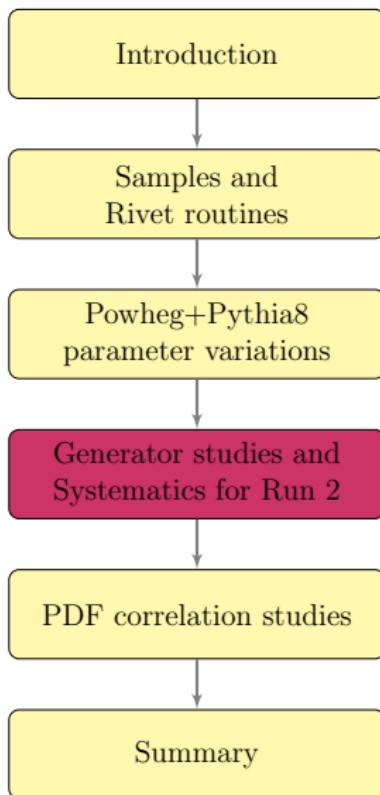


- best data/MC agreement with HERAPDF1.5
- rapidity badly described with CT10

# PDF variations in Powheg+Pythia8 setup



→ less sensitivity to jet multiplicity distributions

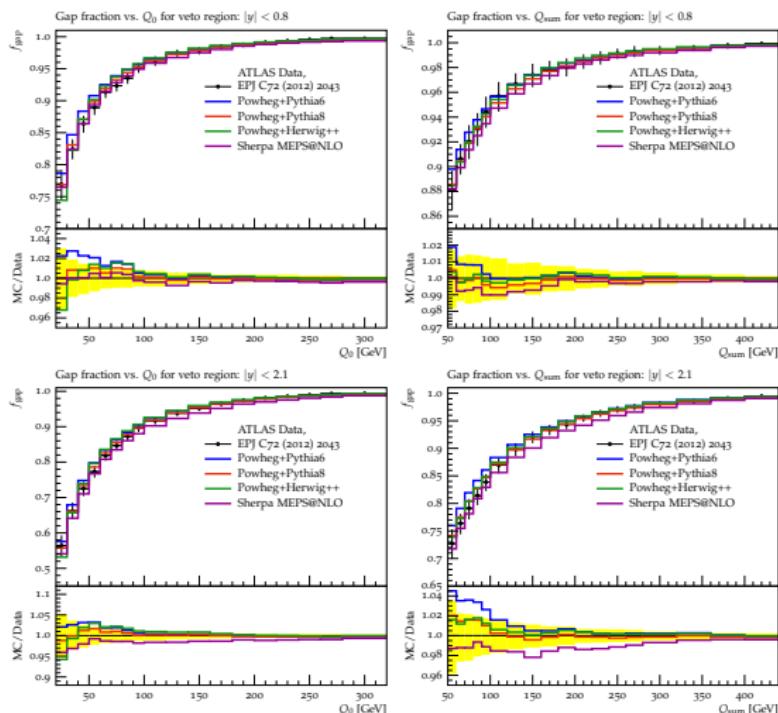


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PS/UE gen.	PYTHIA6(v6.427)	PYTHIA8(v8.183)	HERWIG++(v2.7.1)	SHERPA(v2.1.1)
ME & PS/UE PDF	CT10 & CTEQ6L1	CT10 & CTEQ6L1	CT10 & CTEQ6L1	CT10
PS tune	Perugia 2011C	A14	UEEE5	Default

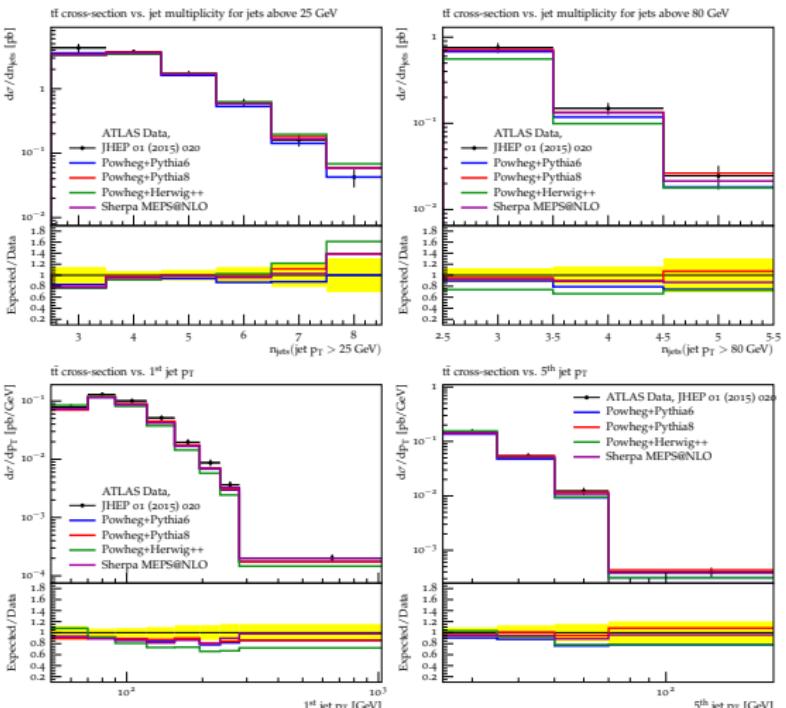
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# Jet gap fraction plots



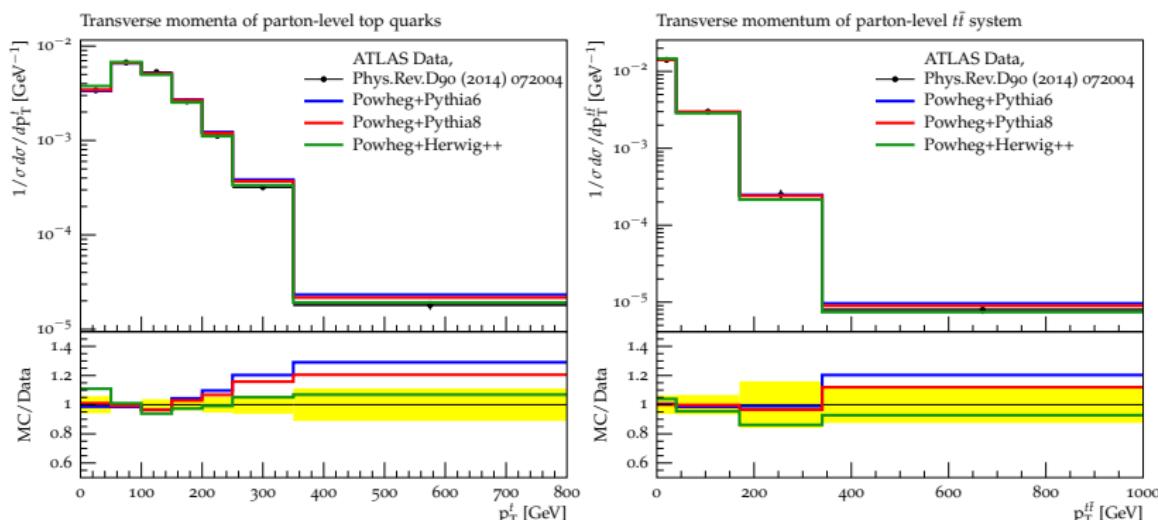
→ best data/MC agreement for Powheg+Pythia8

# Jet multiplicity and momentum



→ best data/MC agreement for Powheg+Pythia8 and Sherpa

# Unfolded distributions (parton level)



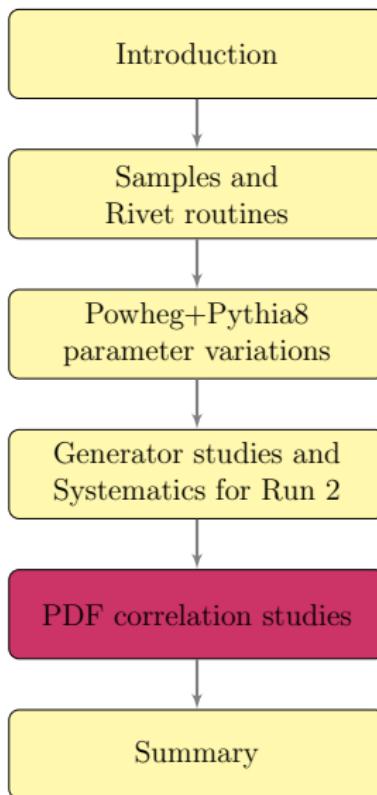
- Powheg+Herwig++: distributions always softer than for Pythia
- Powheg+Py8 softer than Powheg+Py6
- best data/MC agreement for Powheg+Herwig++

# Default Setup and Systematics for Run II

- default: switch from Powheg+Pythia6 to Powheg+Pythia8 or Sherpa
- Hadronisation and PS uncertainty: Powheg+Herwig++
- generator uncertainty: aMC@NLO+Herwig++
- radiation systematics: correlated variations of scales and  $h_{\text{damp}}$  as well as P2012/A14 eigentunes

→ see talk from Dominic in January

▶ Link



# Motivation

- PDF uncertainties can have large impact on measurements
- can impact measurements in different ways:
  - change in acceptance for cross-section measurements
  - change the theoretical cross-section, needed e.g. for  $V_{tb}$  extraction of mass from cross-section

## Goals of this study:

- a) explore the correlations in the acceptance changes between  $Wt$  and  $t\bar{t}$
- b) explore the correlations between the acceptance changes and the theoretical cross-section

## Event selection

- select dilepton sample
- exactly two leptons with high momentum ( $> 25$  GeV)
- $E_T^{miss} > 20$  GeV
- ee/ $\mu\mu$  channel: 10 GeV mass window around  $Z$  mass
- $\geq 1$  jet with  $p_T > 25$  GeV

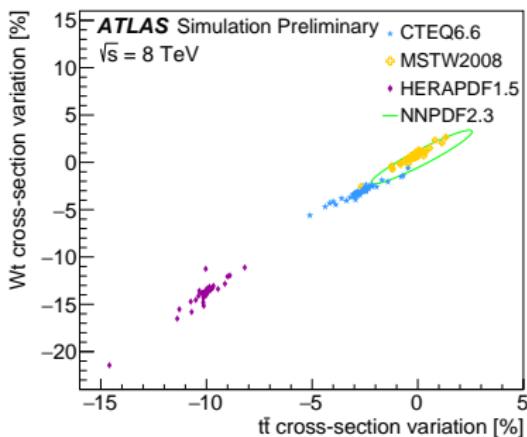
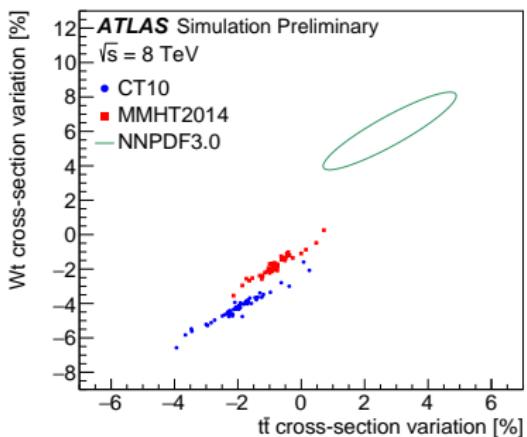
Main PDF sets:

- CT10 eigenvectors
- MMHT eigenvectors
- NNPDF3.0 replicas

# Setup

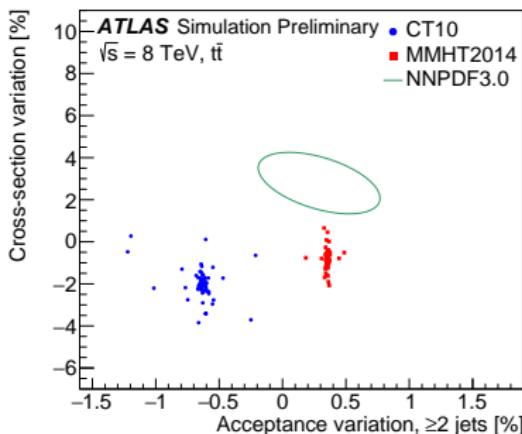
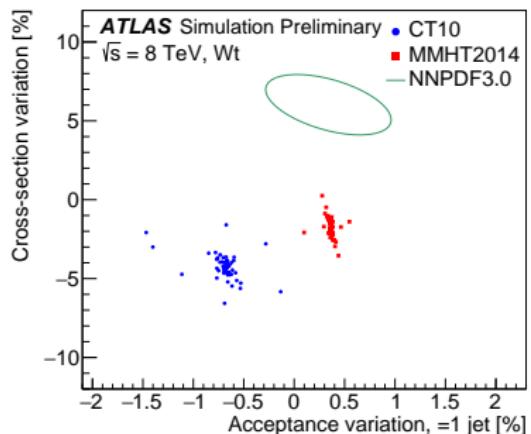
- look at two types of selection:
  - ↪ exactly one jet:  $Wt$ -like
  - ↪ 2 or more jets:  $t\bar{t}$ -like
- use MC@NLO+Herwig&Jimmy (CT10)
- diagram-removal scheme for  $Wt$  channel
- 5 flavour scheme for  $Wt$  channel

# Correlation for cross-sections



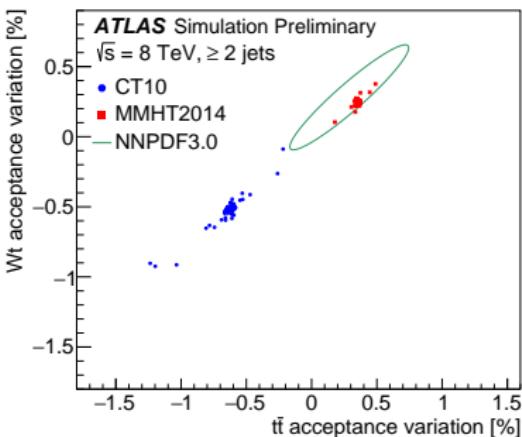
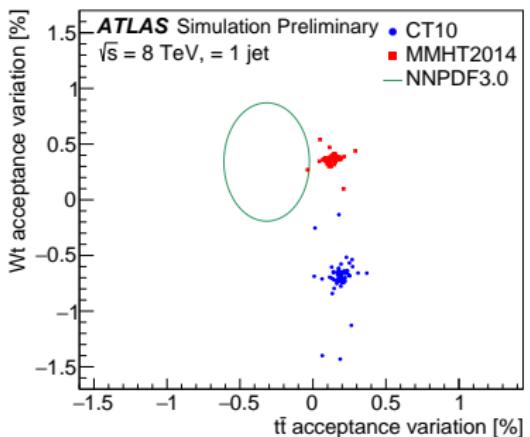
- PDF uncertainty shows high correlations from 0.93-0.98
- should be treated correlated in analyses

# Acceptance vs. cross-section



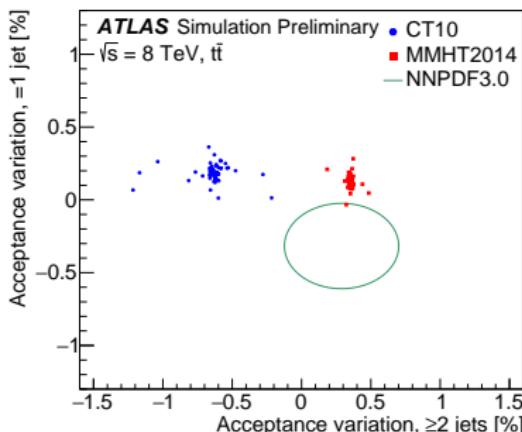
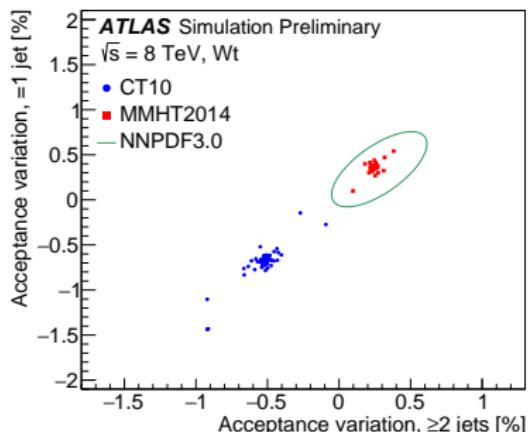
- small or negative correlations for both  $t\bar{t}$  and  $Wt$
- should be treated uncorrelated in analyses
- similar conclusions for CTEQ6.6, MSTW2008, HERAPDF1.5 and NNPDF2.3 (backup)

# Correlation for acceptance variations

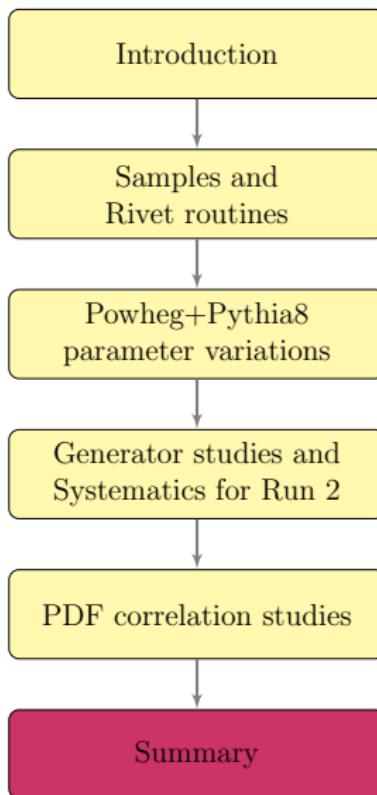


→ very low correlation for exclusive selection, high correlation for inclusive selection

# Correlation for different jet multiplicities



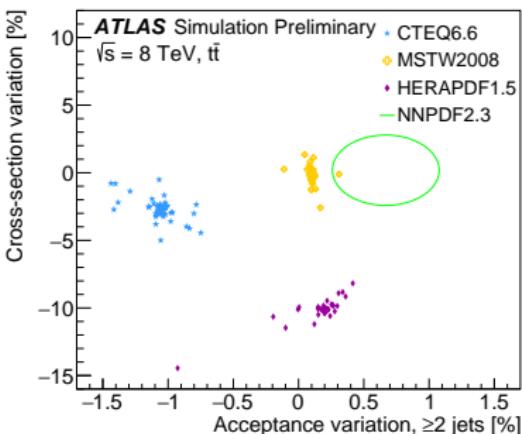
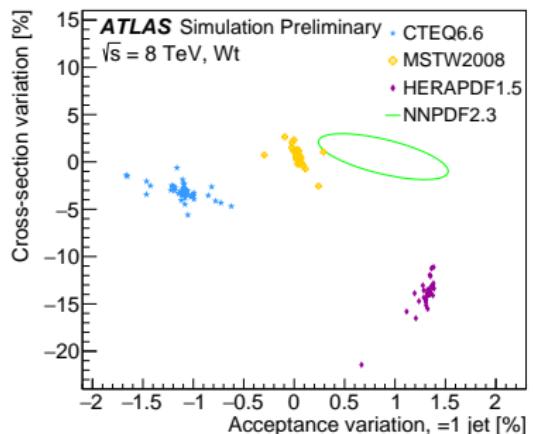
→ strong correlation for  $Wt$ , low correlation for  $t\bar{t}$



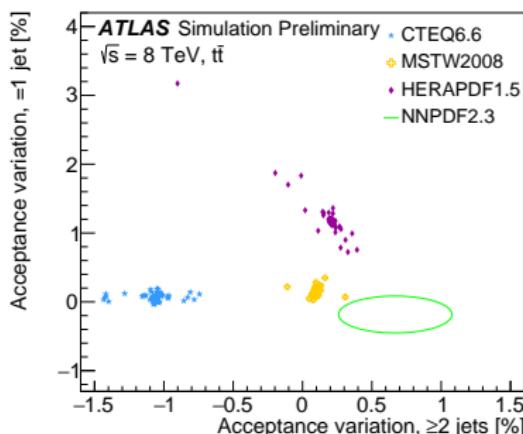
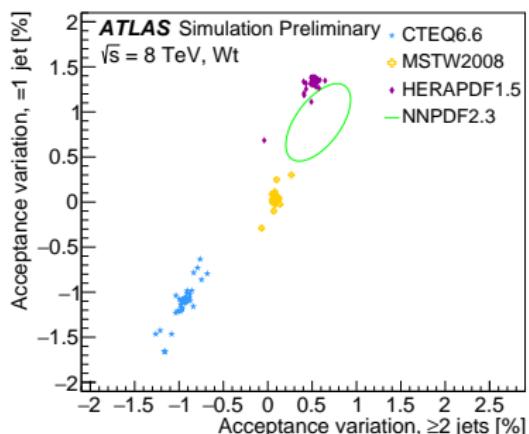
## Summary and Conclusion

- Powheg+Pythia8 setup with  $h_{\text{damp}}$  and PDF variations
  - improved data/MC agreement with  $h_{\text{damp}} = m_{\text{top}}$ , no variation sensitive to top  $p_T$
  - PDF variations: only good top  $p_T$  modelling with HERAPDF
- Generator comparisons:
  - more jets for new generators, reasonable description for most distribution with Powheg+Py8 and Sherpa
  - softer distributions with Herwig++ (good top  $p_T$  agreement)
  - will learn more from comparisons with 8 TeV data
- PDF correlation studies:
  - strong correlations found for  $t\bar{t}$  and  $Wt$  cross sections
  - only small correlations for cross-section vs. acceptance
  - consistent for almost all PDF sets (exception: HERAPDF1.5)

# Correlation between cross-section/acceptance corr



# Correlation for different jet multiplicities



→ strong correlation for  $Wt$ , low correlation for  $t\bar{t}$  (except for HERAPDF)