

# Boosted $t\bar{t}$ xsection at 13 TeV in all-hadronic final state

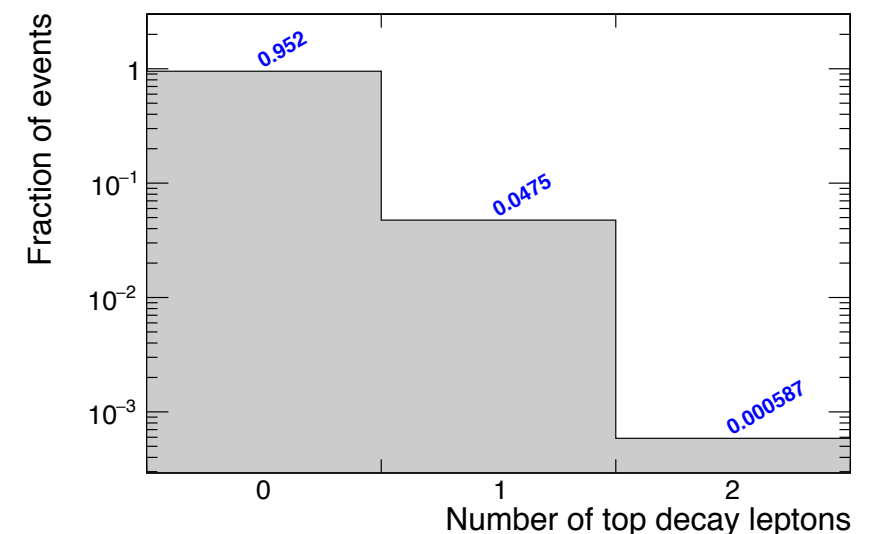
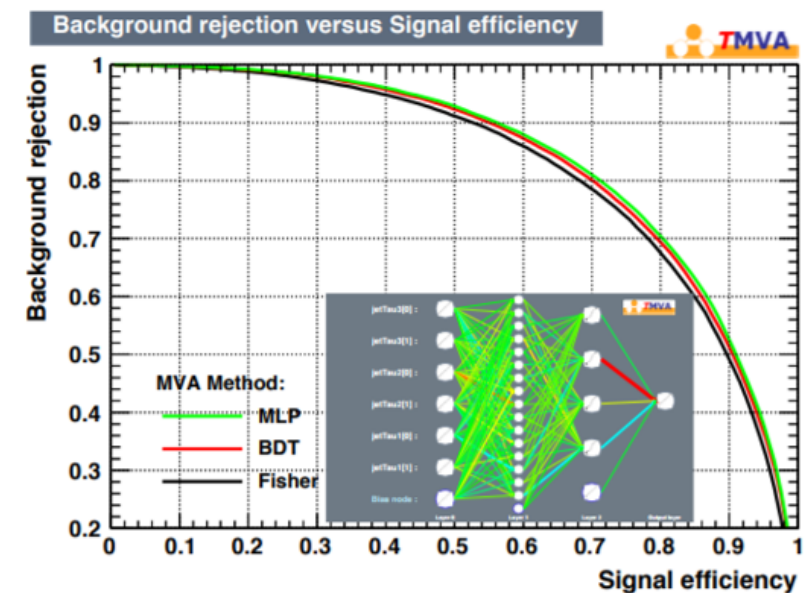
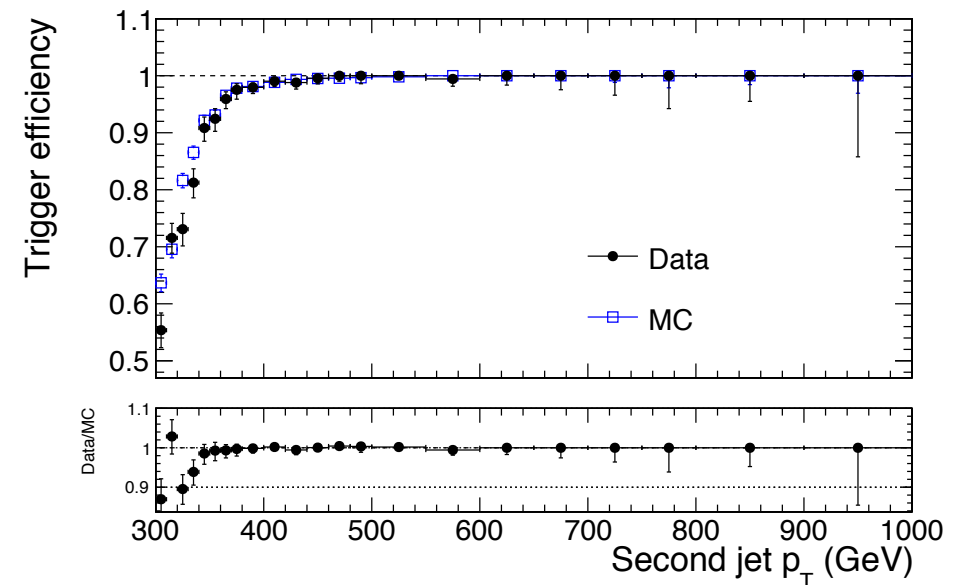
**Update**

07 September 2018

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A. Castro, F. Celli (INFN Bologna), P. Kumar Mal (NISER)*

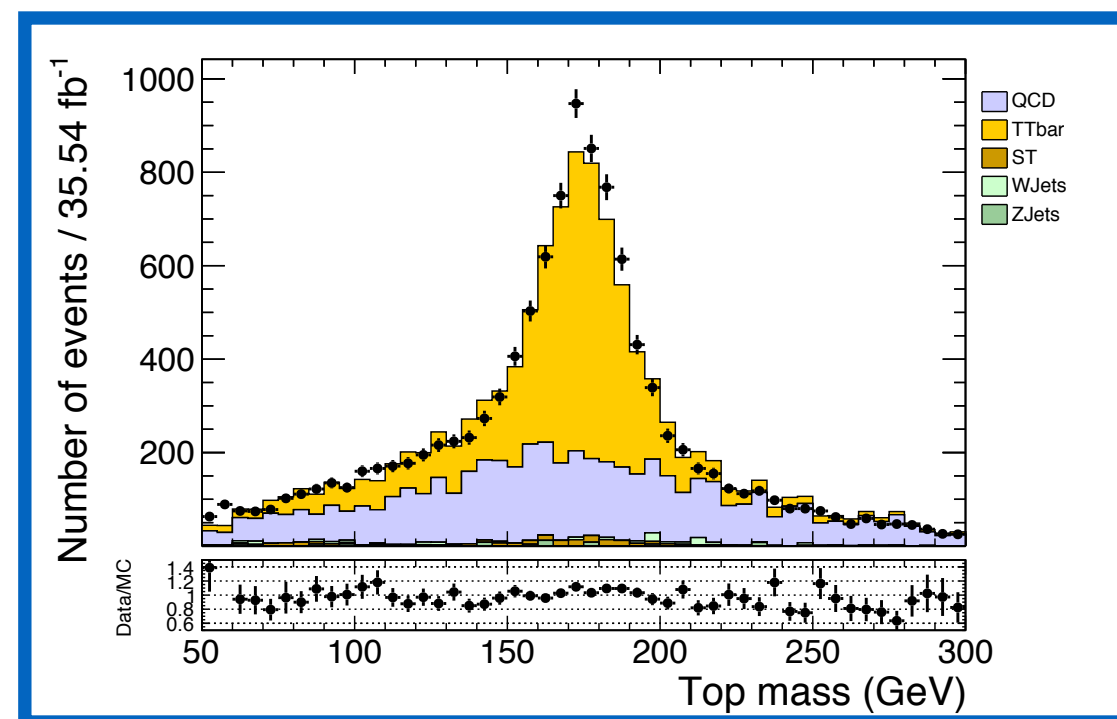
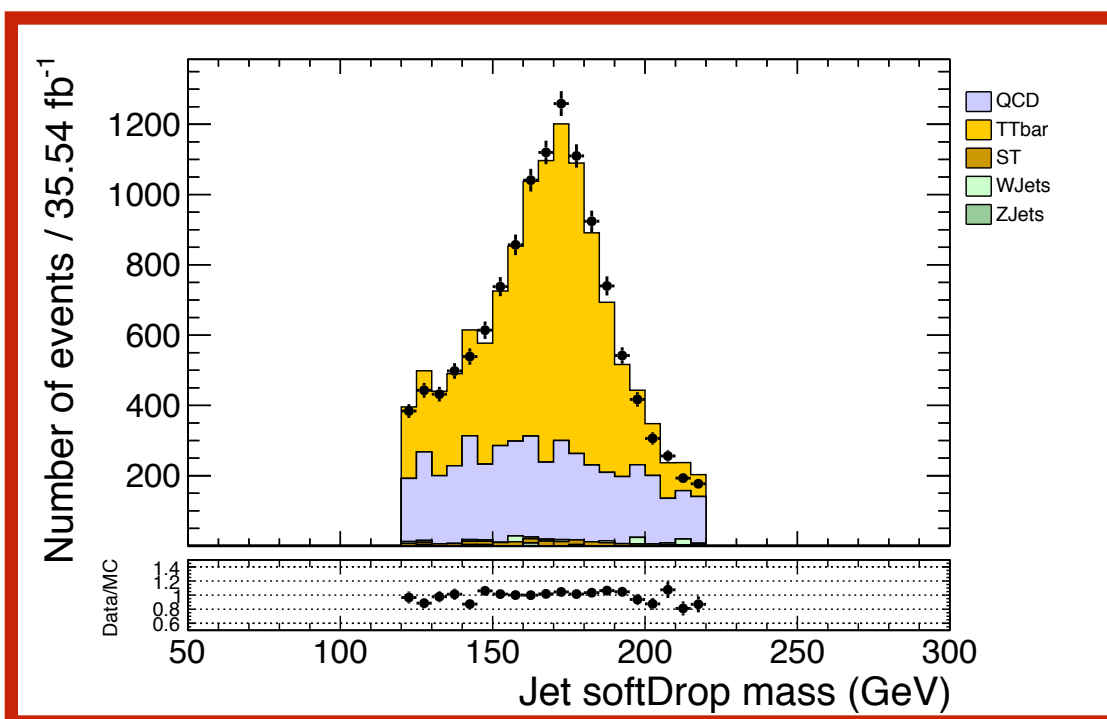
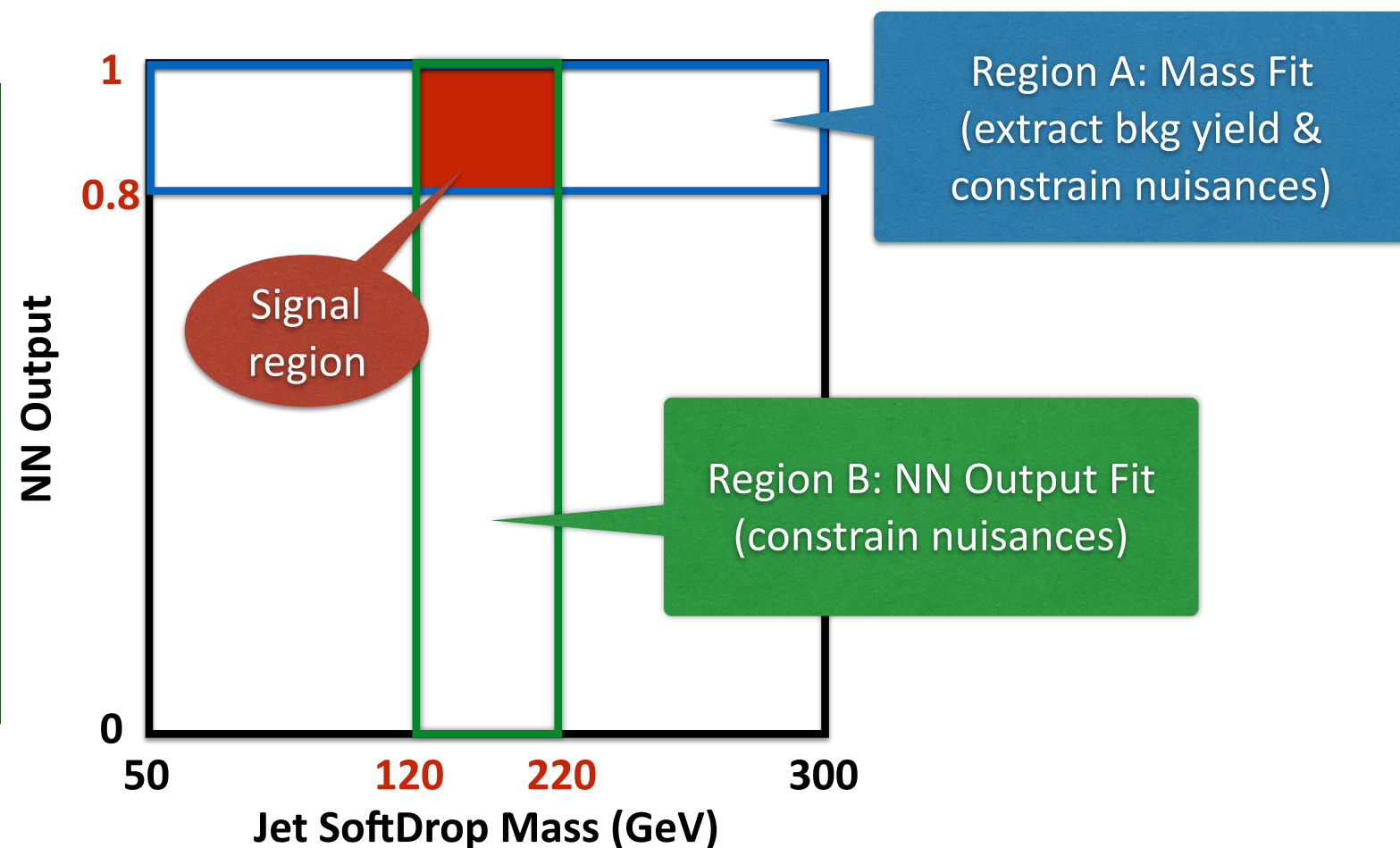
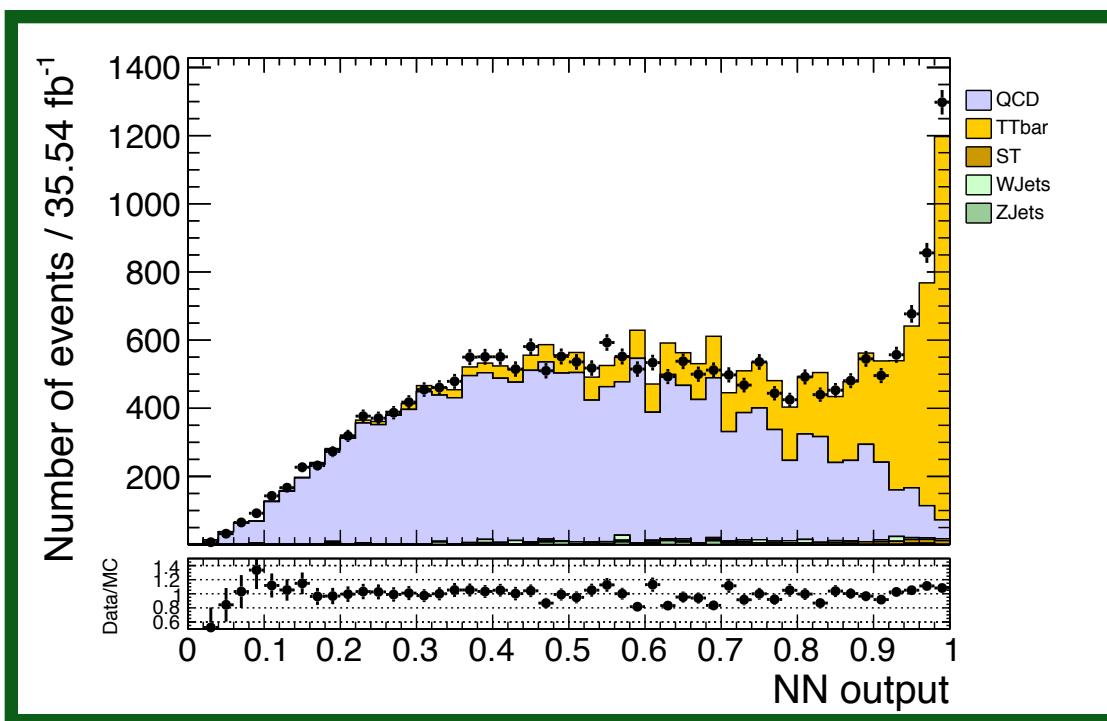
# Analysis Overview

- **2016 dataset**
  - very well understood (calibrations, scale factors, etc)
  - adequate MC statistics after the additional systematics samples
- **Trigger:** HLT\_AK8DiPFJet280\_200\_TrimMass30\_BTagCSV\_p20
  - excellent data vs MC agreement
- **Selection**
  - two AK8 jets with  $p_T > 400$  GeV
  - MVA training using jet substructure variables as inputs
  - categories based on subjet b-tagging
    - 0-btag: control
    - 2-btag: signal
  - Backgrounds
    - QCD dominant: taken from data
    - others (ST, W/Z+jets): negligible
- **Deliverables**
  - differential cross sections
  - five observables: top  $p_T$  &  $\eta$ ,  $t\bar{t}$  system mass,  $p_T$  & rapidity
  - fiducial, unfolded to parton level, unfolded to particle level

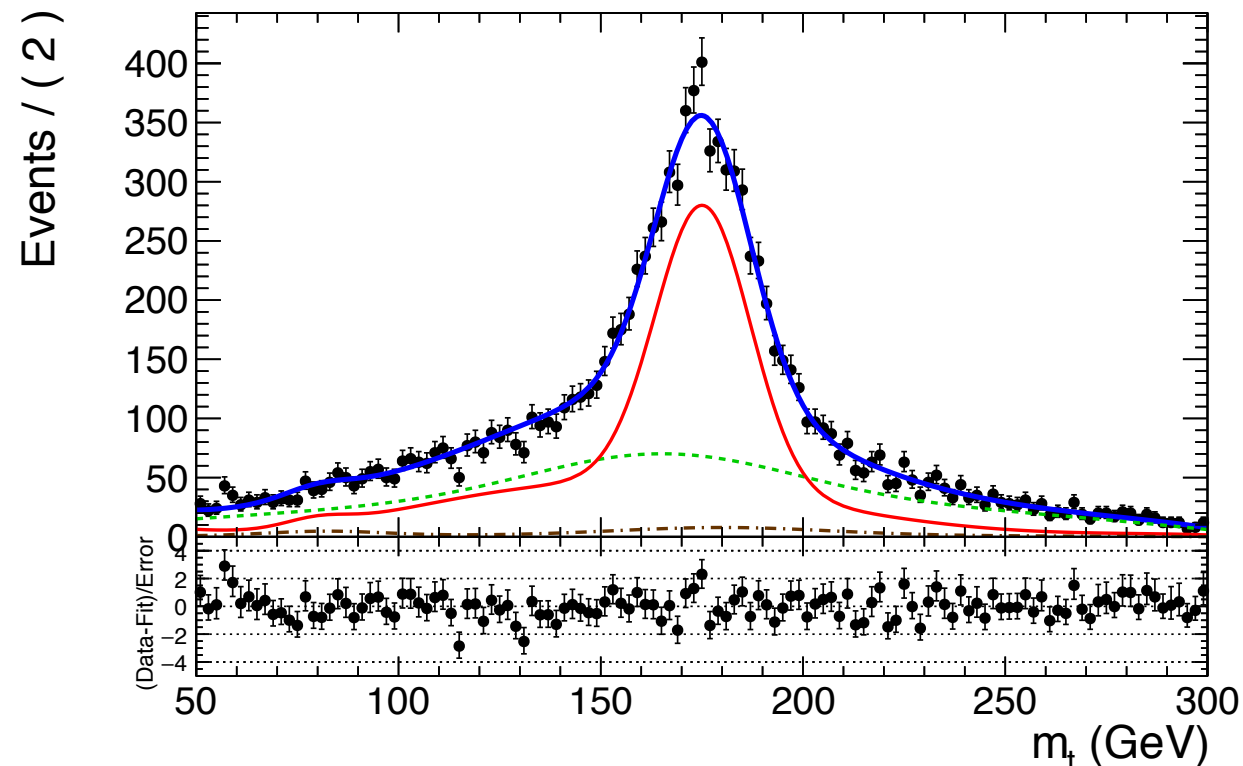
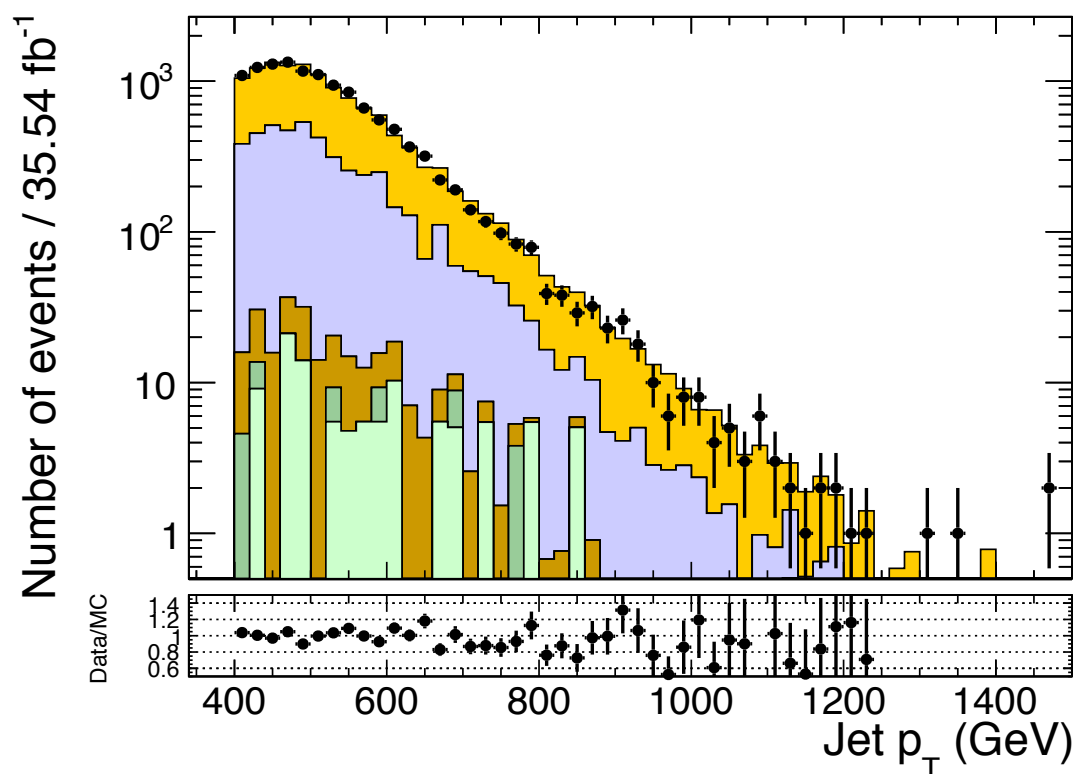
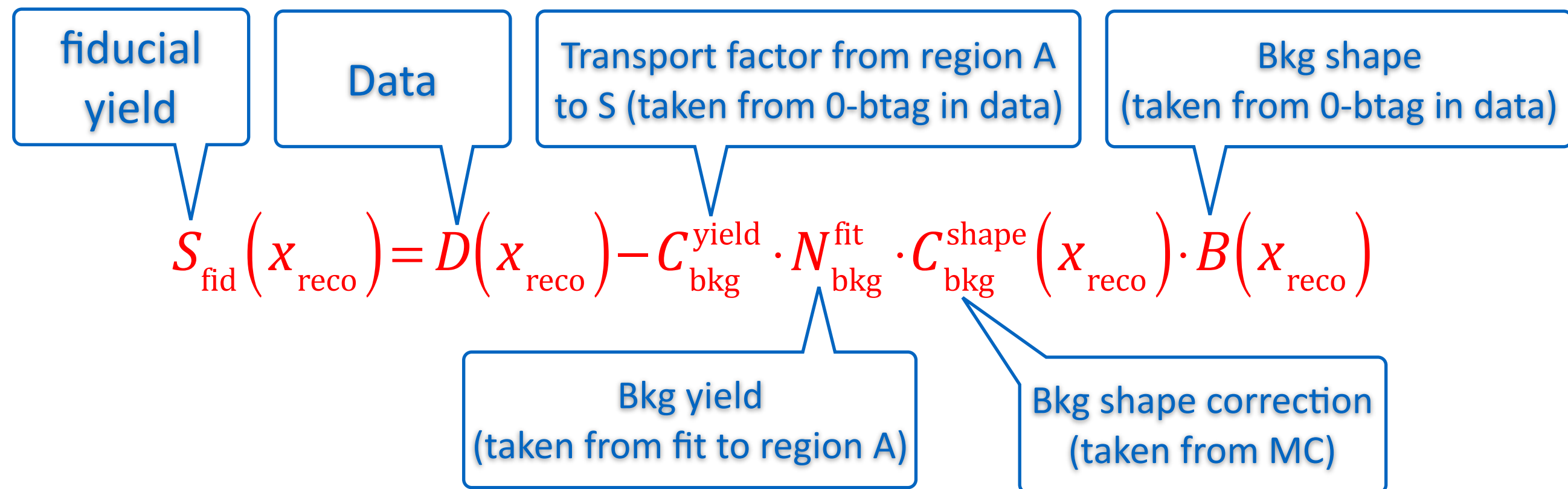


Today we present the  
unfolded results at parton  
& levels

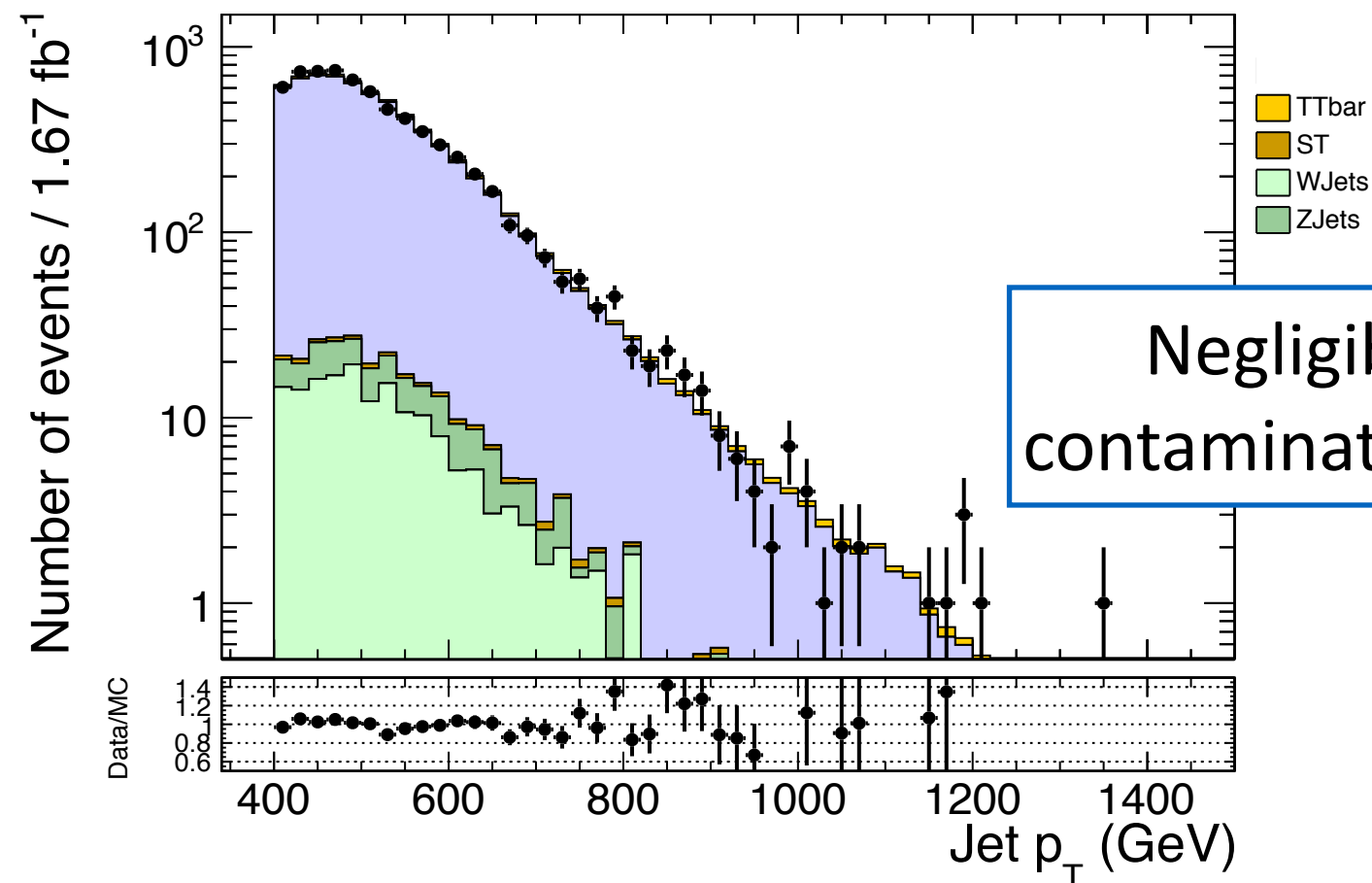
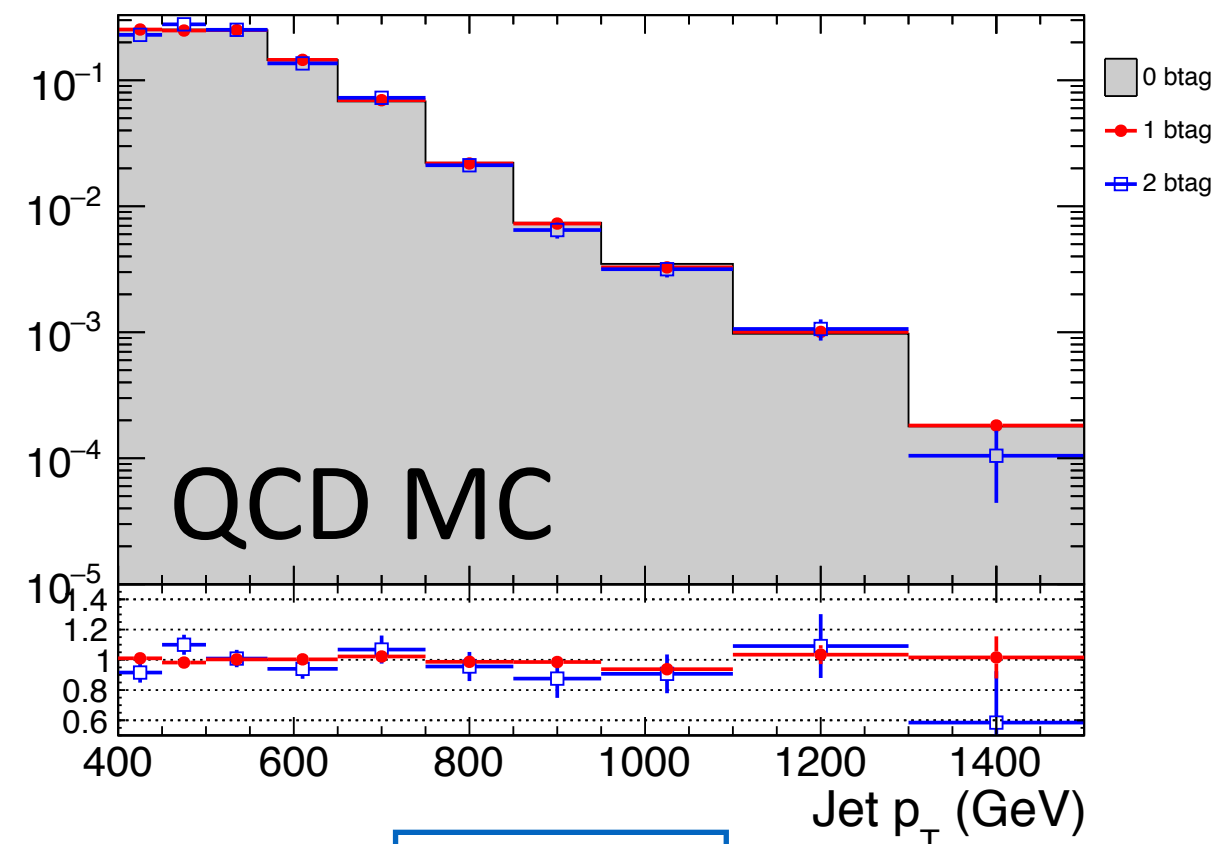
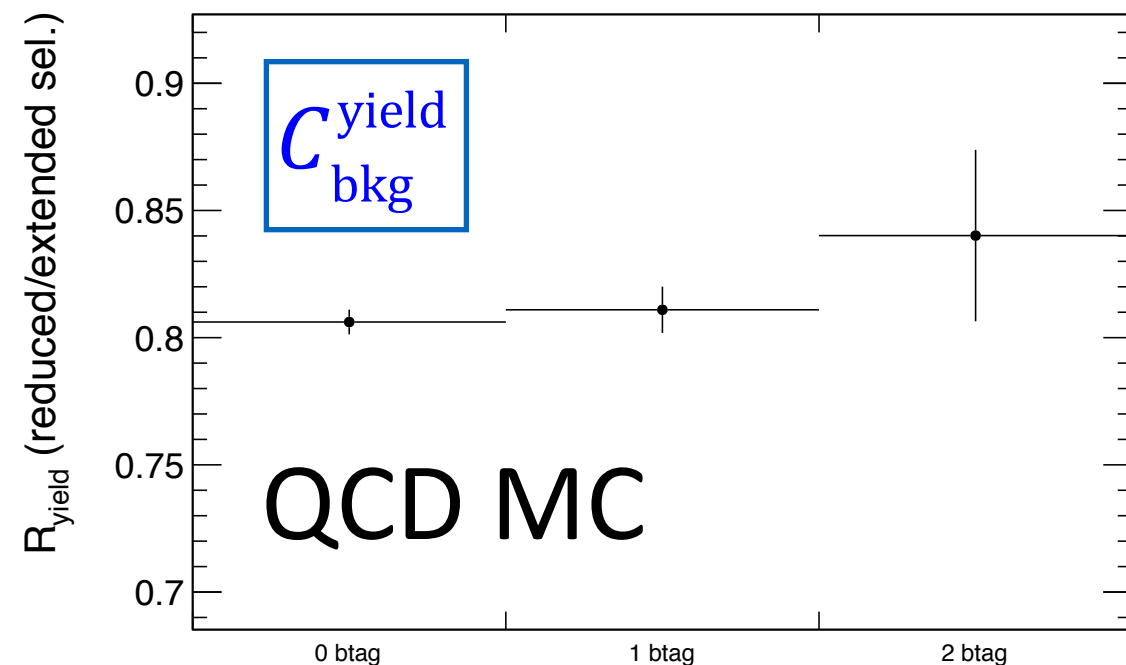
# Analysis regions



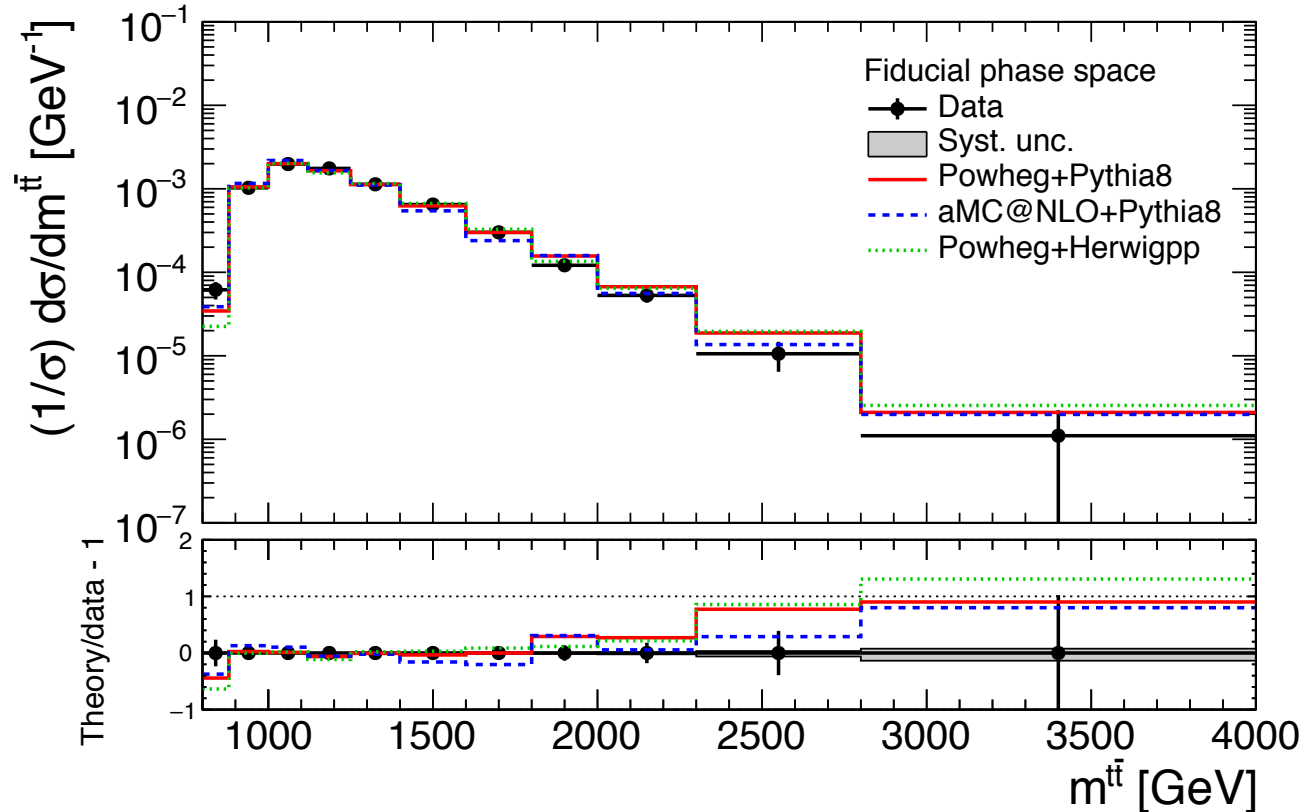
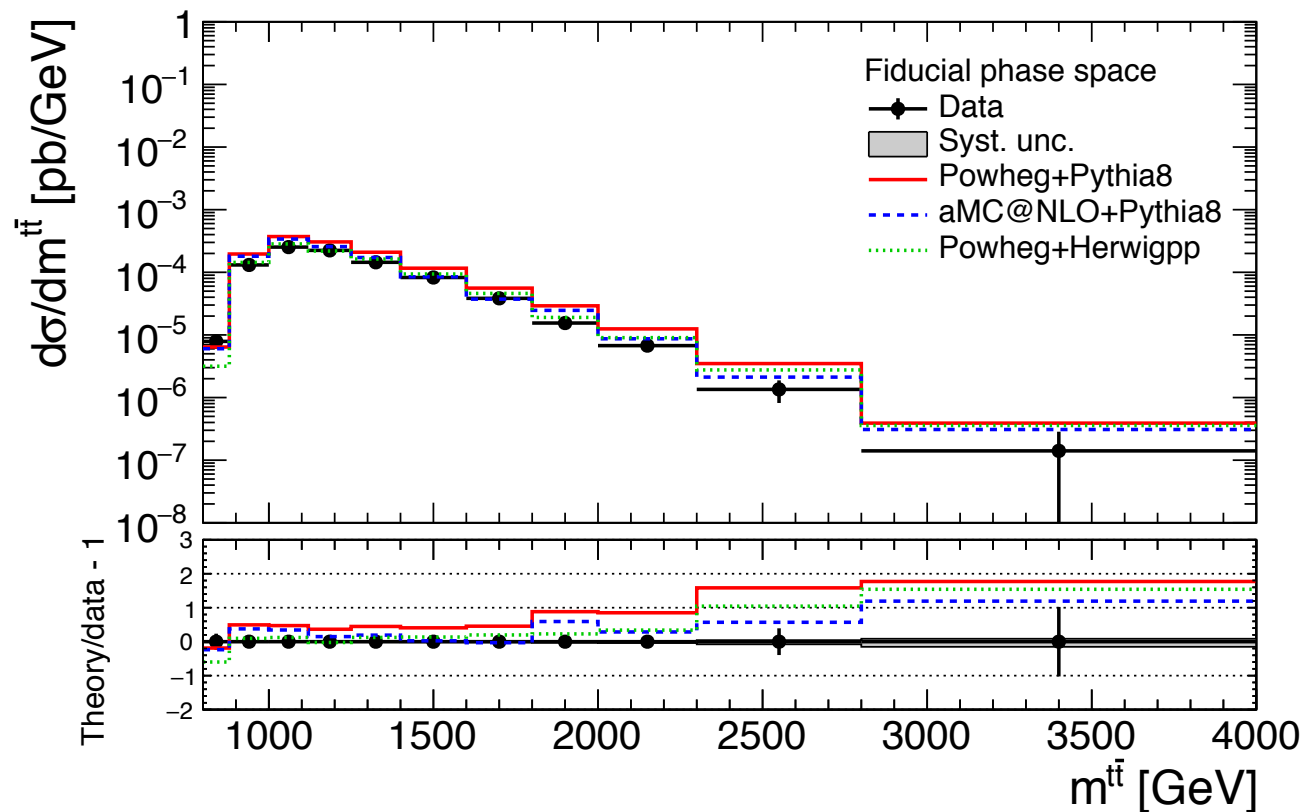
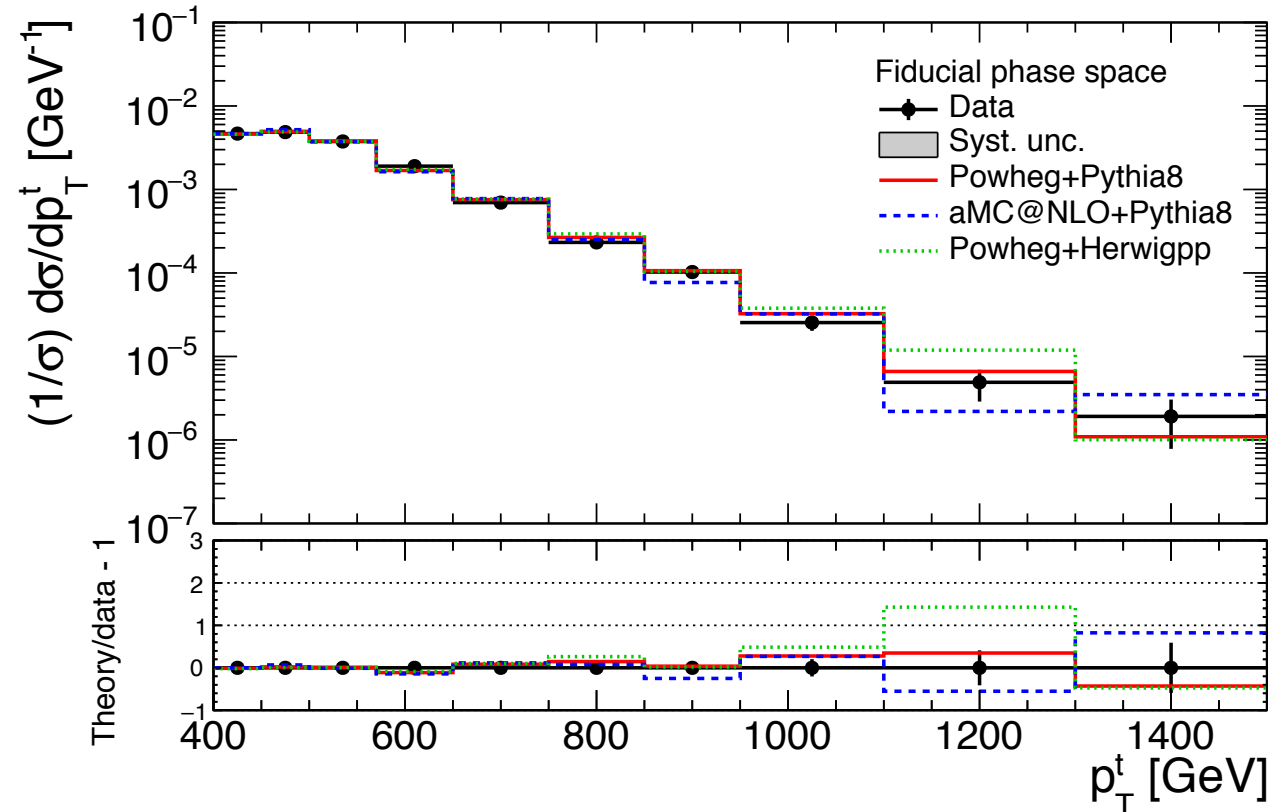
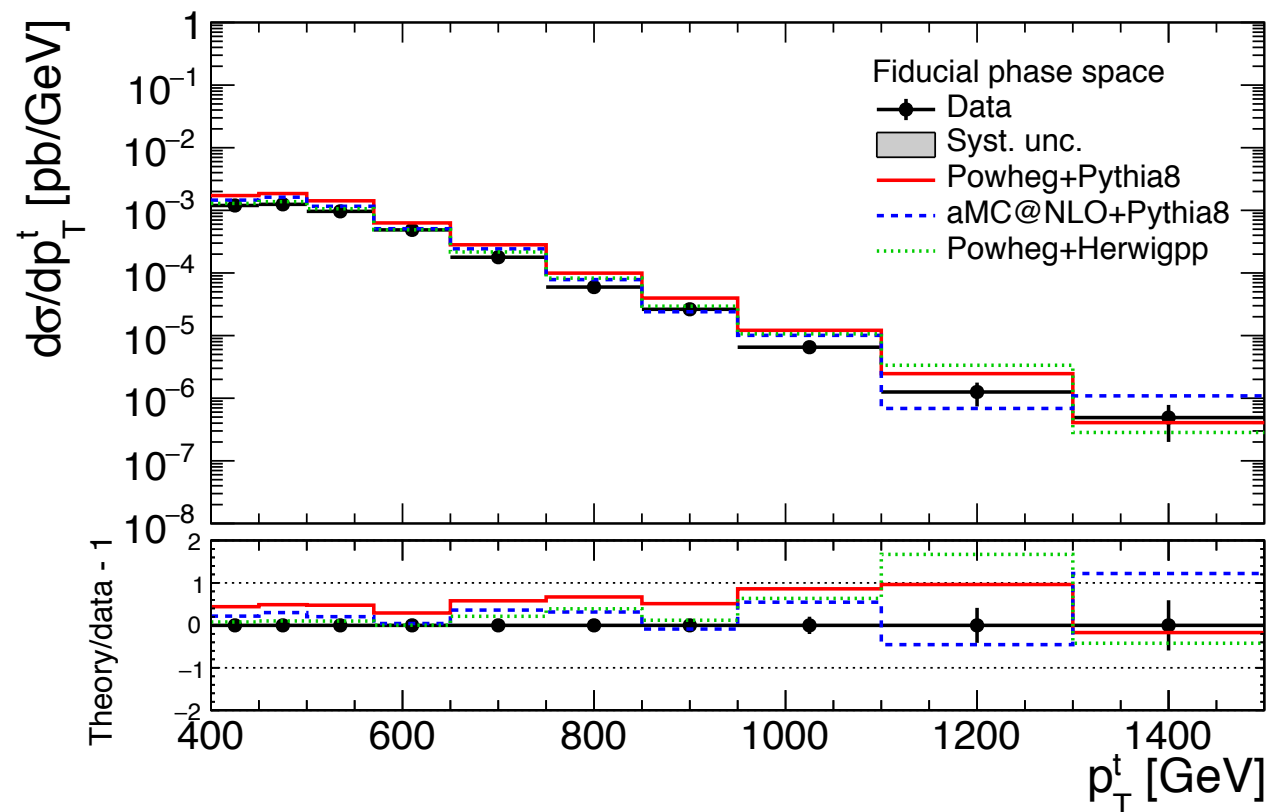
# Signal extraction



# Validation of the background method



# Results (fiducial, top $p_T$ , $m_{t\bar{t}}$ )



# Definition of various levels

## - Parton

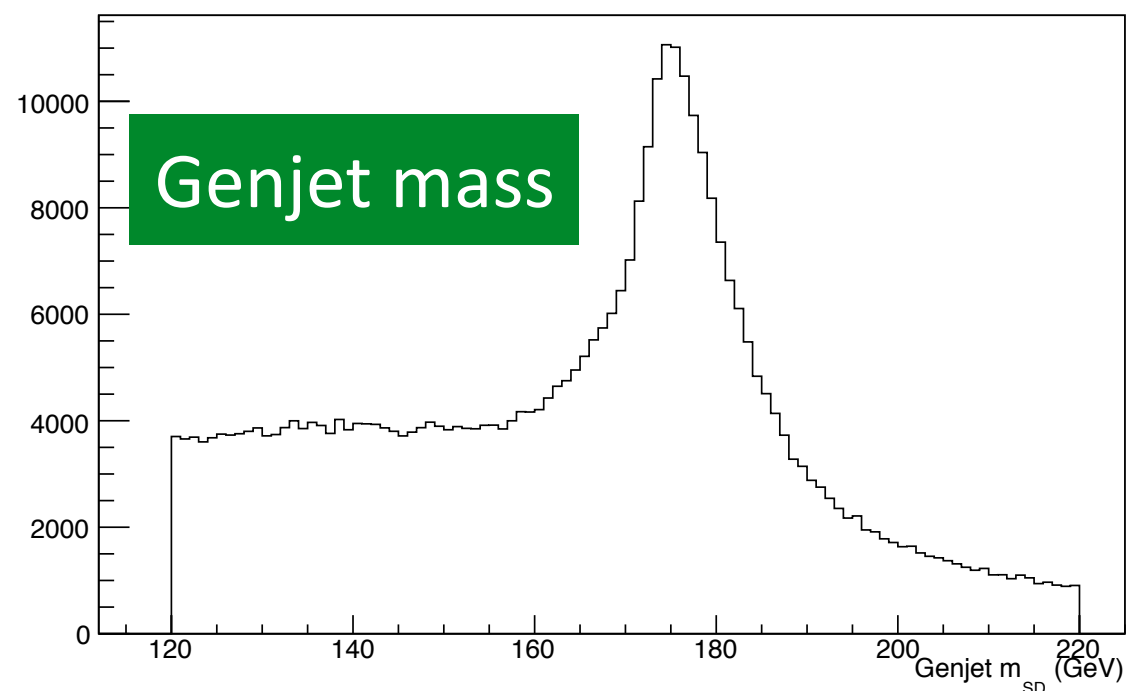
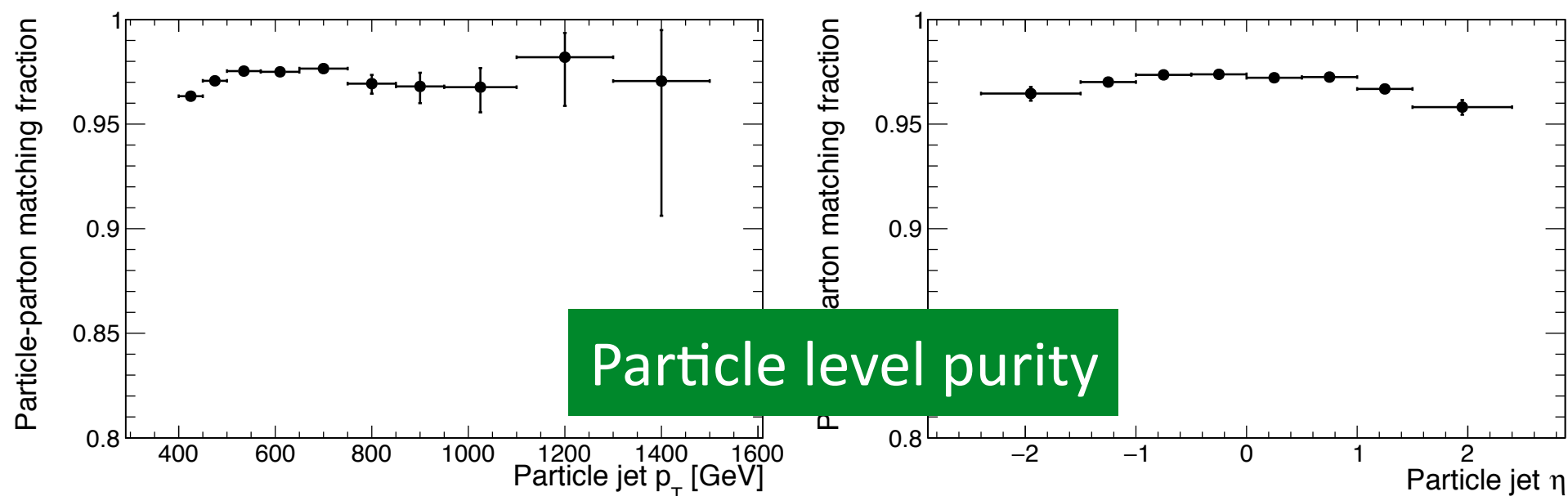
- $p_T > 400$  GeV (both tops)
- $|\eta| < 2.4$  (both tops)
- $m_{tt} > 800$  GeV

## - Particle

- cluster genjets with AK8
- top candidates: two leading genjets
- $p_T > 400$  GeV (two leading genjets)
- $|\eta| < 2.4$  (both leading genjets)
- genjets' softdrop mass in  $[120, 220]$  GeV
- $m_{jj} > 800$  GeV

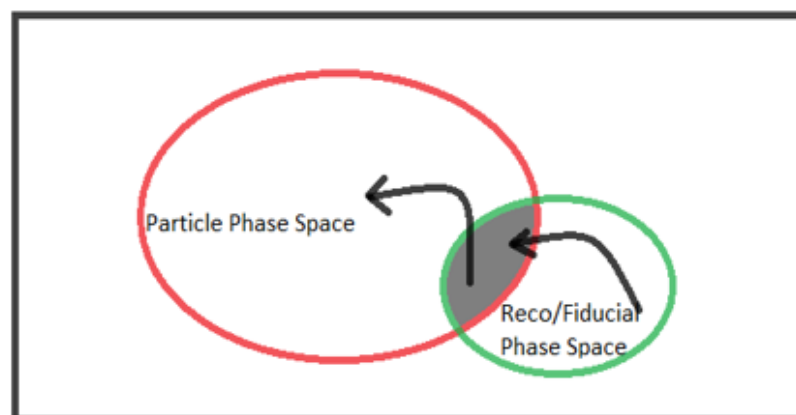
## - Reco

- cluster PF+CHS jets with AK8
- trigger
- top candidates: two leading reco jets
- $p_T > 400$  GeV (both leading jets)
- $|\eta| < 2.4$  (both leading jets)
- subjet btagging (both jets leading jets)
- $mva > 0.8$
- jets' softdrop mass in  $[120, 220]$  GeV
- $m_{jj} > 800$  GeV





# Parton & Particle levels



$$S_{unf}(x_{\text{true}}) = \frac{1}{\mathcal{E}(x_{\text{true}})} \cdot \left\{ R^{-1}(x_{\text{true}}, x_{\text{reco}}) \odot \left[ \frac{1}{\mathcal{E}'(x_{\text{reco}})} \cdot S_{\text{fid}}(x_{\text{reco}}) \right] \right\}$$

efficiency of the reco  
+particle selection

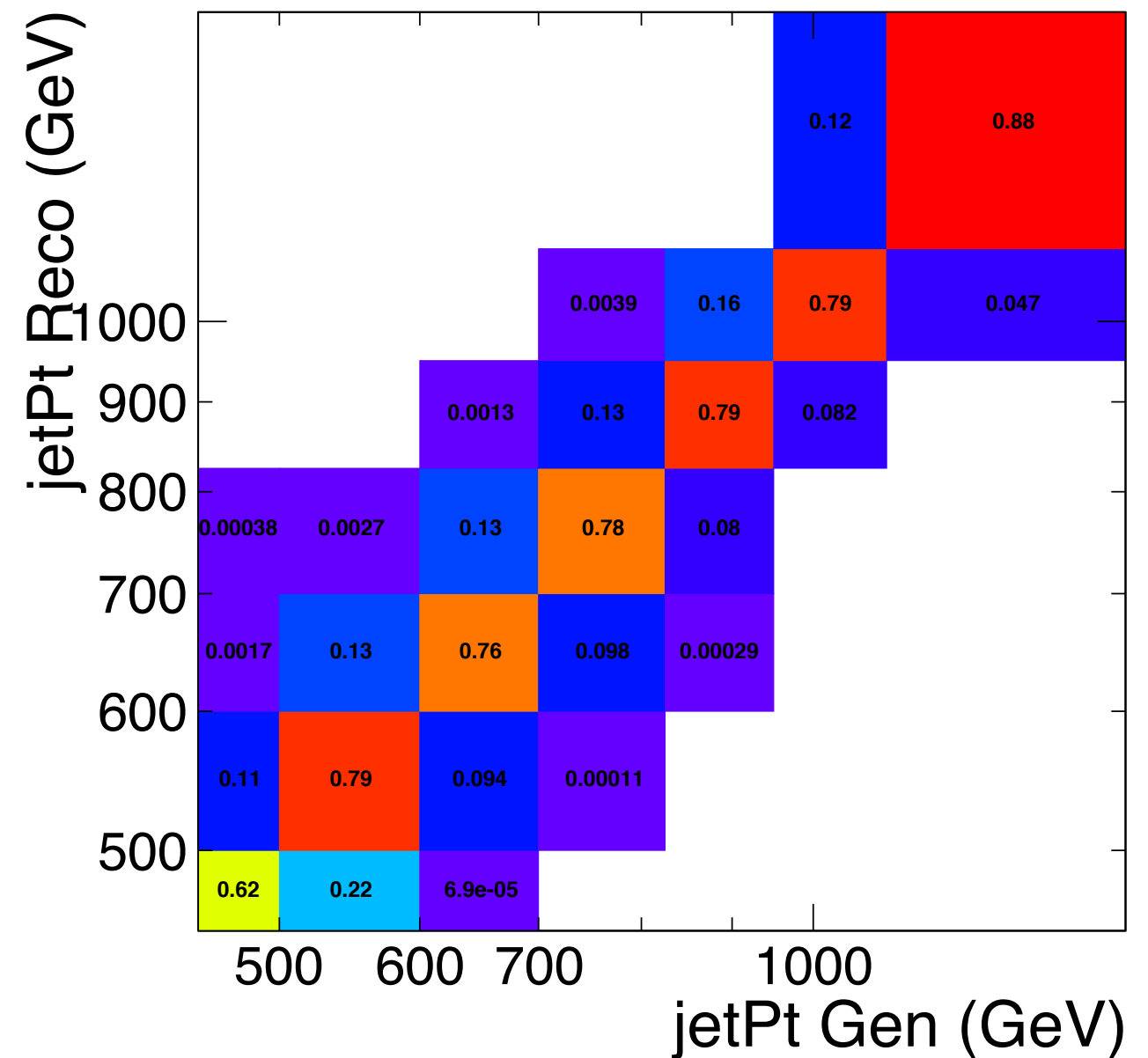
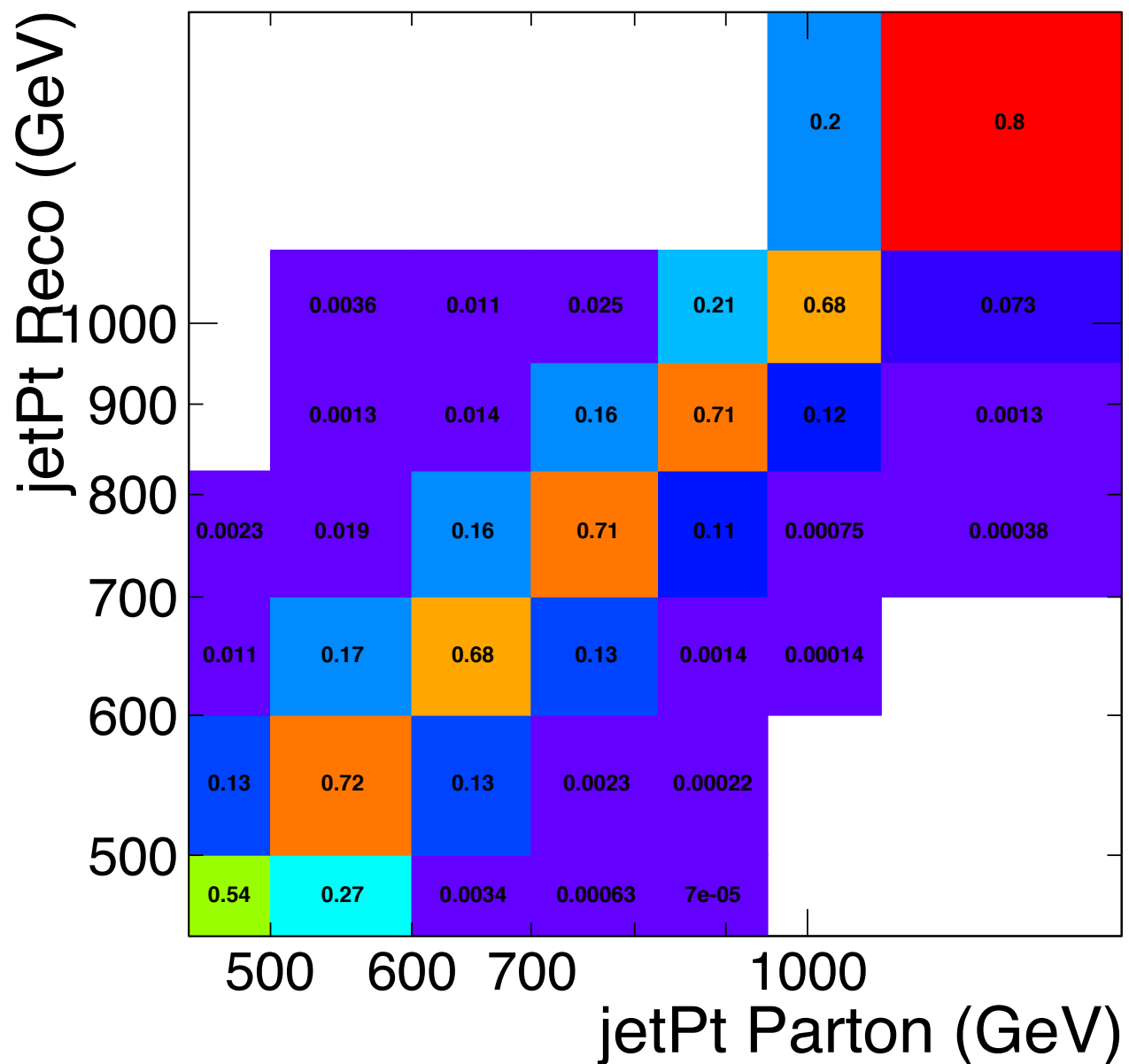
response matrix

reco efficiency of the  
reco+true selection

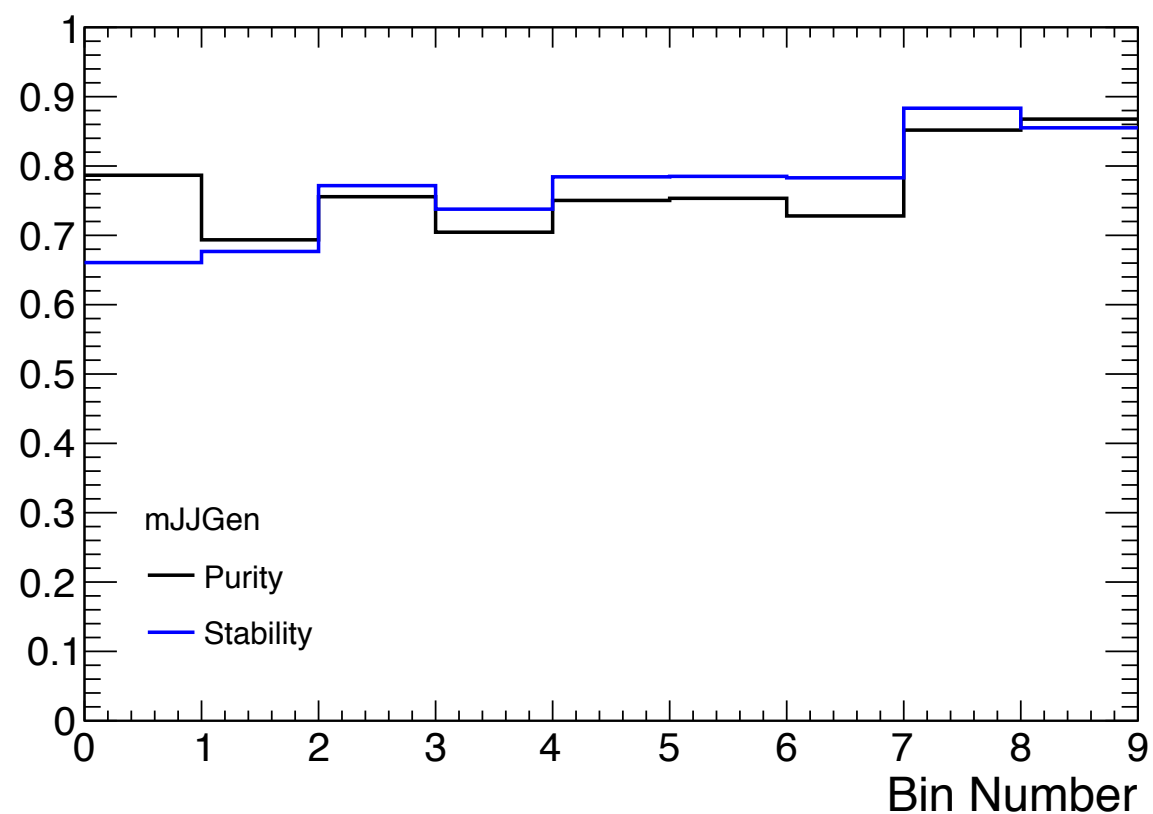
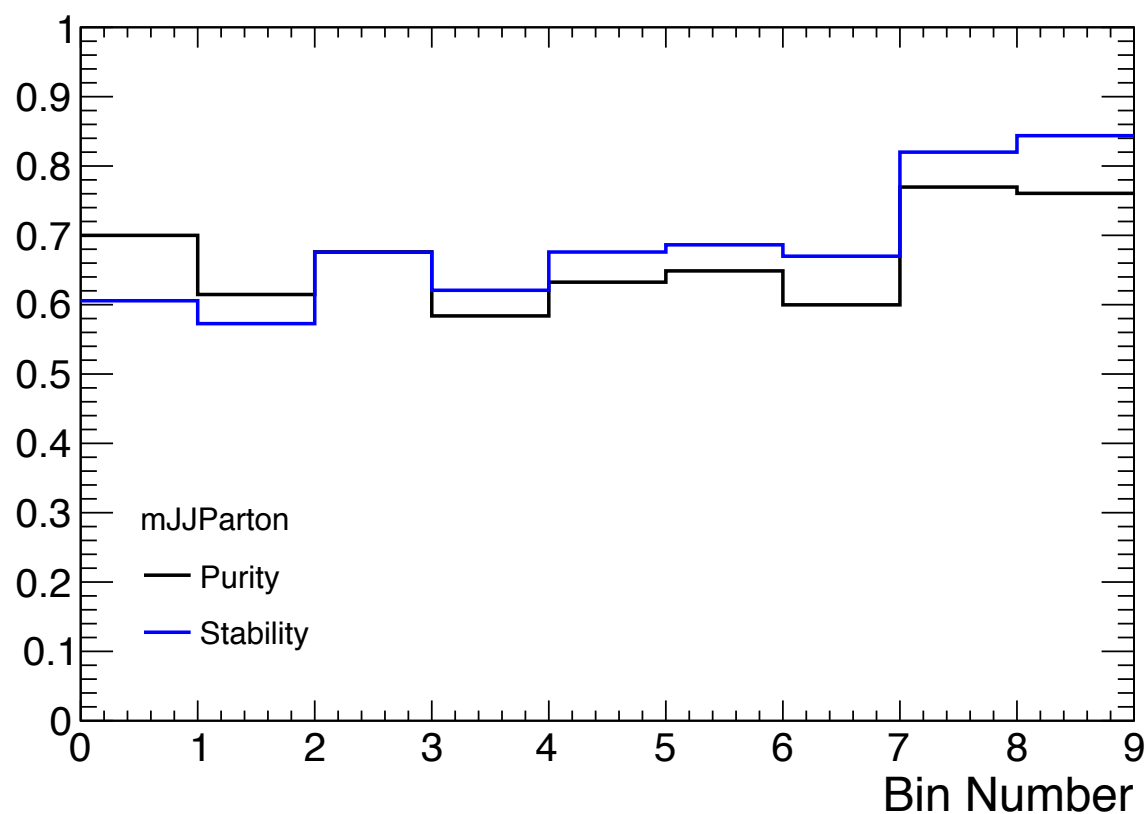
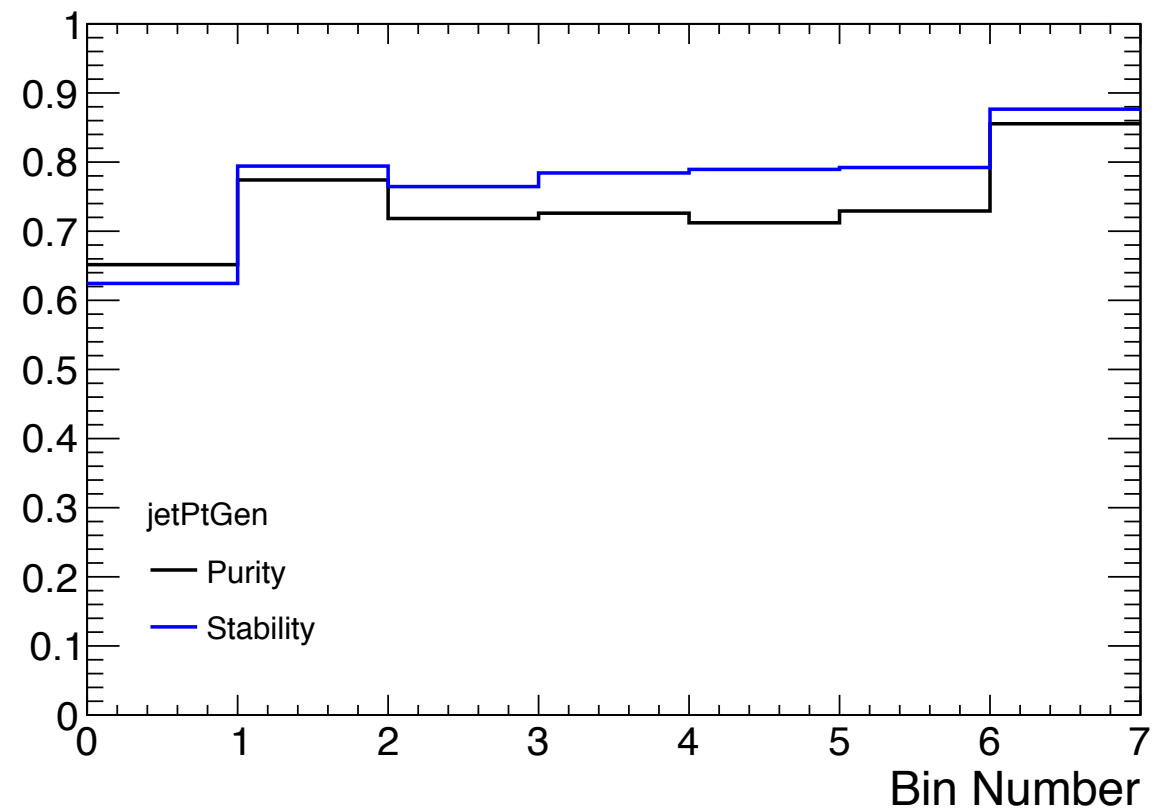
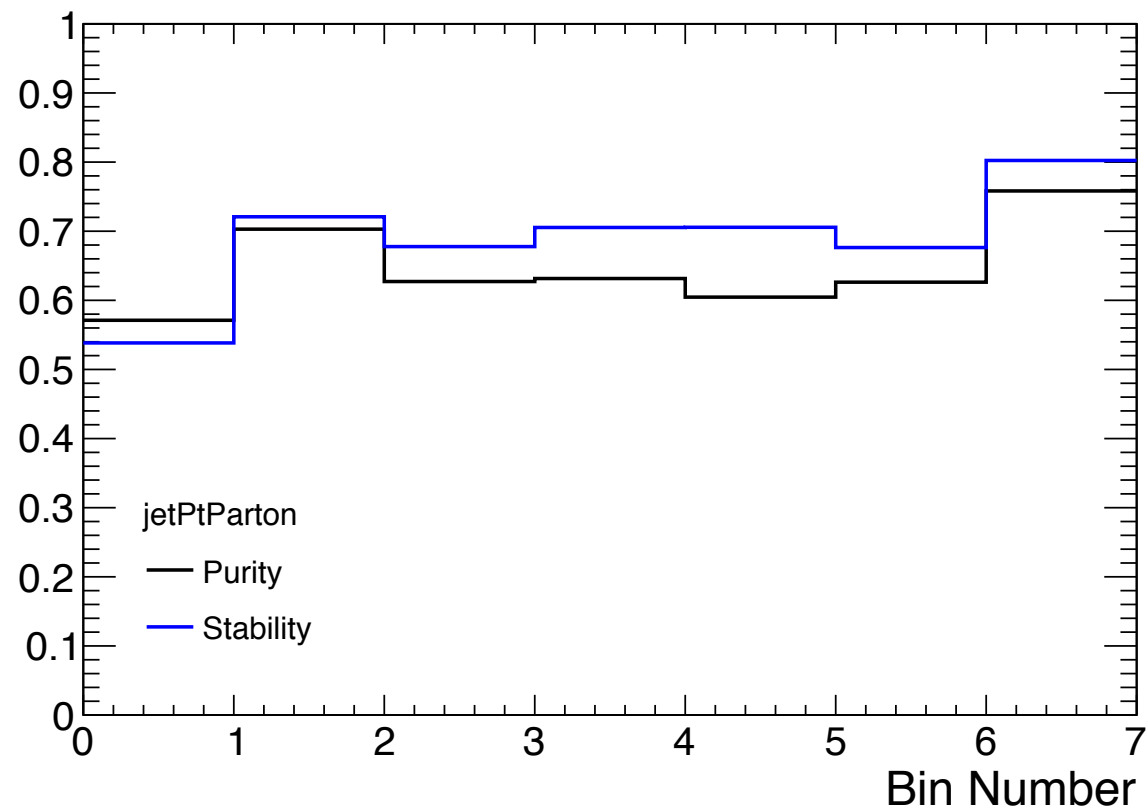
Unfolding: simple response matrix inversion w/o regularisation



# Response matrices (top $p_T$ )

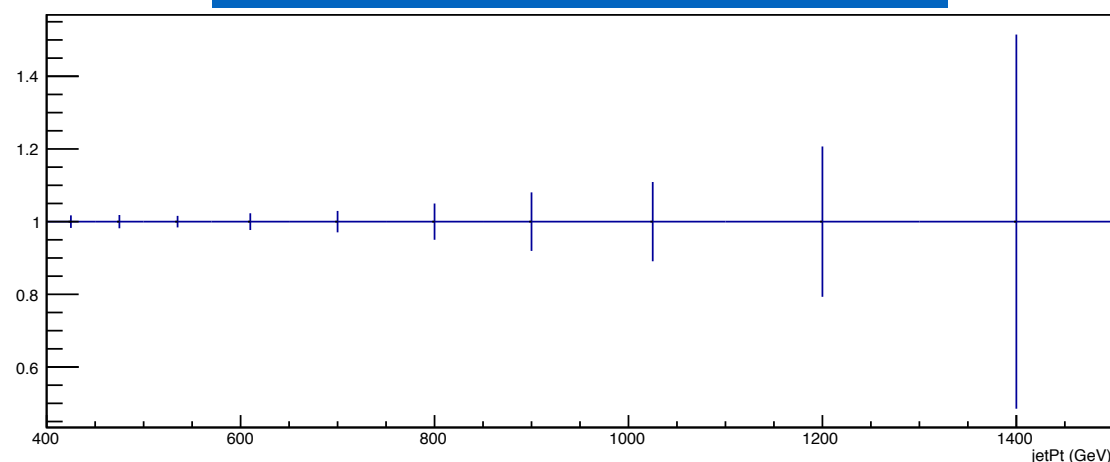


# Stability & purity (top $p_T$ , $m_{t\bar{t}}$ )

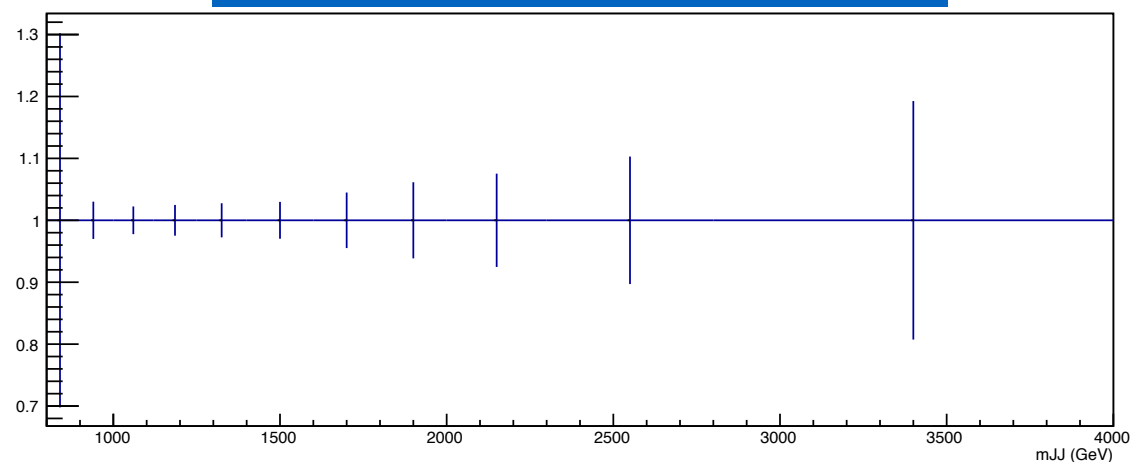


# Unfolding tests (top $p_T$ , $m_{tt}$ )

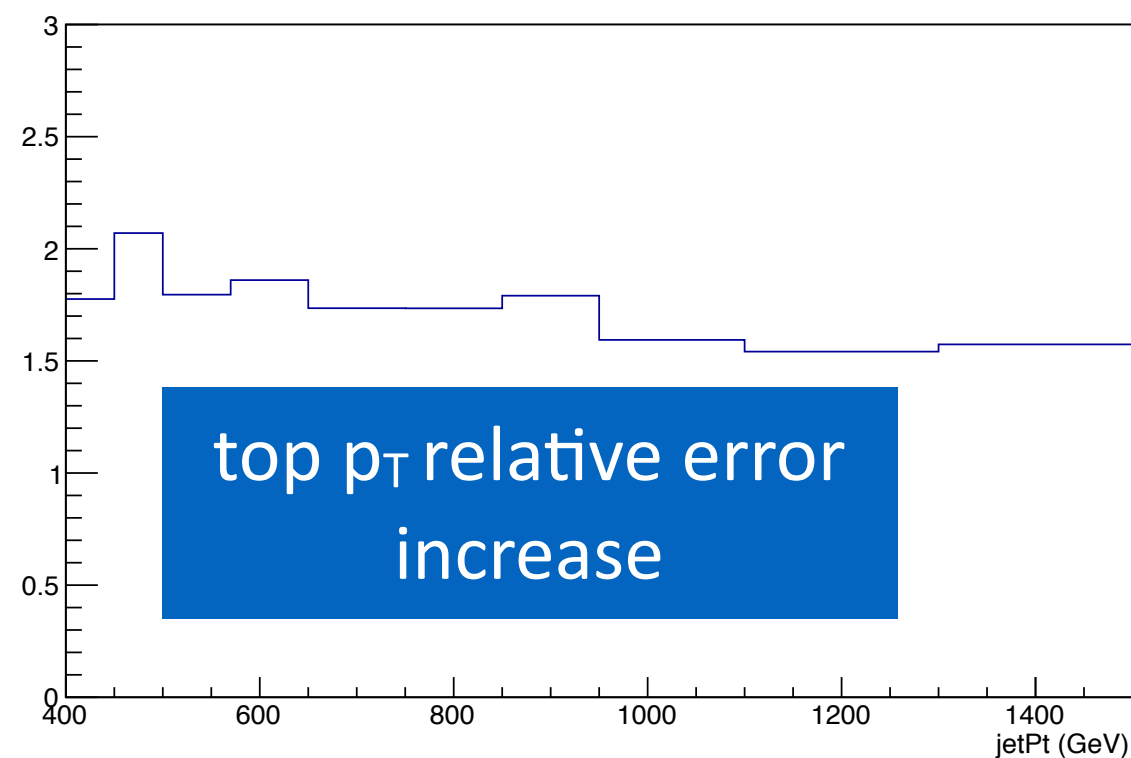
top  $p_T$  MC closure test  
(unfolded/true)



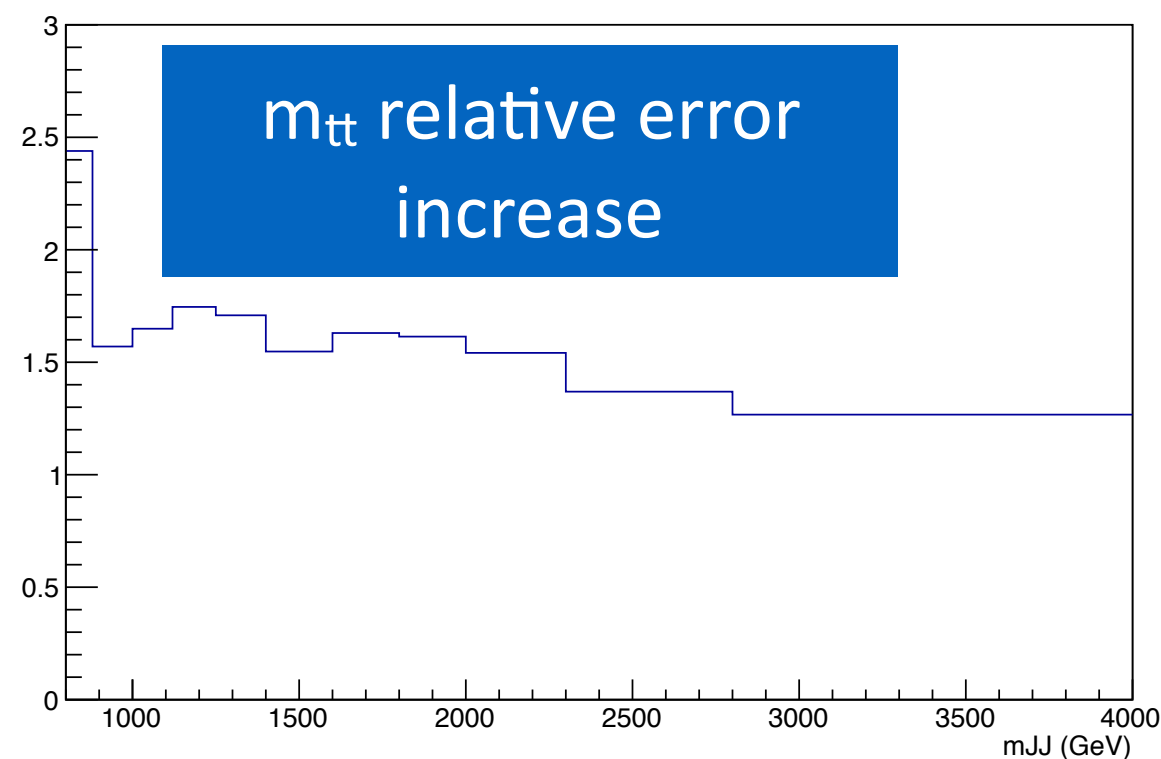
$m_{tt}$  MC closure test  
(unfolded/true)



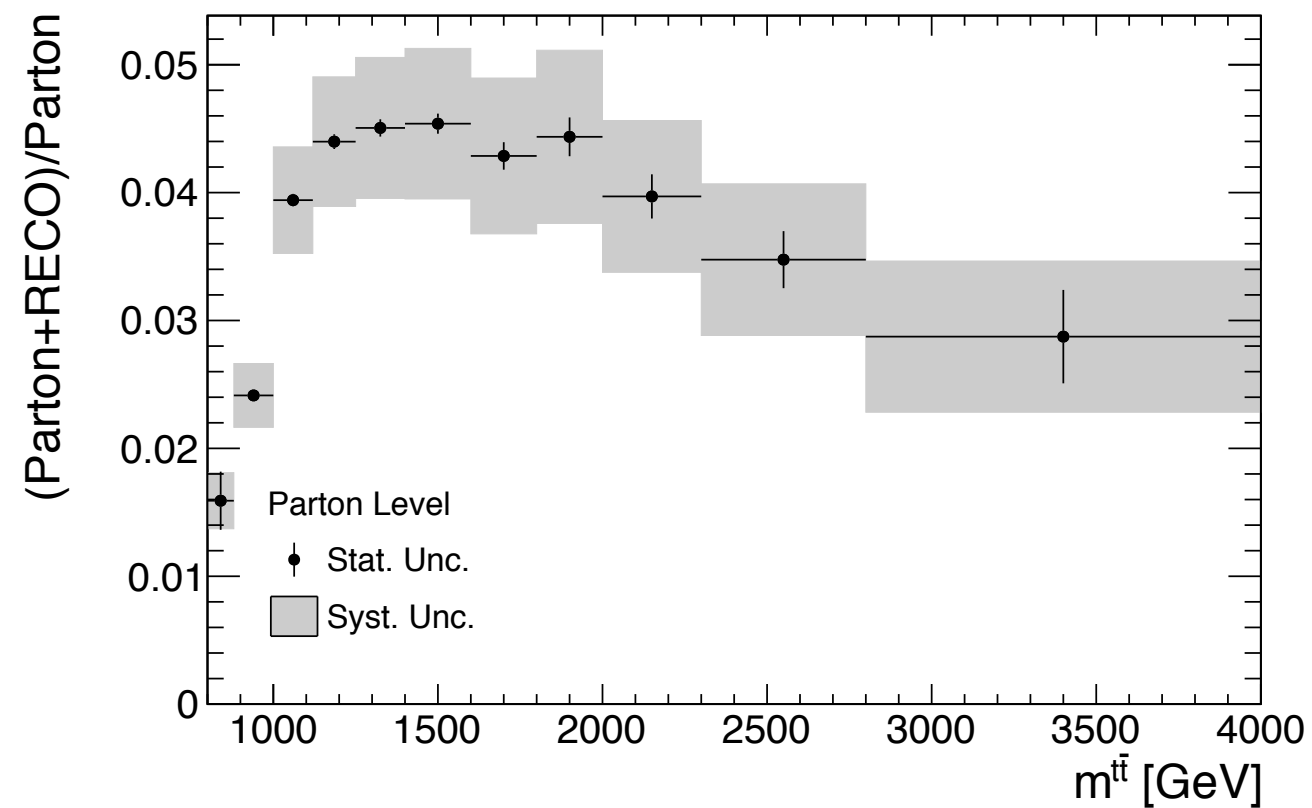
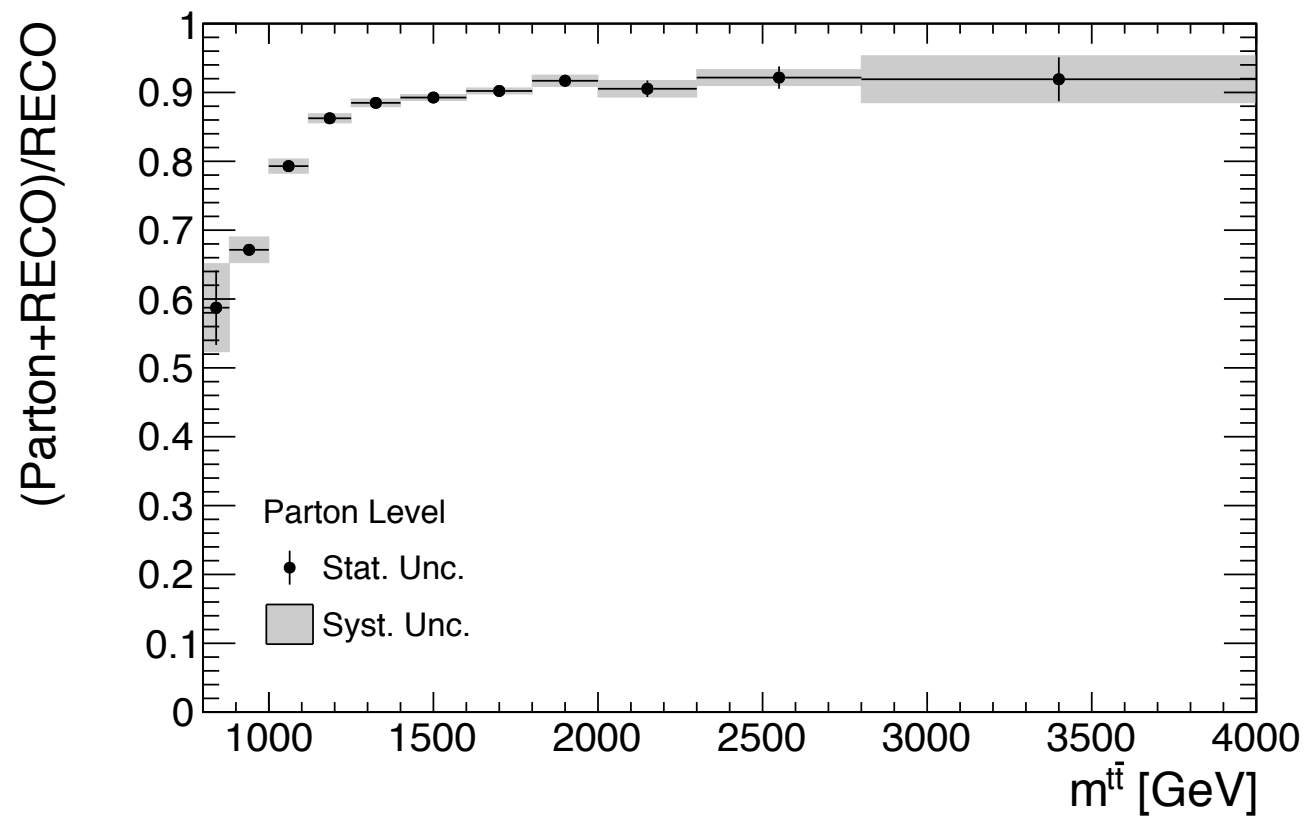
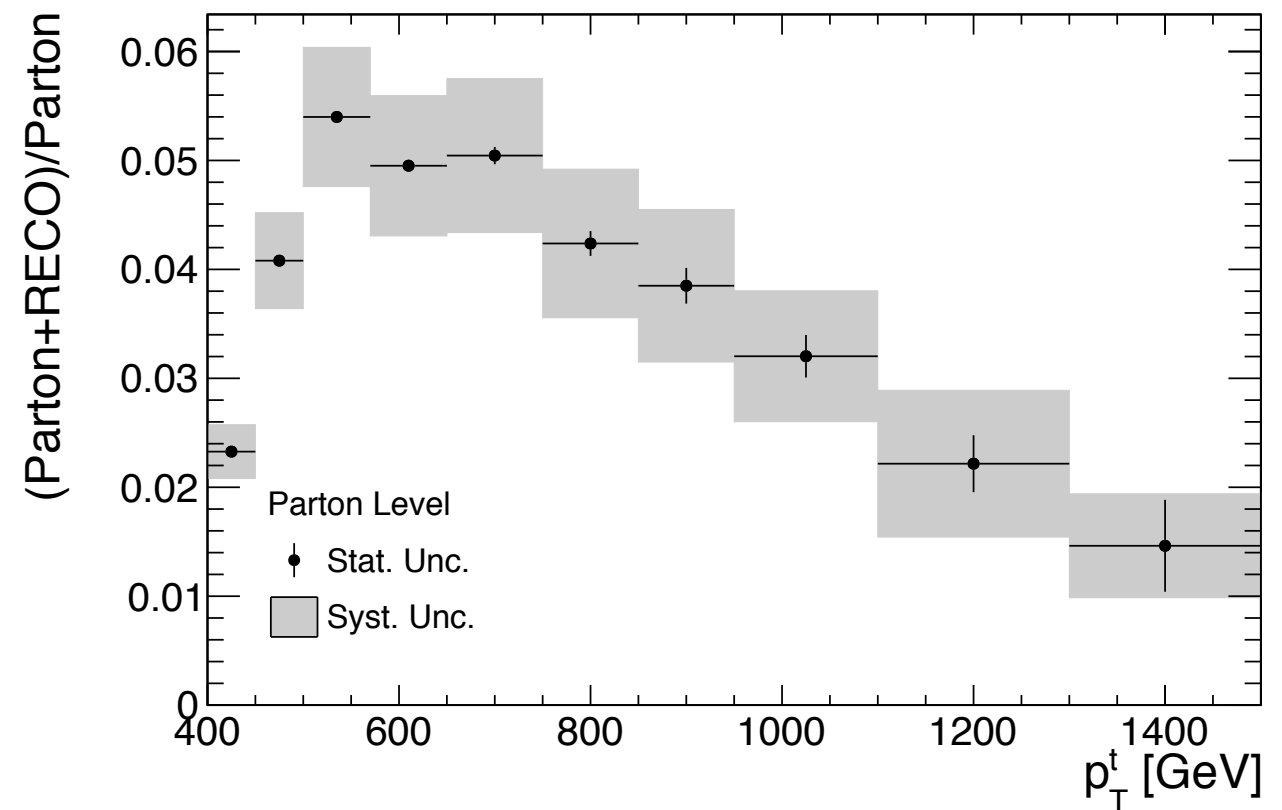
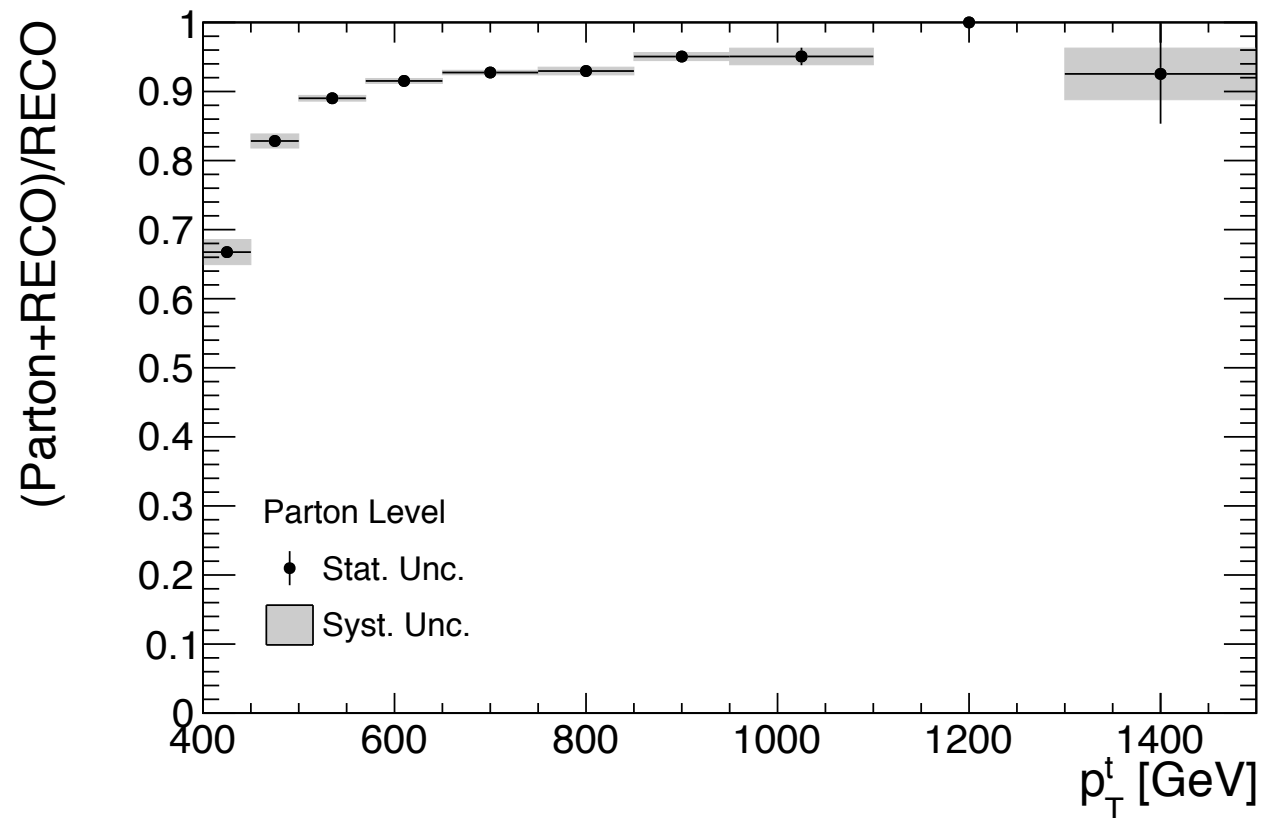
Ratio of relative errors  $h_{\text{Unfolded}}/h_{\text{Reco}}$  for jetPt



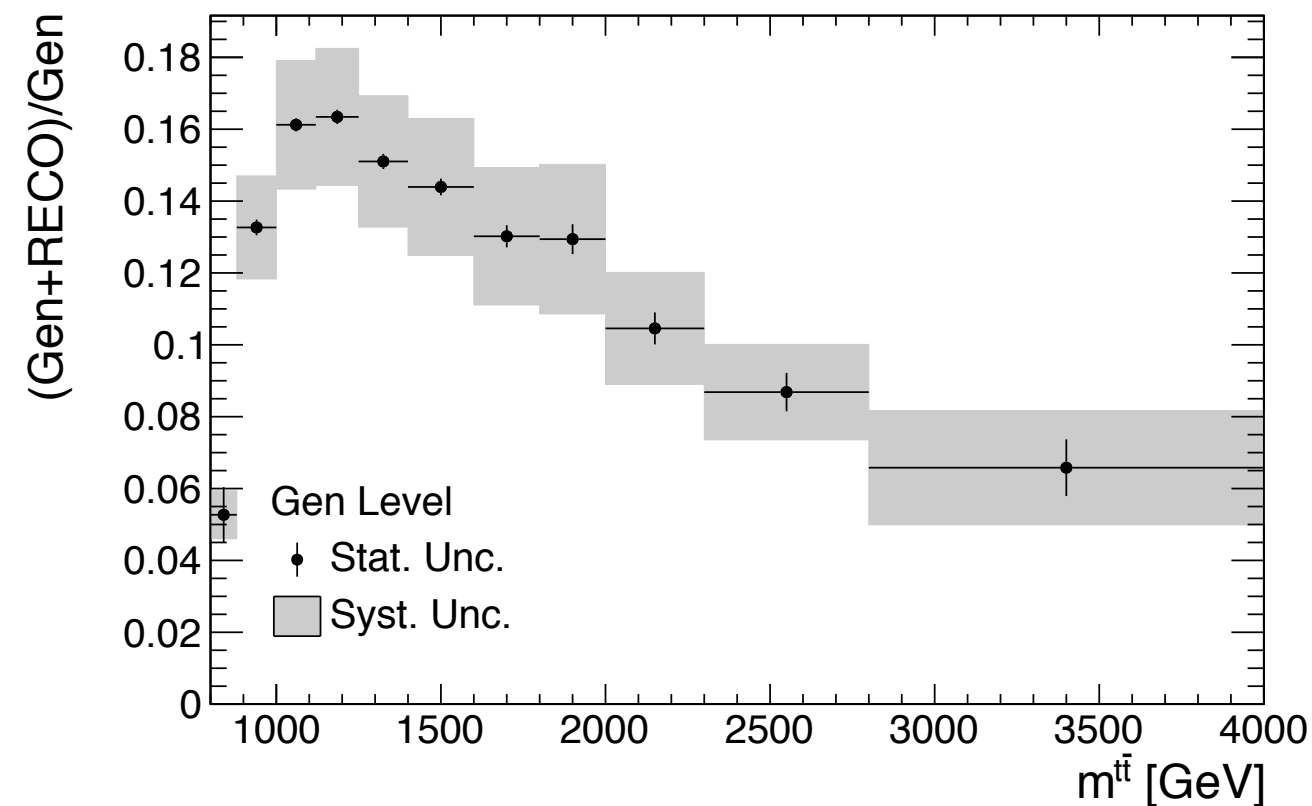
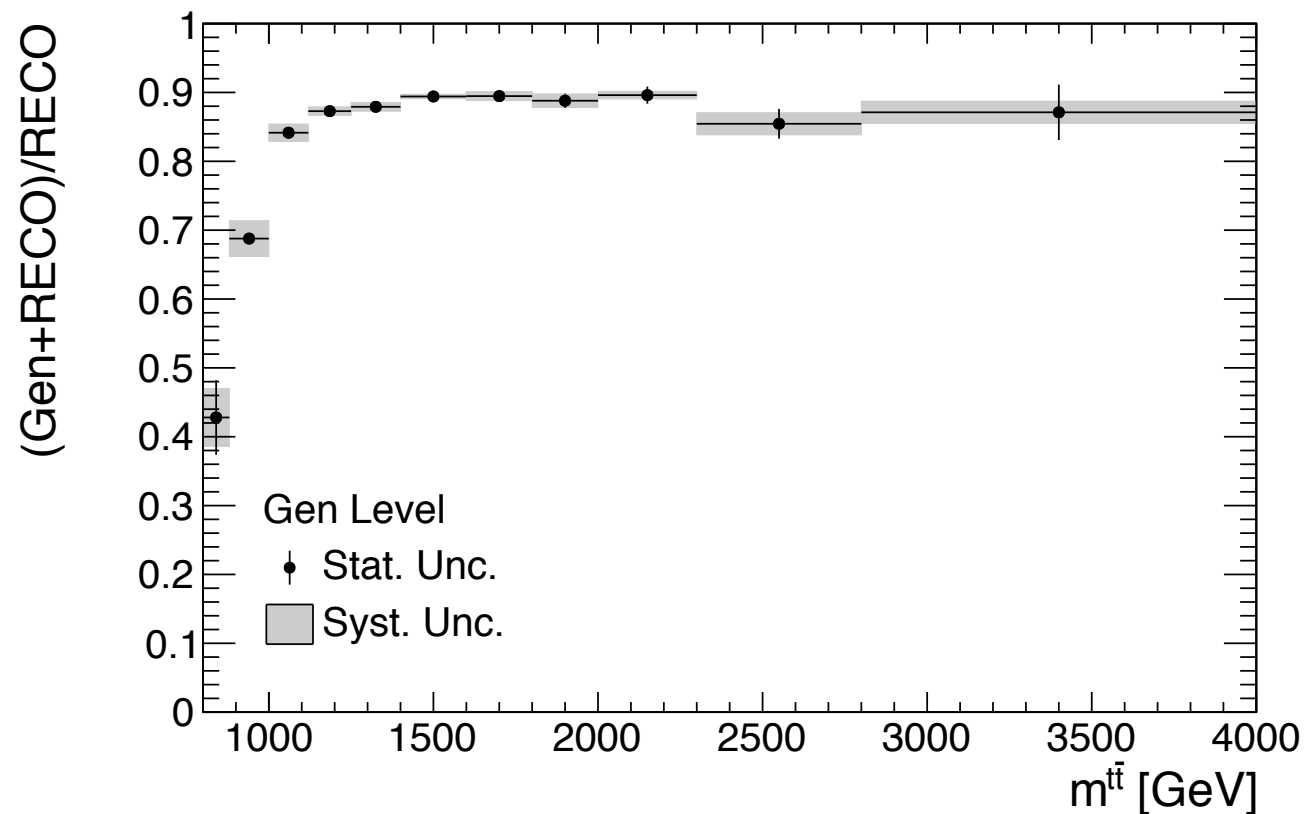
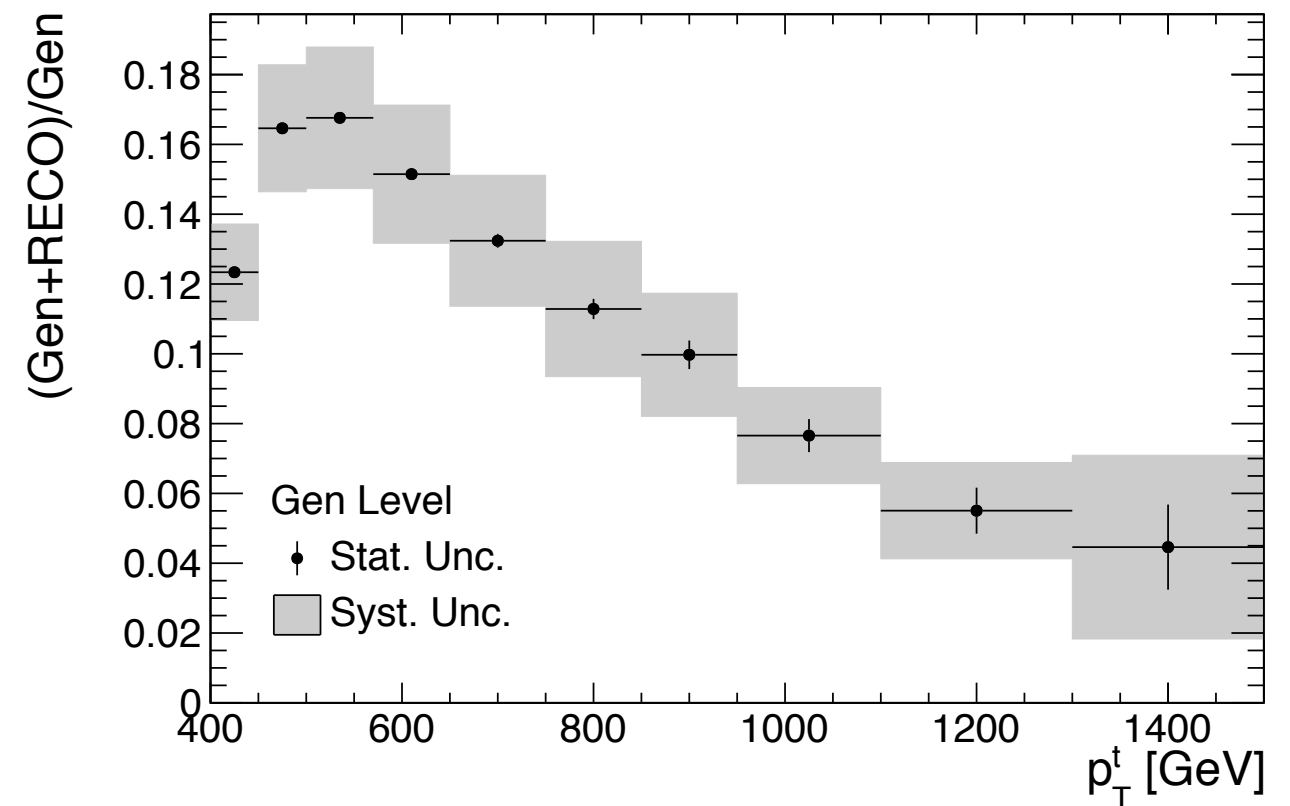
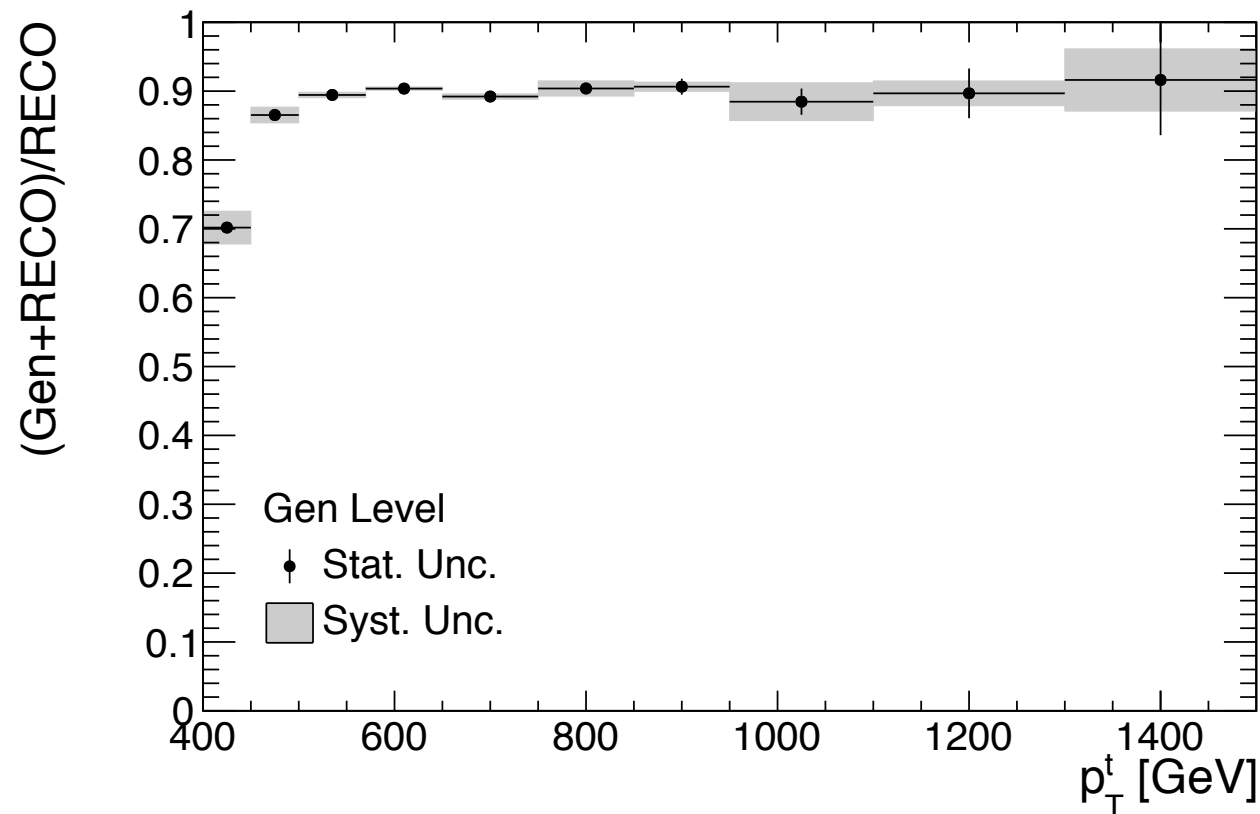
Ratio of relative errors  $h_{\text{Unfolded}}/h_{\text{Reco}}$  for  $m_{JJ}$



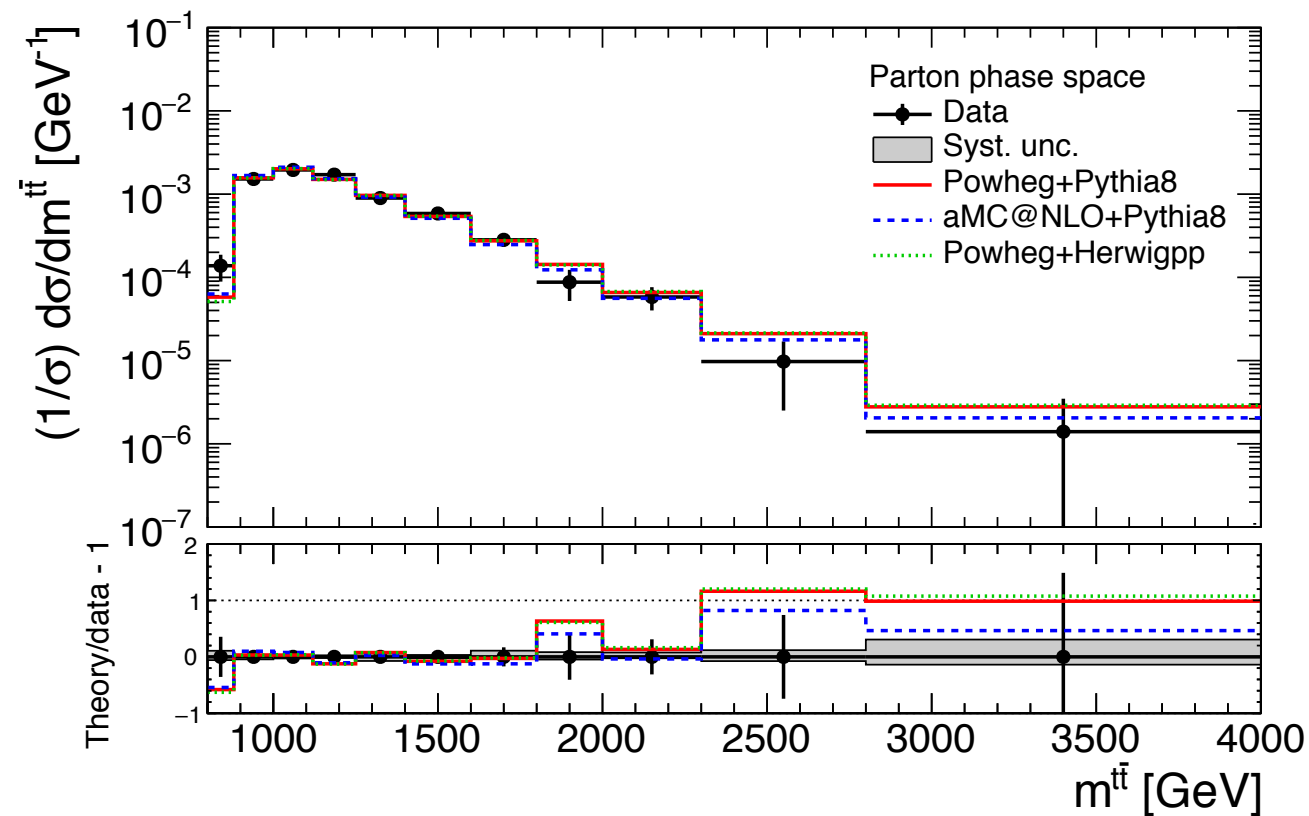
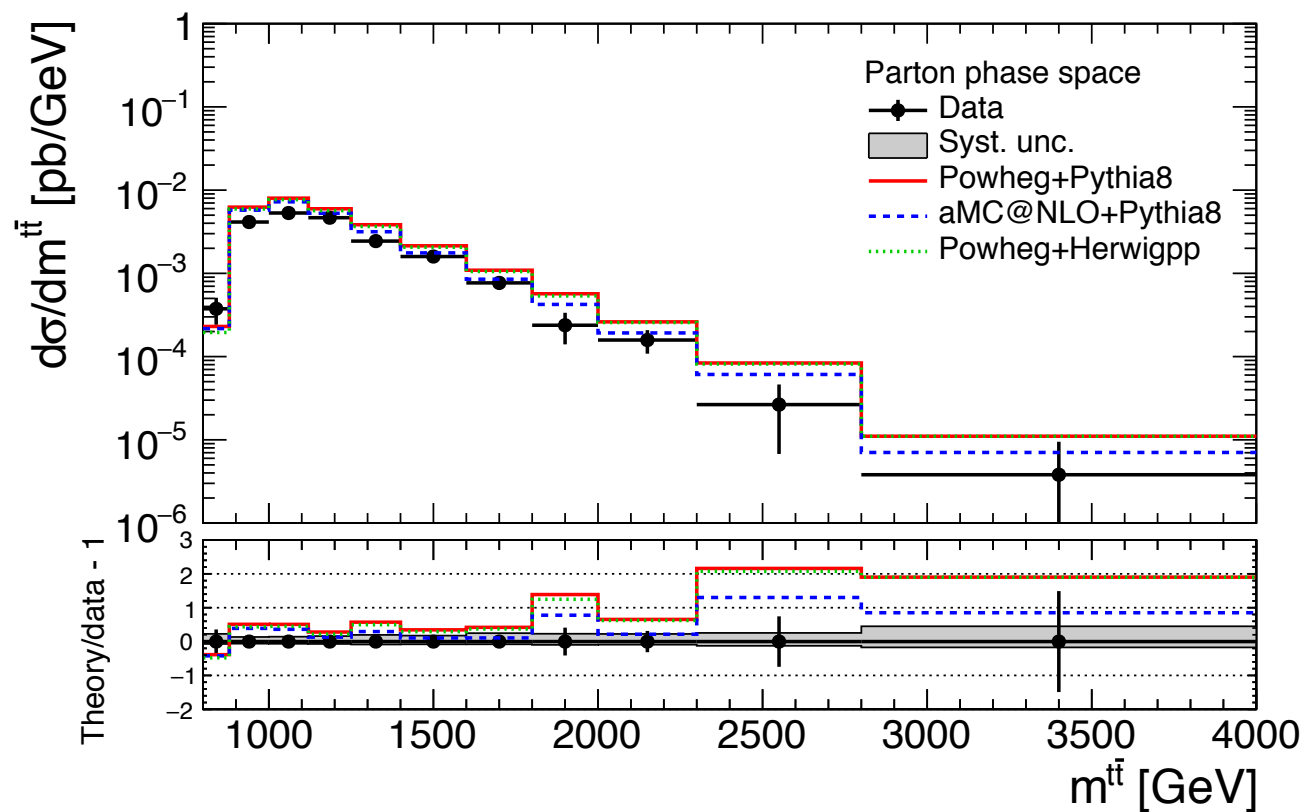
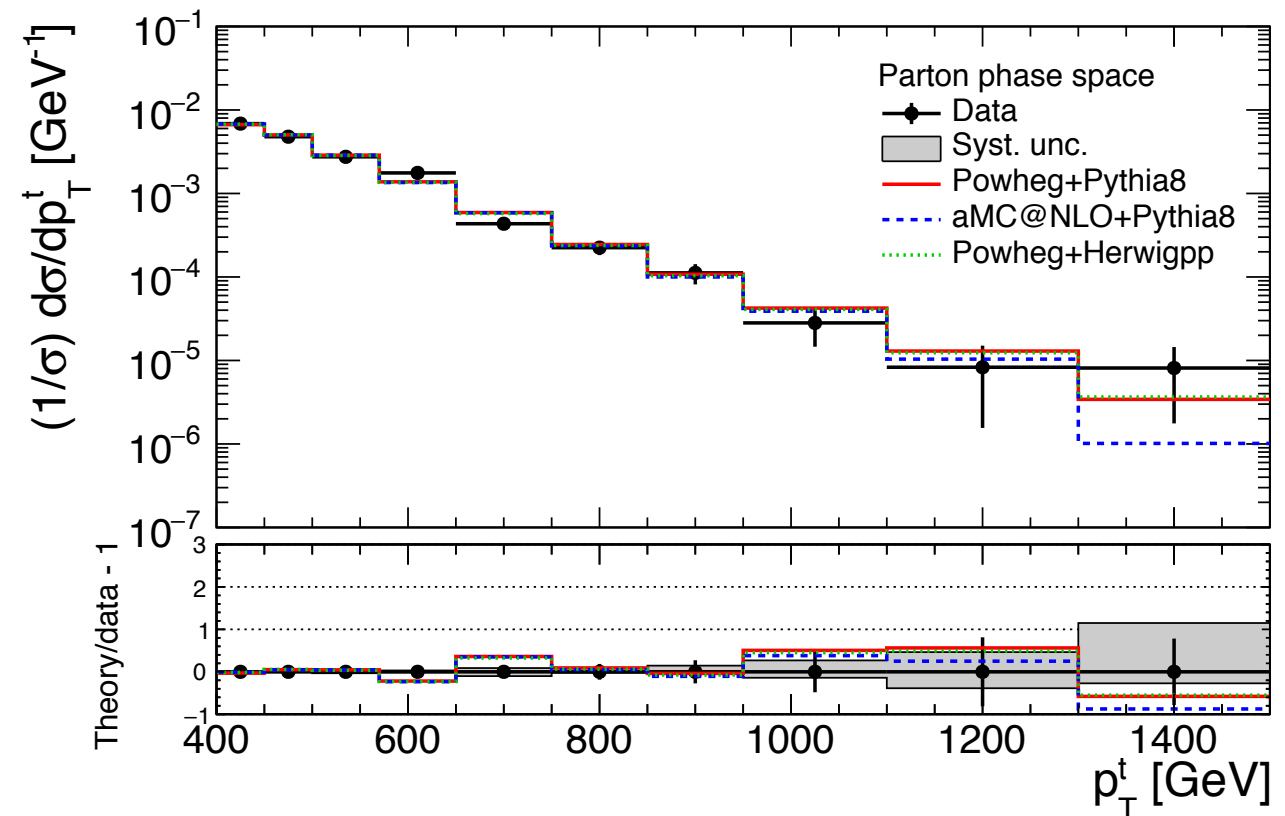
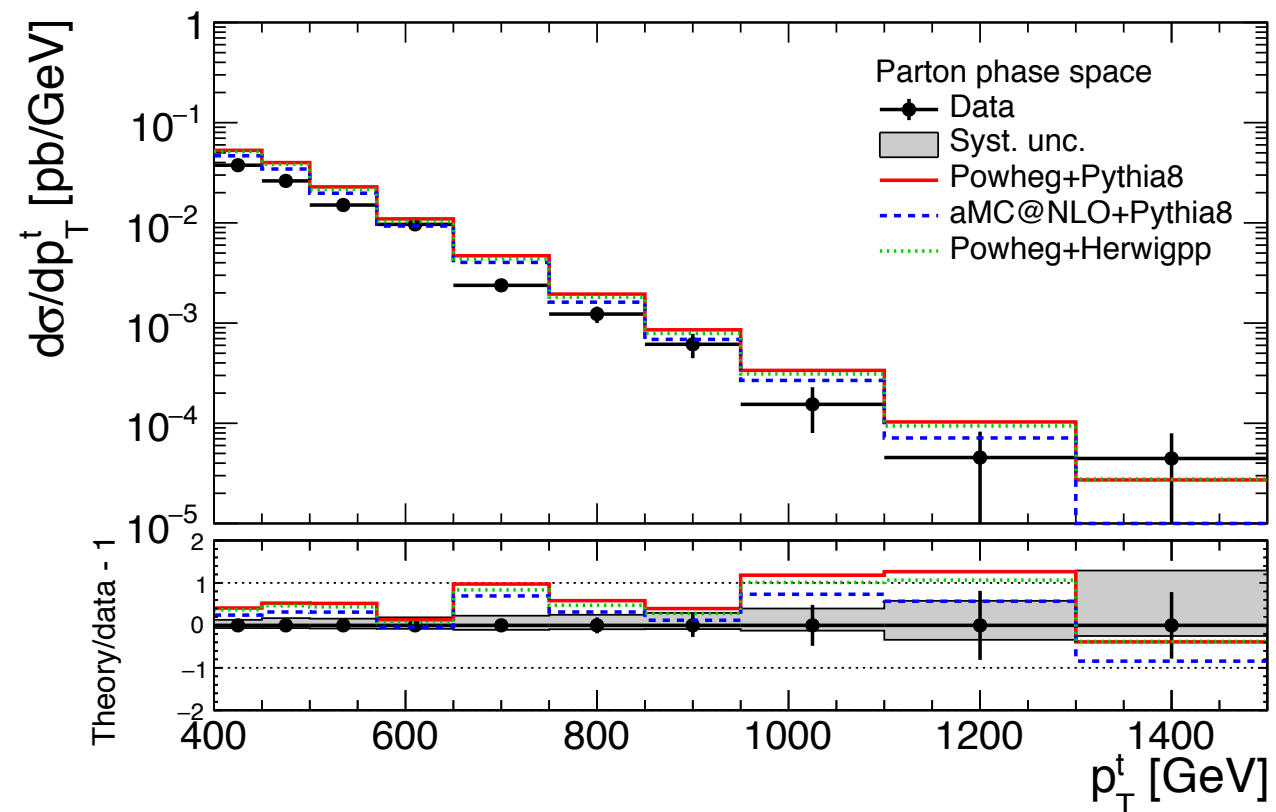
# Parton efficiency (top $p_T$ , $m_{t\bar{t}}$ )



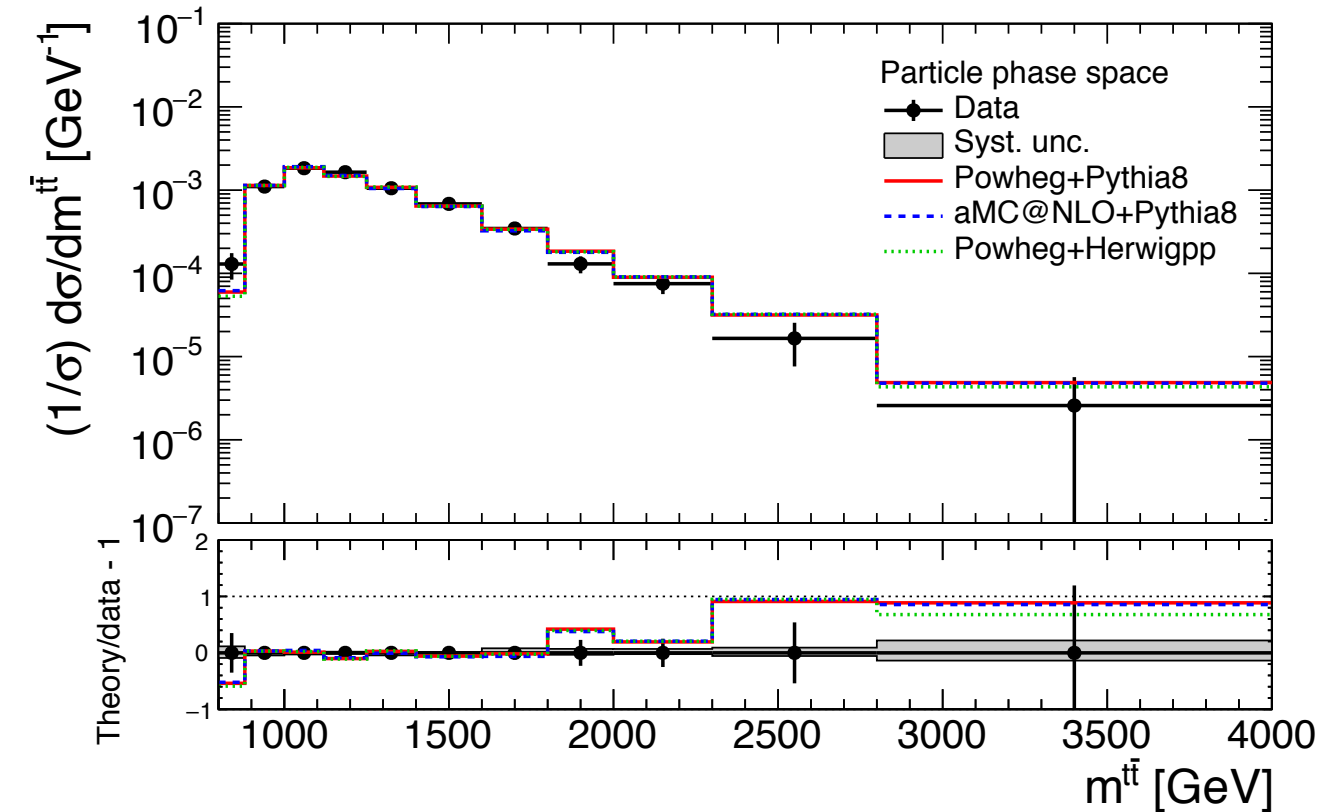
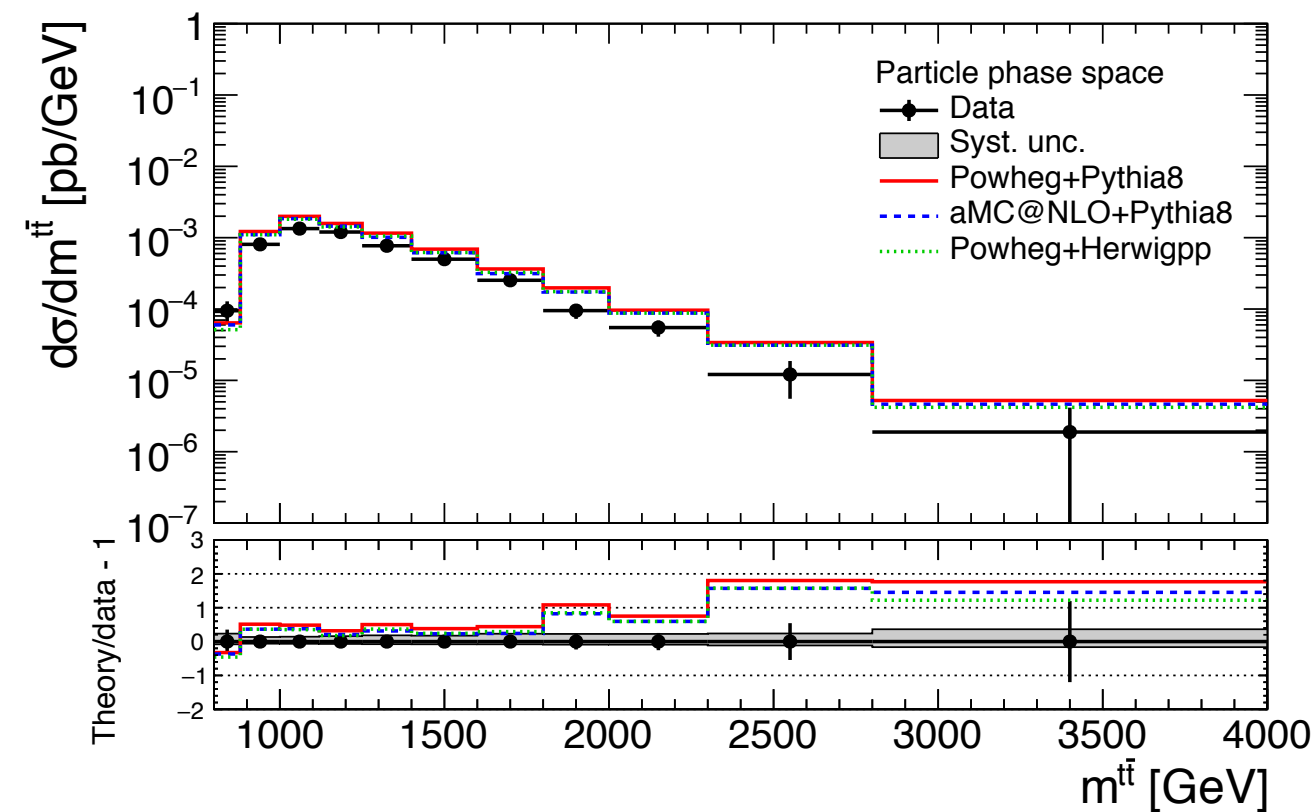
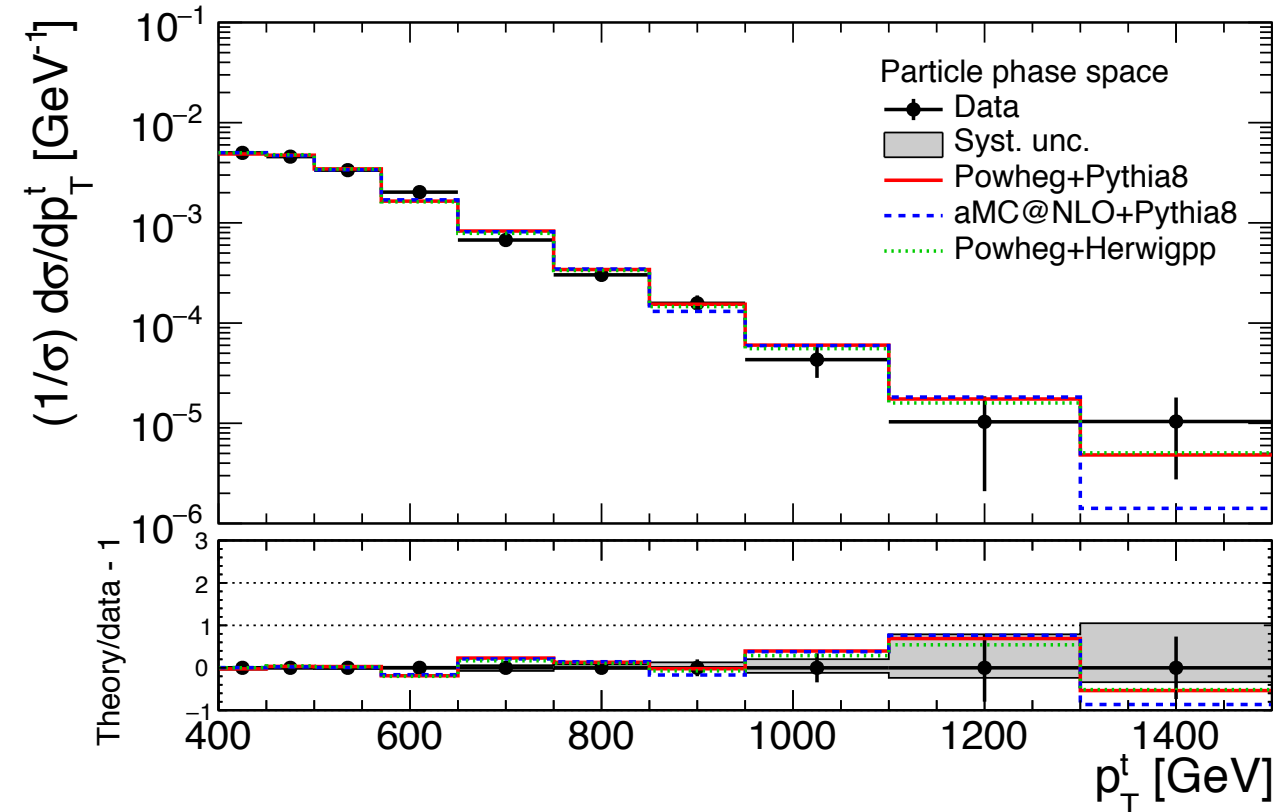
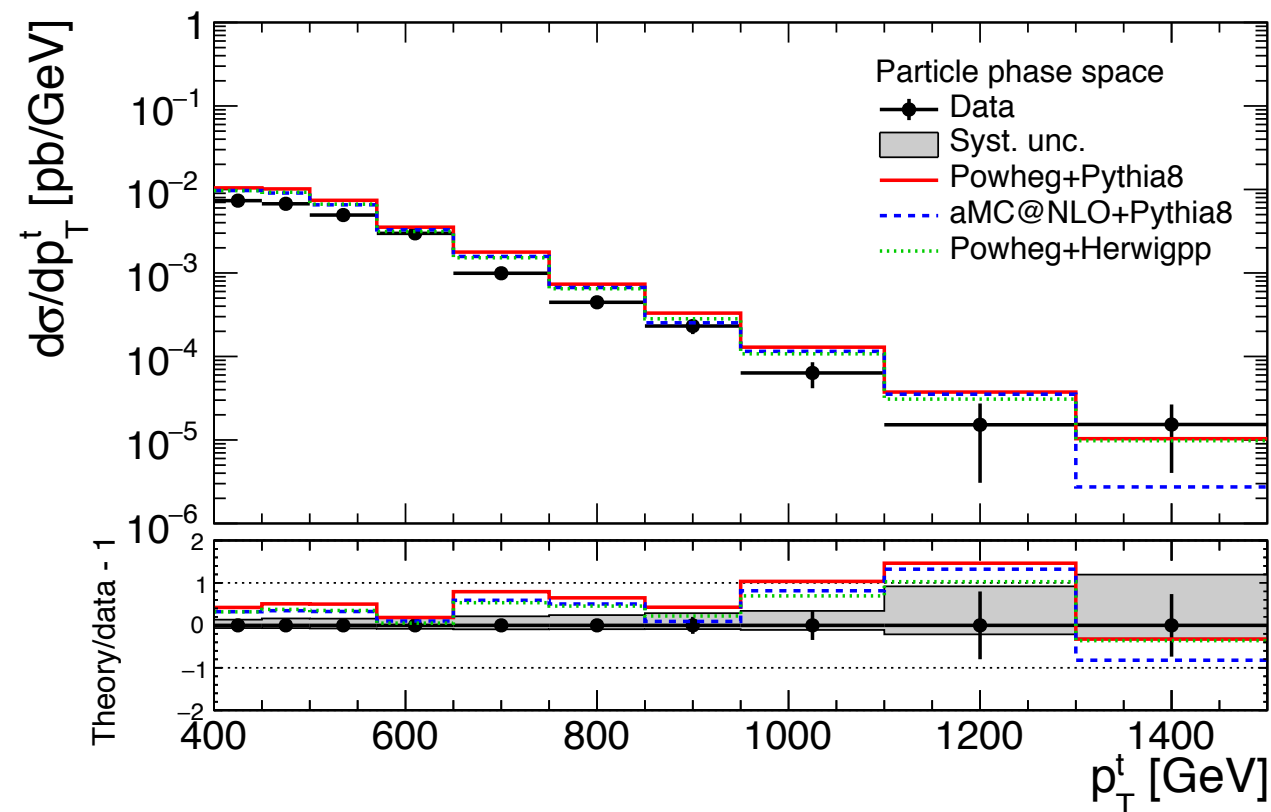
# Particle efficiency (top $p_T$ , $m_{t\bar{t}}$ )



# Results (parton, top $p_T$ , $m_{t\bar{t}}$ )



# Results (particle, top $p_T$ , $m_{t\bar{t}}$ )





# Summary

- ◆ presented the unfolded distributions (parton & particle level)
- ◆ use binning with high purity & stability ==> simple response matrix inversion for the unfolding seems to be sufficient
- ◆ normalised cross section: mostly in agreement with the theoretical predictions
  - but overall shift of the order of 40% in the total cross section
- ◆ systematics: for every source we redo the measurement
  - mostly affecting the efficiency/extrapolation corrections
- ◆ **next steps**
  - finalise the theory uncertainties (pdf,  $\alpha_S$ , scale)
  - complete the AN note (missing only one section)
  - compute the covariance matrices