Zγ+jets Status Updates

Theoretical Uncertainty

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Outline

- Unfolded Theoretical Uncertainty
  - Introduction
  - Unfolded Results

Unfolding Introduction

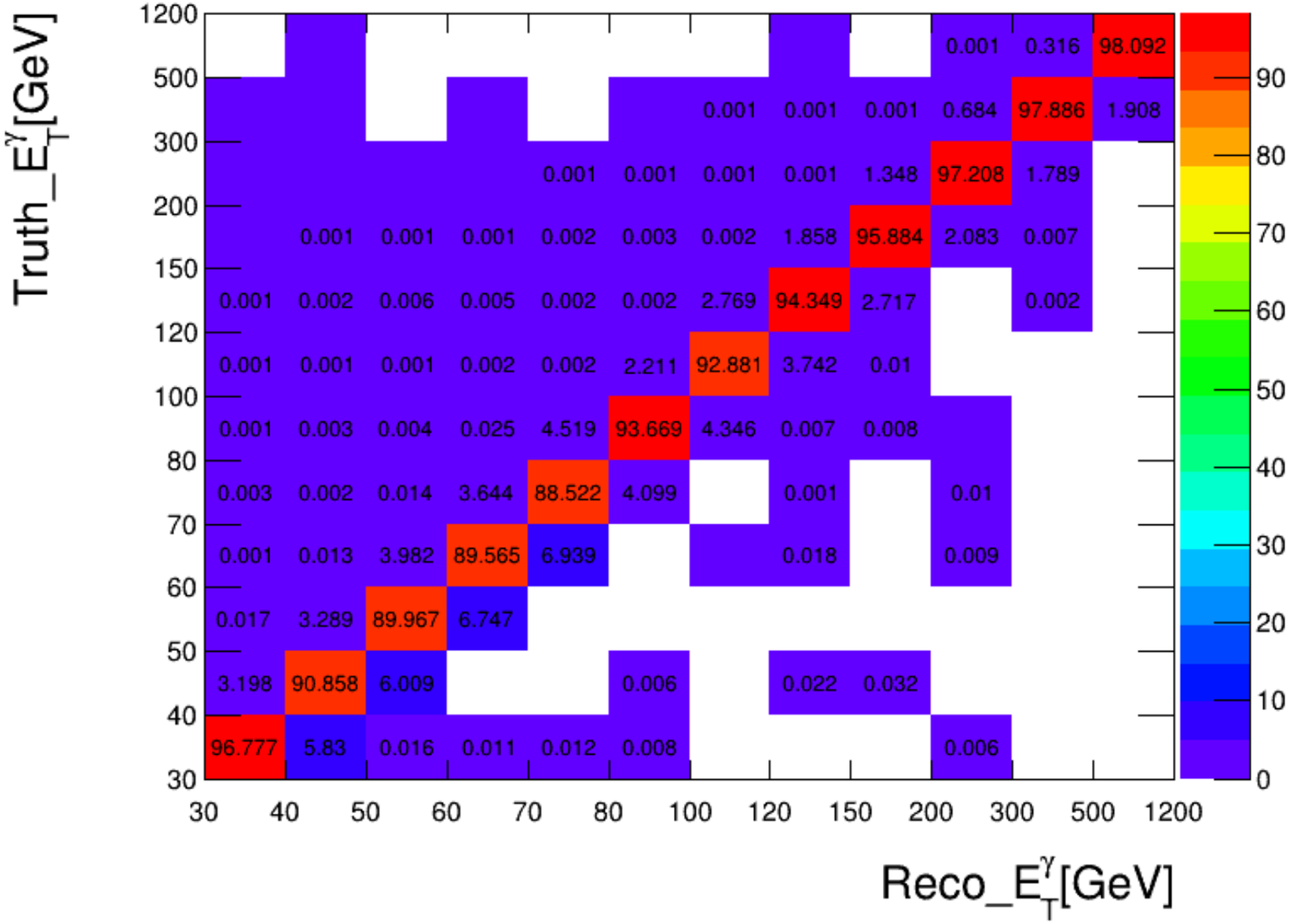
Detailed Information

- In order to compare the experimental distributions with theoretical predictions, the detector effects should be corrected (unfolded) to the particle level.
  - One of the most popular unfolding methods is used here :
    - The Bayesian iterative unfolding method
- Detector effects such as smearing effect, limited acceptance and inefficiency can distort the measured distributions.

Response Matrix

We have unfolded difference observables, E_γ^T, $|\eta_\gamma|$, $M_{ll\gamma}$, $pT_{ll\gamma}$, $dPhi_{lly}$, N_{jets}

- Response matrix
  - Monte Carlo (MC) Simulation can be used to construct a response matrix that indicates the bin-by-bin migration of events from a truth bin to a reconstructed one.



Response matrix for E_γ^T distribution obtained from Sherpa 2.2.4 LO

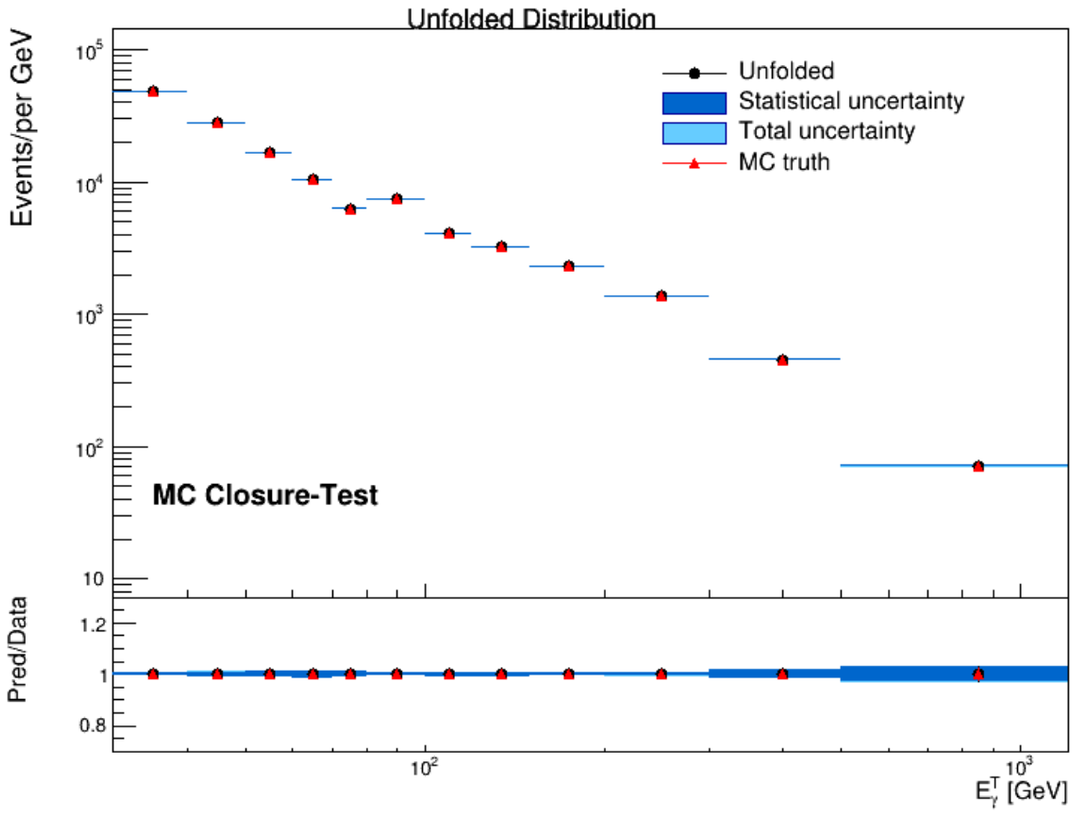
The distribution has well diagonalization.

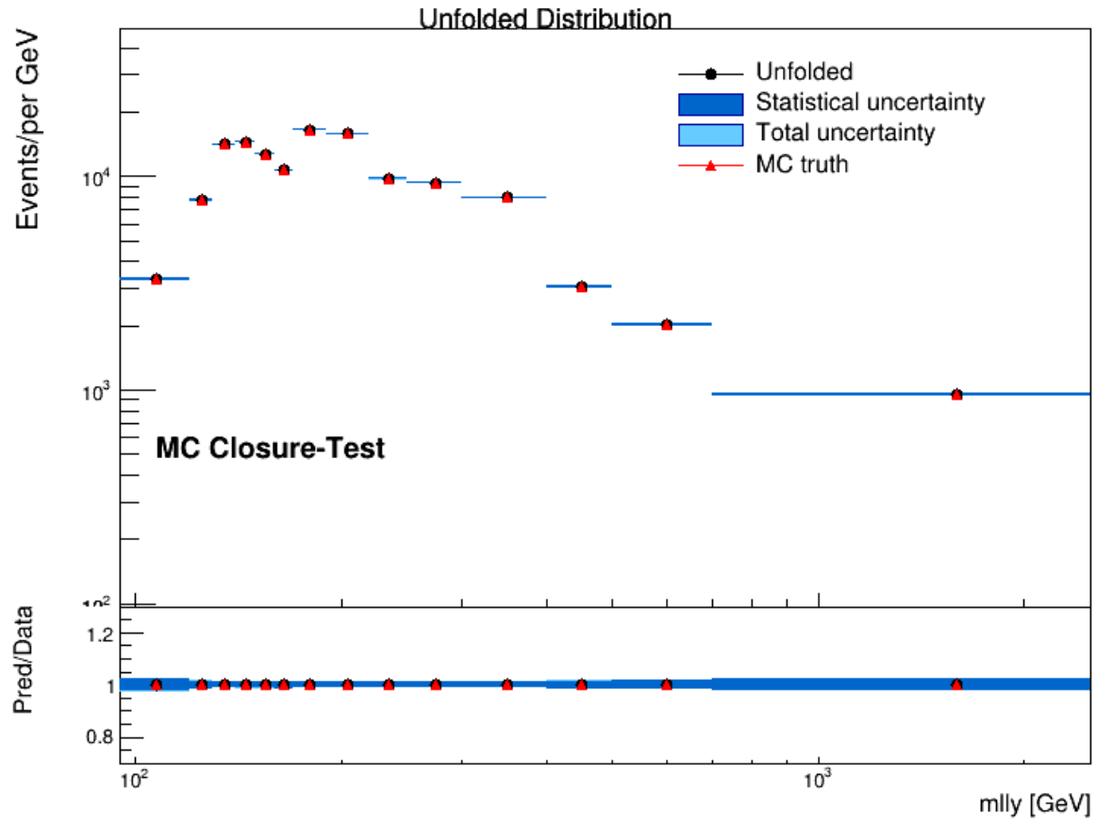
Most truth values are well reconstructed at eco level.

KEY to Unfolding !

Closure Test

- A closure test is performed to verify the correctness of the procedure applied.
  - The Signal MC (Sherpa 2.2.4 LO.) is used to generate the response matrix and then the reconstruction level distribution from the same MC is unfolded.
  - The unfolded and truth distribution are found to match exactly





Signal MC : Sherpa 2.2.4 LO.

Data-bkg : Sherpa 2.2.4 LO.

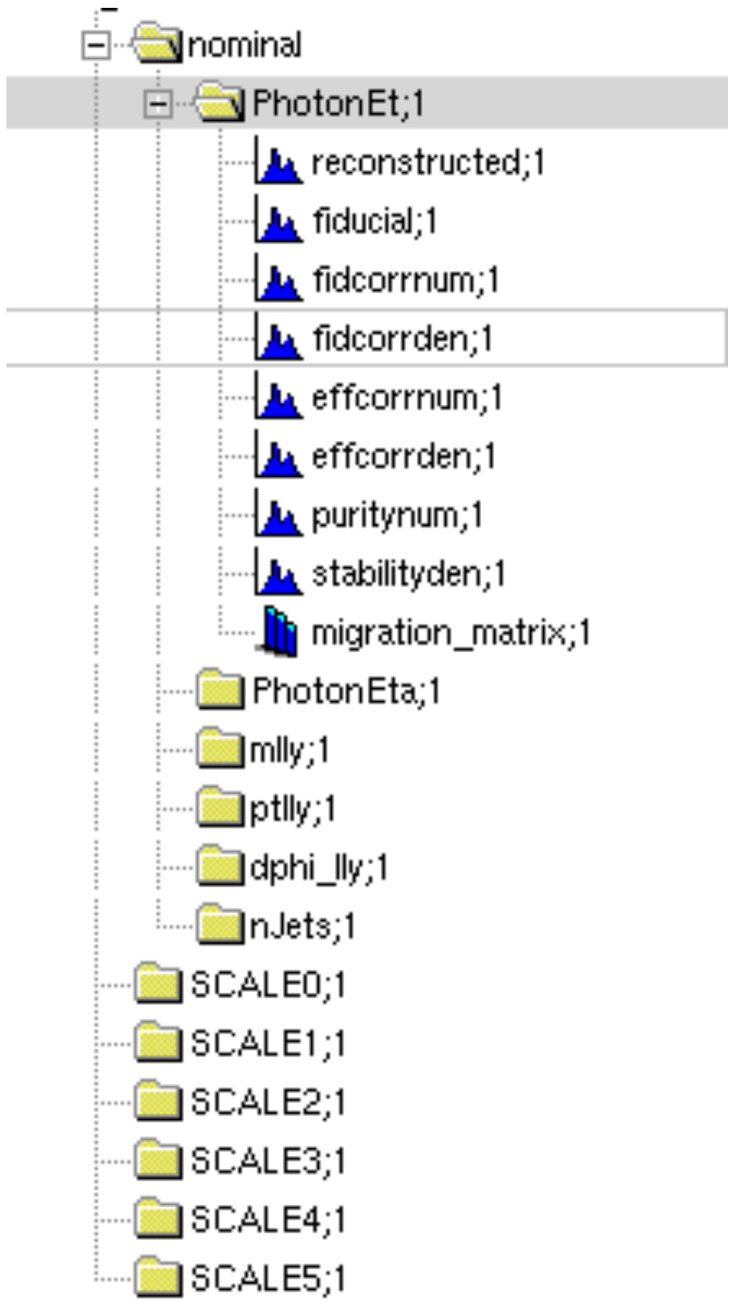
Used for Unfolding → **Matches well !!!**

Total Uncertainty : combination of statistical uncertainty + background uncertainty without considering theoretical systematics

Unfolding Results

- Uncertainties considered in the unfolding process includes:
  - Experimental uncertainties (electron, muon, jet, pile-up related)
  - Uncertainties due to background estimations
  - **Generators (difference between Sherpa and Madgraph)**
  - **Theoretical uncertainties (both from scale and pdf variations)**
  - Data-driven uncertainty
- Unfolded Results contains :
  - Efficiency and fiducial correction
  - Unfolded distribution with uncertainties
  - Unfolded distribution with different methods
  - Relative uncertainties

Histograms used in Unfolding

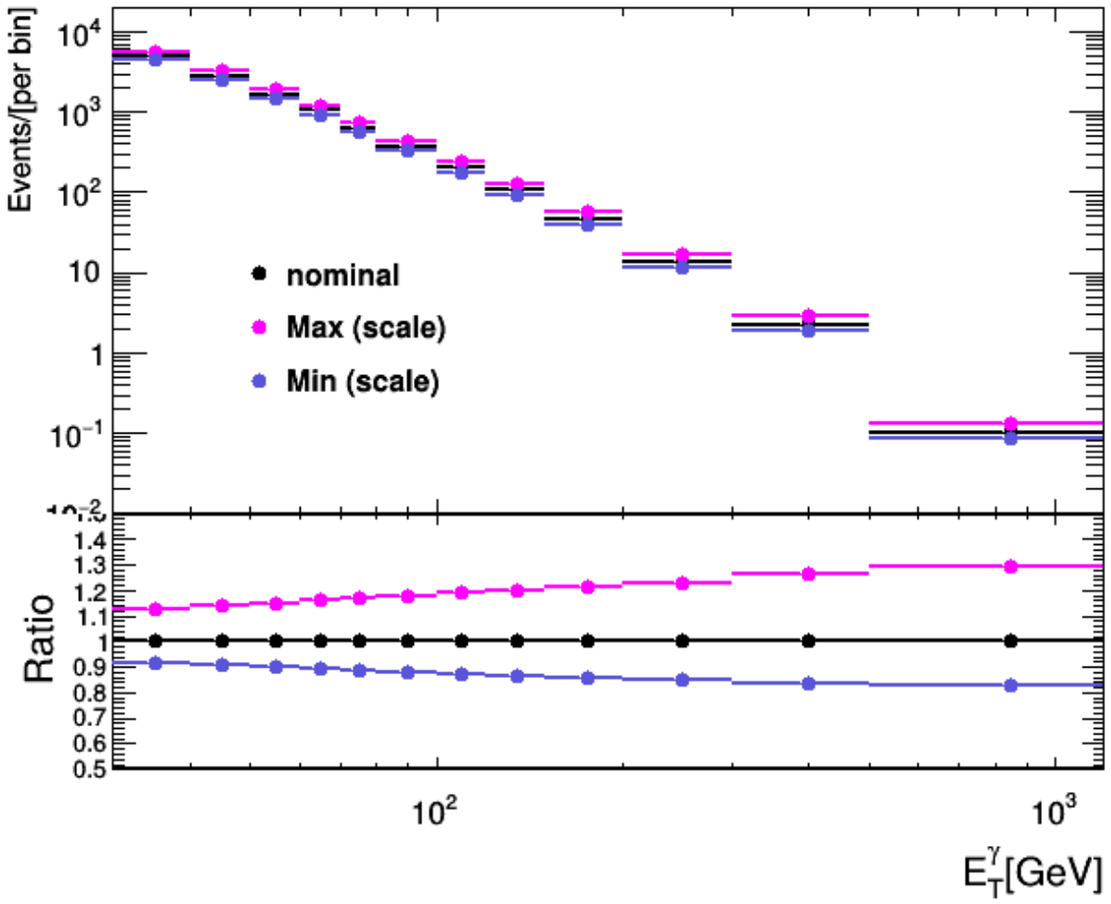


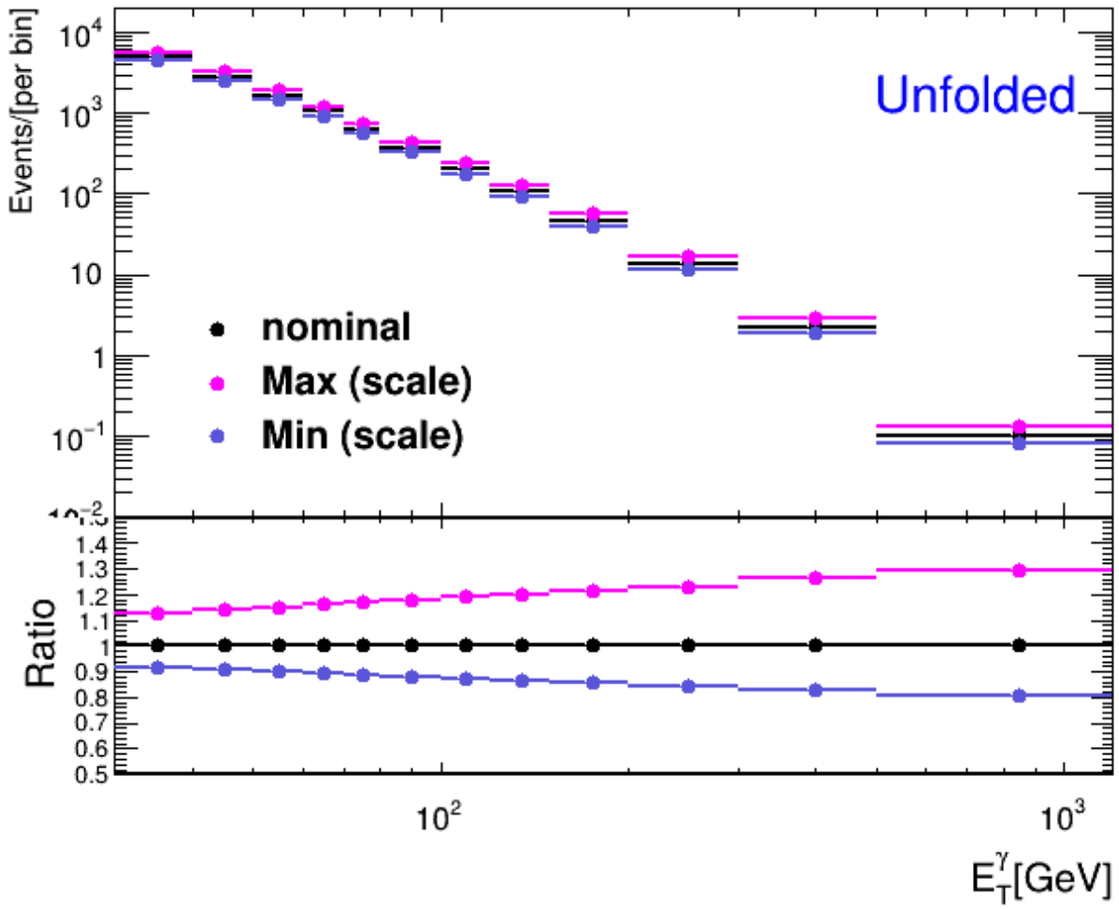
	Pass Fiducial	
Descriptions	Effcorrden	truthVar, truthWeight
	Pass Reconstructed	
	Fidcorrden	recoVar, recoWeight
	Stabilityden	truthVar, recoWeight
	Pass Fiducial and Reconstructed	
	Fidcorrnum	recoVar, recoWeight
	Effcorrnum	truthVar, recoWeight
	Puritynum	truthVar, truthWeight
	Migration Matrix	recoVar, truthVar, recoWeight

- Considering only truth event-weight has theoretical variations, just replace truthWeight by other theoretical systematics weights

Unfolded Results with Uncertainty

Scale Variation Comparison: Signal = Sherpa224, Data - bkg = Sherpa224



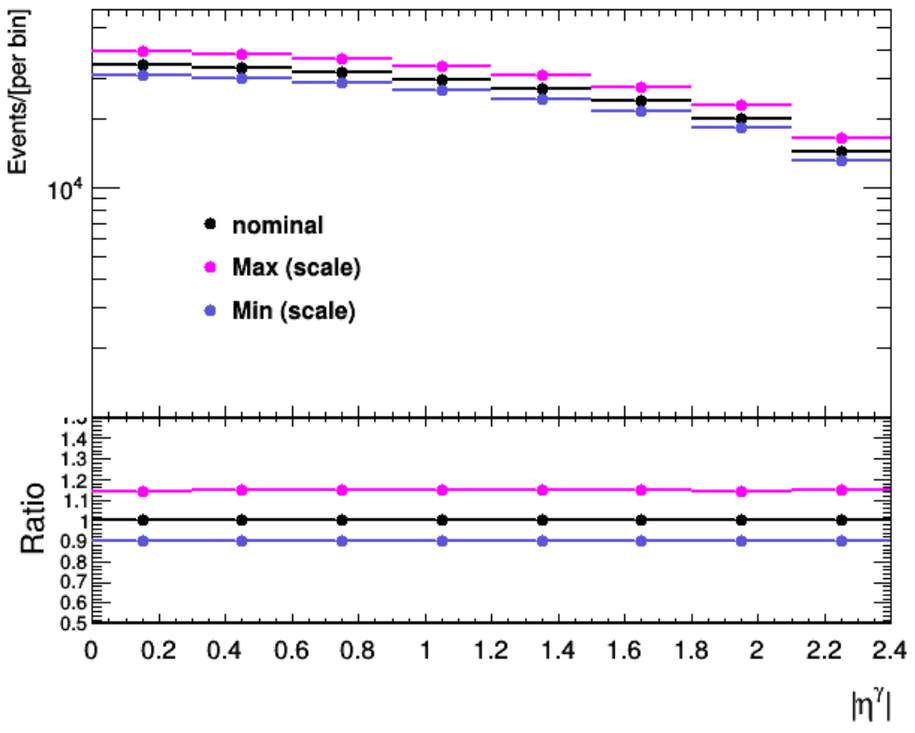


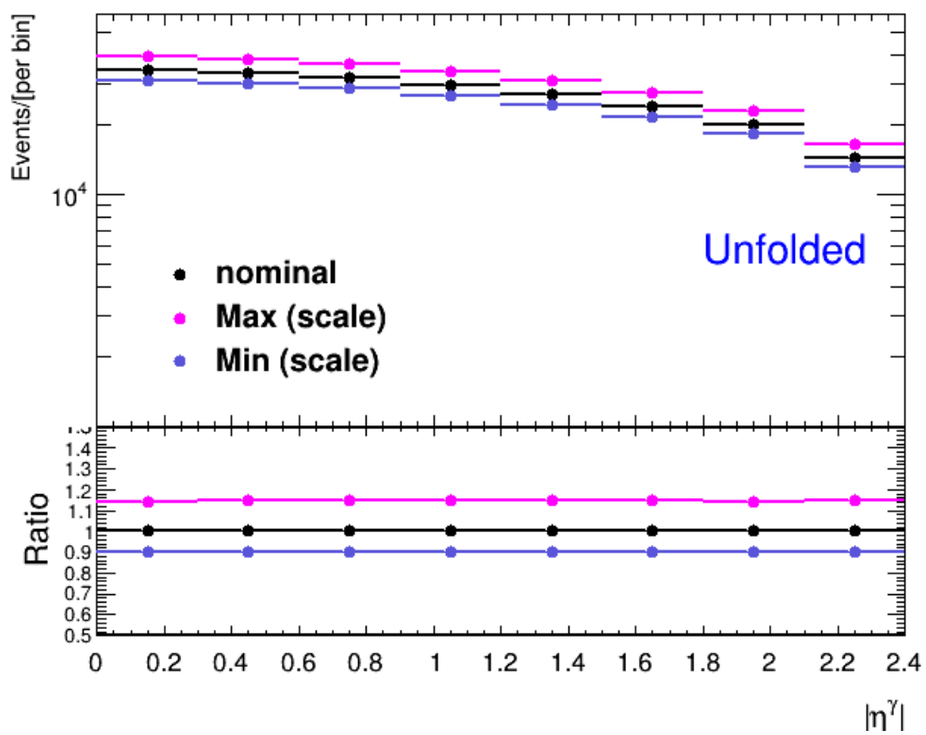
- Left plot : Envelope result for E_γ^T, obtained directly from variation plots
- Right plot : Envelope result for E_γ^T, after unfolding

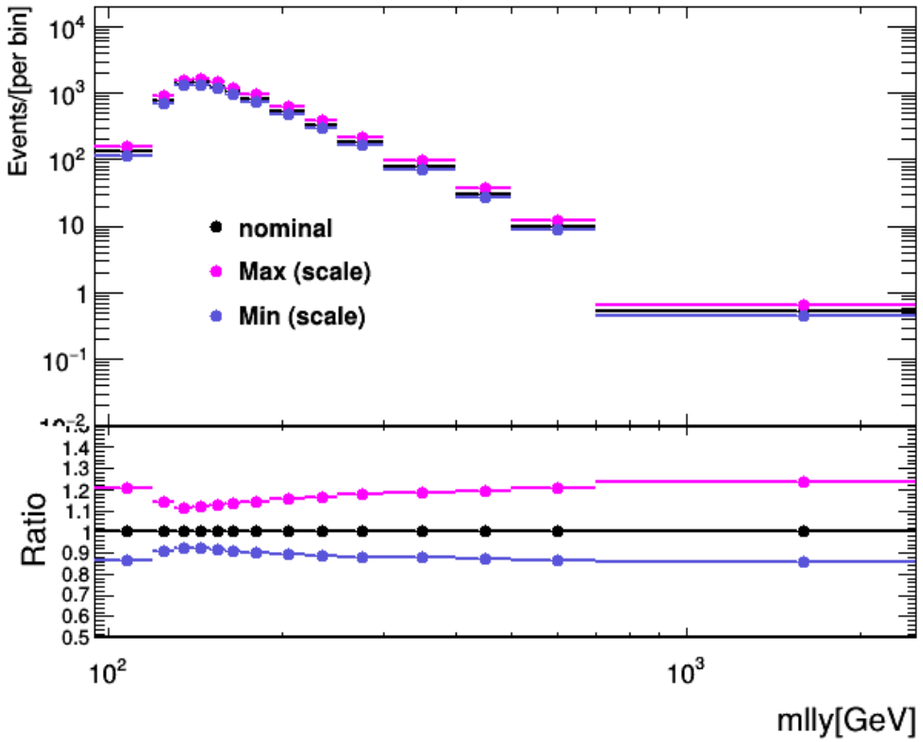
Two plots are exactly same !!! → Same MC samples for data and MC !!!

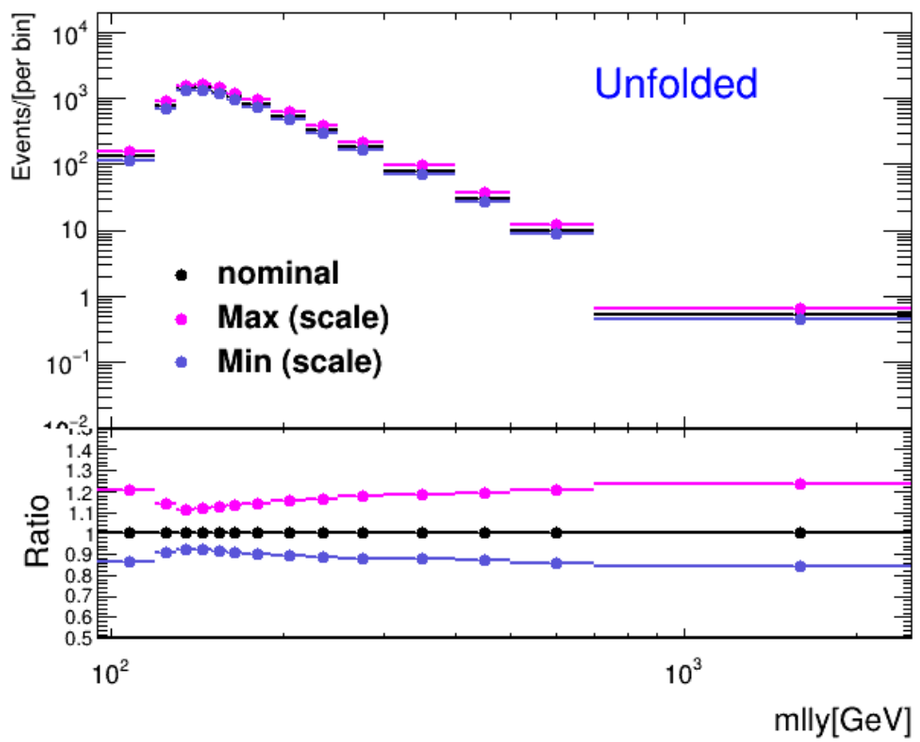
Unfolded Results with Uncertainty

Scale Variation Comparison: Signal = Sherpa224, Data - bkg = Sherpa224



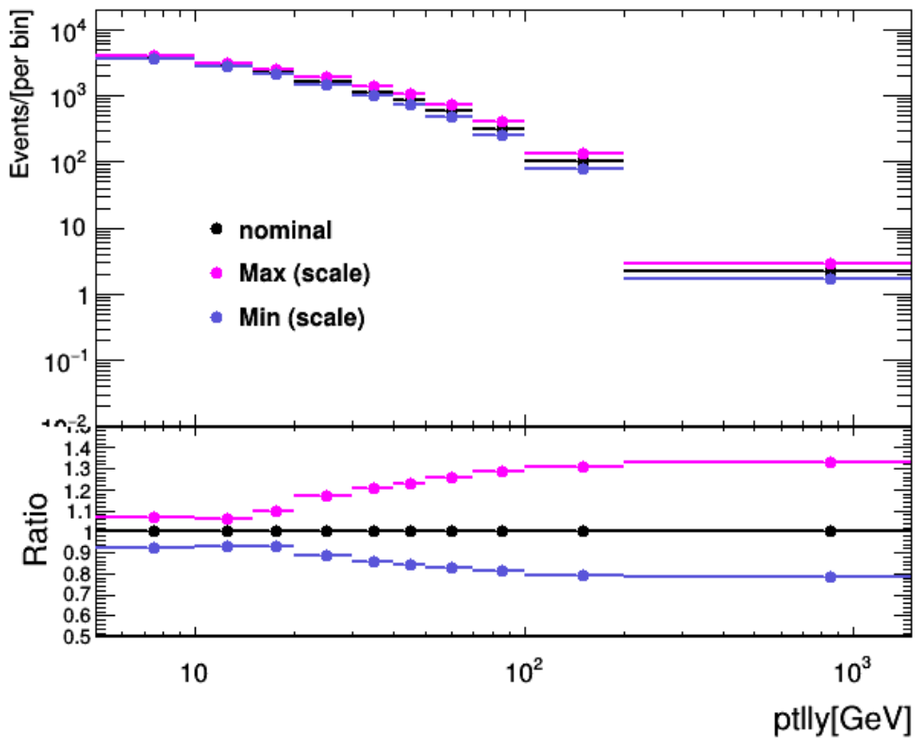


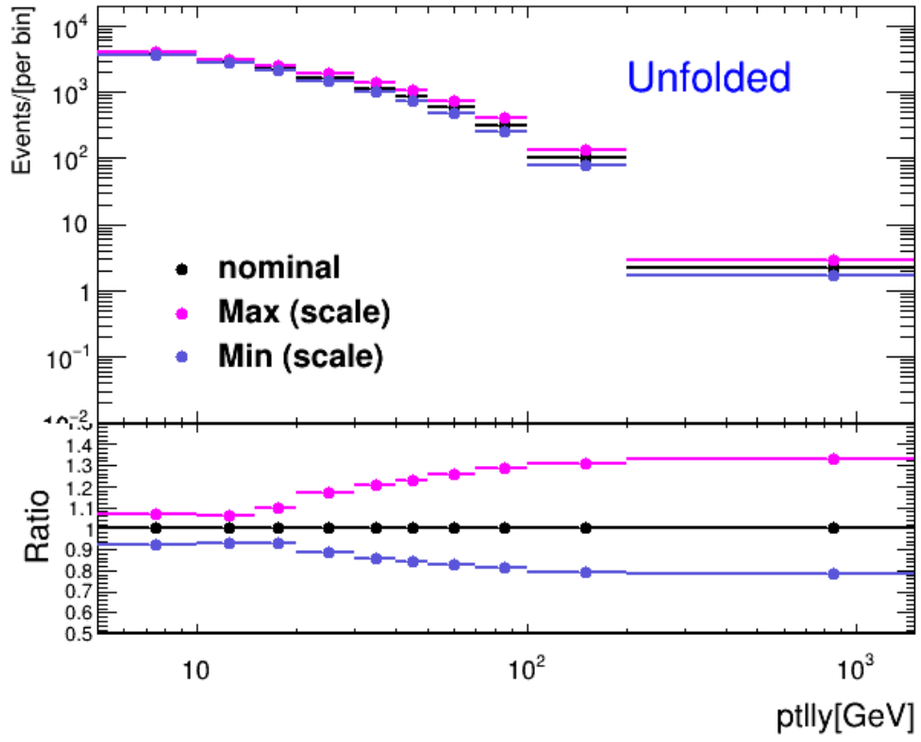


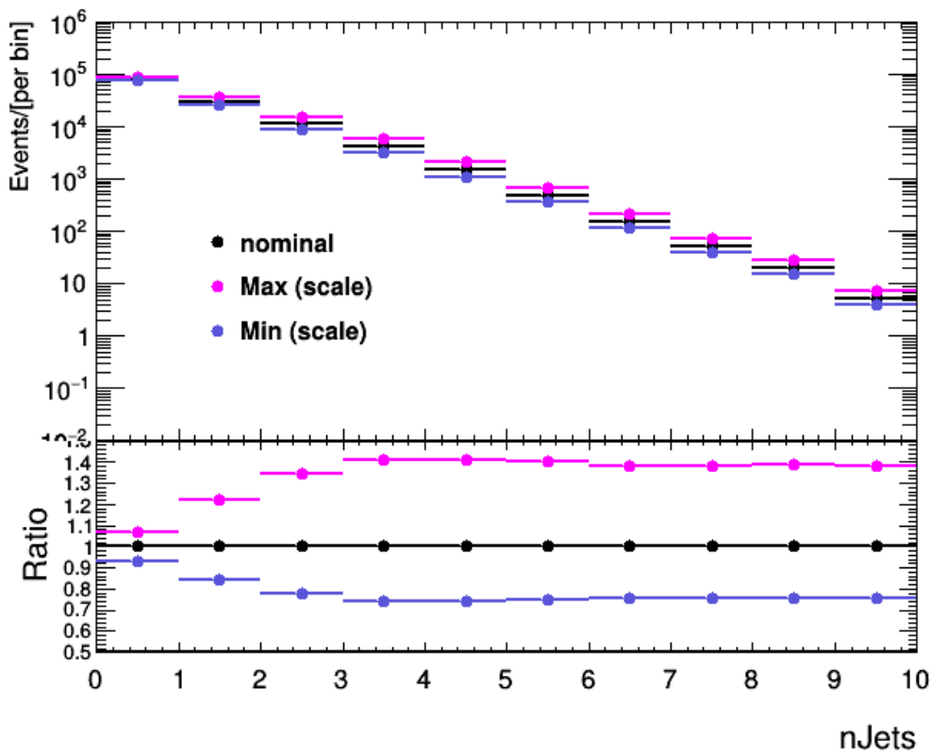


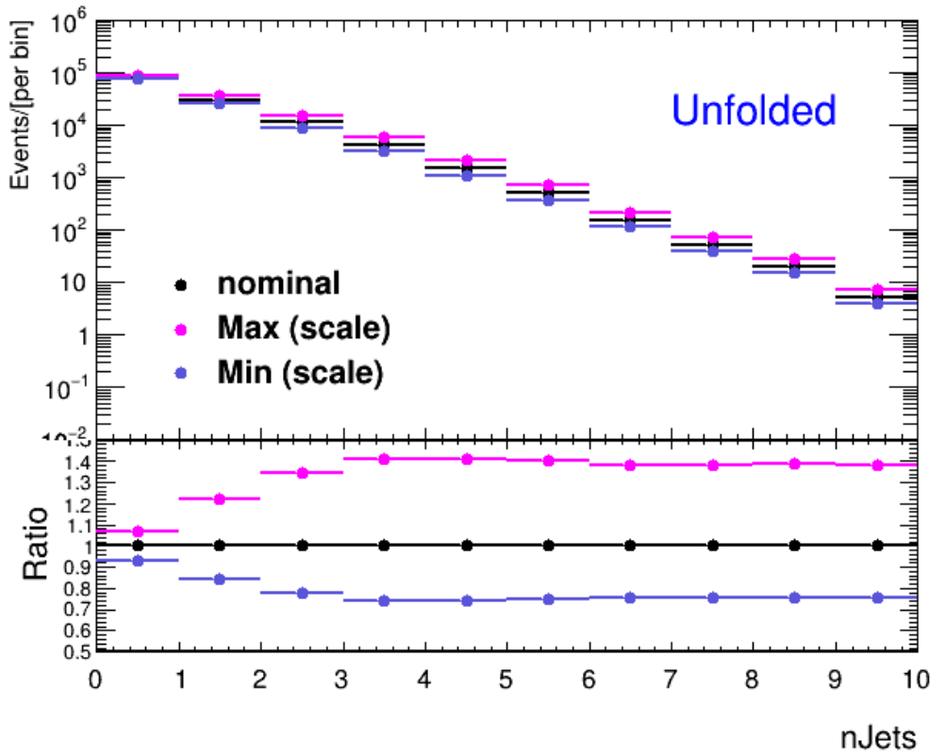
Unfolded Results with Uncertainty

Scale Variation Comparison: Signal = Sherpa224, Data - bkg = Sherpa224

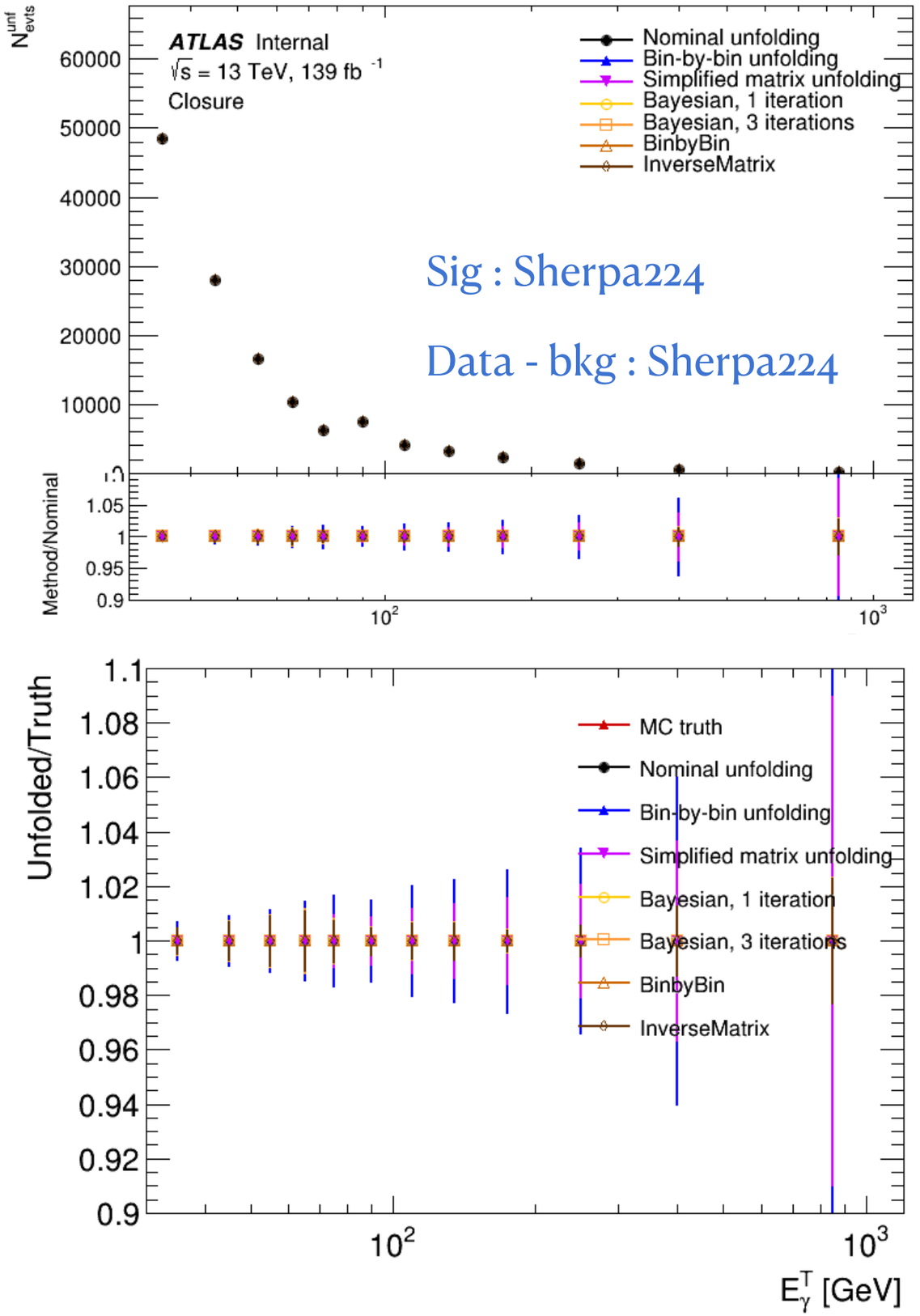


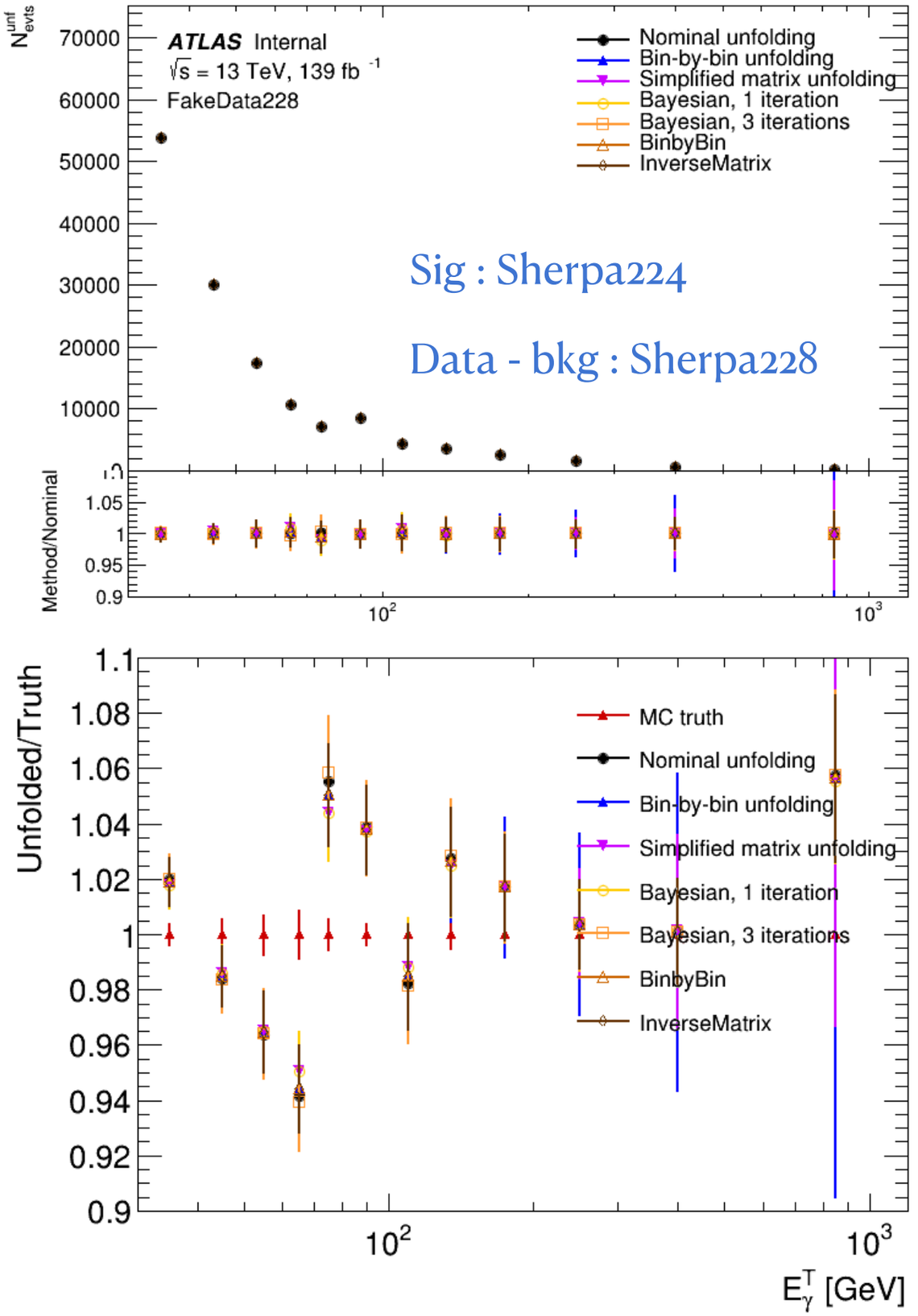






Unfolded Distribution with Different Methods



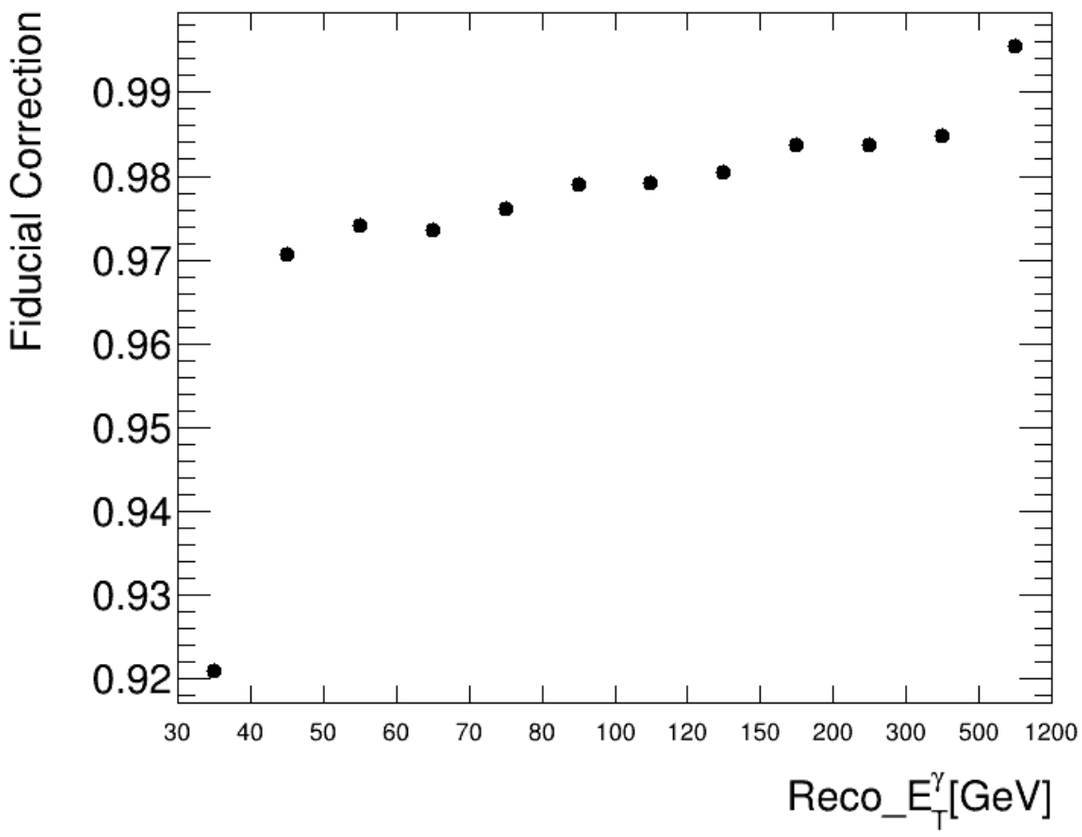


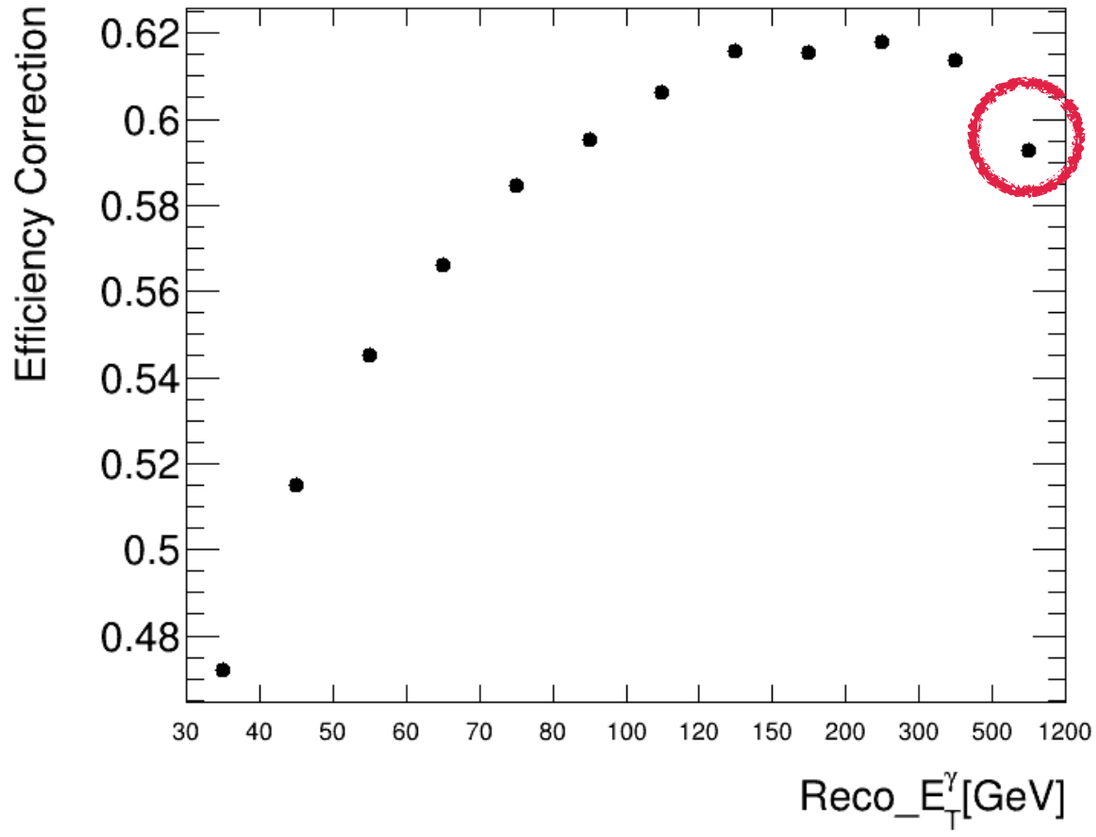

Backup

Efficiency and fiducial correction

- Fiducial correction (left plot) : correct for events which are reconstructed in the signal region while not in the fiducial region
- Efficiency correction (right plot) : correct for the events passing the fiducial region while not reconstructed in the signal region

Quality	Fiducial Selection	Reconstructed Selection
Lepton cuts	$pT_{l_1} > 30GeV, pT_{l_2} > 25GeV, \lvert\eta_\gamma\rvert < 2.47$	
Photon cuts	$pT_\gamma > 30GeV, \lvert\eta_\gamma\rvert < 2.37, \Delta R(\gamma, l) > 0.4$	Loose identification/Tight identification
Photon isolation	$E_T^{cone}/E_T^\gamma < 0.07$	FixedCutLoose/ $\frac{pT_\gamma^{cone}}{pT_\gamma} < 0.05, \frac{E_\gamma^{Tcone}}{pT_\gamma} < 0.065$
Mass cuts	$m(ll) > 40GeV, m(ll) + m(ll\gamma) > 182GeV$	Still in progress





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Efficiency and fiducial correction

CrossCheck

Object definition (Reco)			
Electron	**pt > 25 GeV**	**0 < |eta| < 1.37 || 1.52 < |eta| < 2.47**	
Muon	**pt > 25 GeV**	**|eta| < 2.5**	
Photon	**pt > 15 GeV**	**0 < |eta| < 1.37 || 1.52 < |eta| < 2.37**	
Jet	**pt > 30 GeV if |eta| < 2.5 || pt > 50 GeV if 2.5 < |eta| < 4.4**		
Object definition (Truth)			
Electron	**pt > 25 GeV**	**|eta| < 2.47**	
Muon	**pt > 25 GeV**	**|eta| < 2.47**	
Photon	**pt > 15 GeV**	**|eta| < 2.37**	**ΔR(photon, lepton) > 0.4 for all selected leptons**
Jet	**pt > 25 GeV**		**ΔR(jet, photon) > 0.4 for all selected photons**

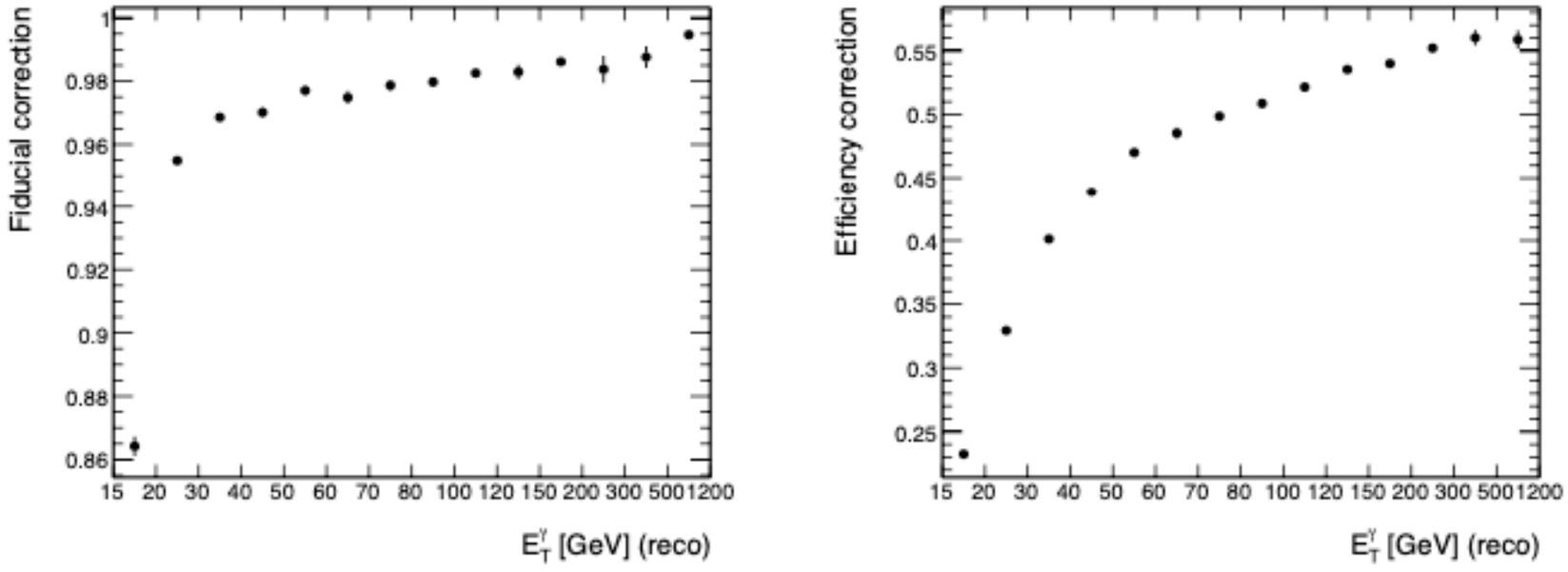

Figure 27: (a) Fiducial correction and (b) reconstruction efficiency for the E_T^γ distribution obtained from SHERPA 2.2.4 LO.