

Studies into Performance and Systematics of ME-PS matching in W+Jets

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Overview

- Used Alpgenv2 to study performance and possible systematics of ME-PS matching in W+Jets:
 - Dependence on PS/UE
 - Dependence on P_T^{\min} generation cut
 - Dependence on CKKW K_T factor
 - Hadron-Parton level relationship
- All studies done at particle-level and at 1.96 TeV.
- Plan to extend this study to other approaches and LHC energies - this is a snapshot!
- Compare predictions to W+Jets measurement (see Andrea's talk) but also to each other.

Details of Study (i)

- Cross-section definition for predictions identical to our measurement:
 - $E_T^{\text{ele}} > 20 \text{ GeV}$, $|\eta^{\text{ele}}| < 1.1$, $E_T^{\nu} > 30 \text{ GeV}$, $M_T^W > 20 \text{ GeV}/c^2$
 - Particle-level predictions clustered using JETCLU cone 0.4.
- Distributions under study:
 - $\sigma(W + \geq n \text{ jet})$ inclusive cross-section jet $E_T > 25 \text{ GeV}$.
 - Differential $d\sigma(W + \geq n \text{ jet})/dE_T^{\text{nth}}$ jet spectra for jet $E_T > 20 \text{ GeV}$
 - Differential $d\sigma(W + \geq 2 \text{ jet})/d\Delta R_{jj}$ jet spectra for jet $E_T > 15 \text{ GeV}$

Details of Study (ii)

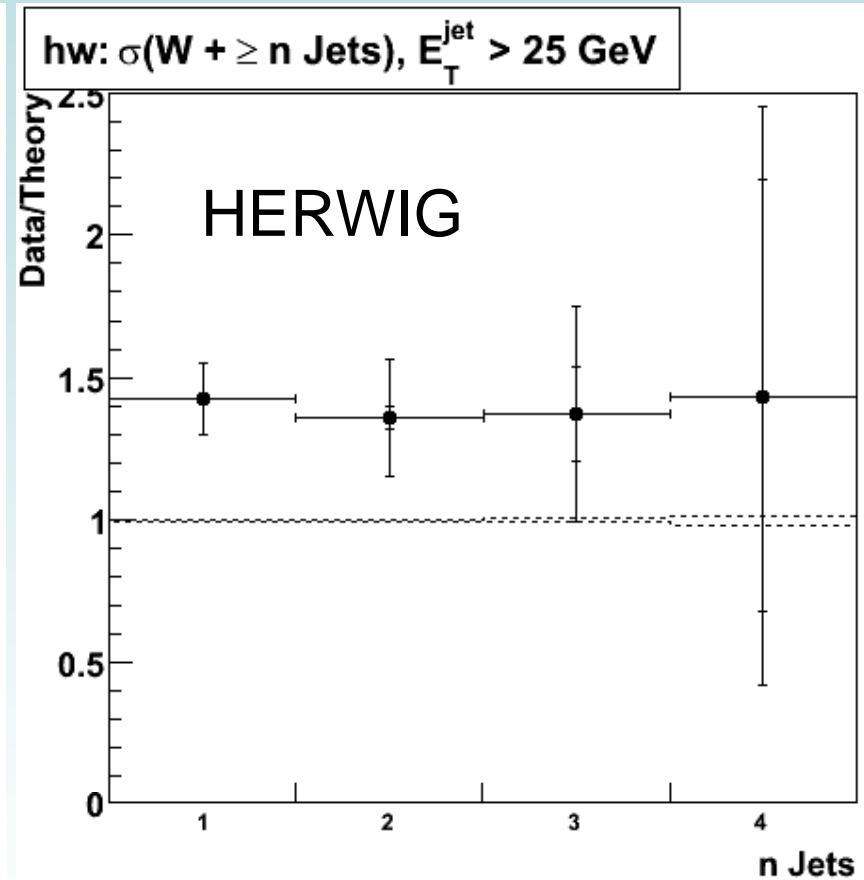
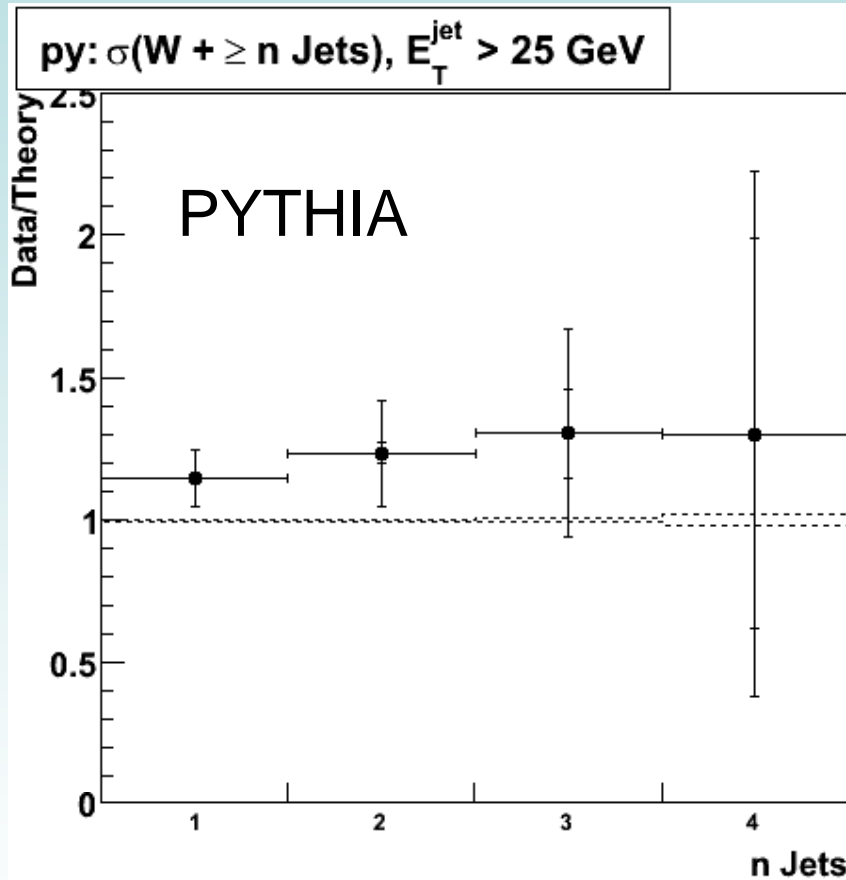
- **Constants of our generation:**
 - Alpgen v2.13 matrix element - showering with literally identical generation.
 - PDF: CTEQ5L
 - Renorm/Factorisation scale $Q = \sqrt{M_W^2 + \sum P_{T,jet}^2}$
- **Default generation parameters:**
 - Parton P_T^{\min} 15 GeV
 - $\Delta R_{jj} > 0.4$, $|\eta_{jet}| < 2.5$
 - CKKW K_T factor = 1.0
- **“Matching” parameters are always:**
 - Jet $E_T > (P_T^{\min} + 5)$ GeV
 - $R_{cone} = 0.4$, $|\eta_{jet}| < 2.5$
 - $\Delta R(\text{parton-jet}) < 0.6$

Details of Study (iii)

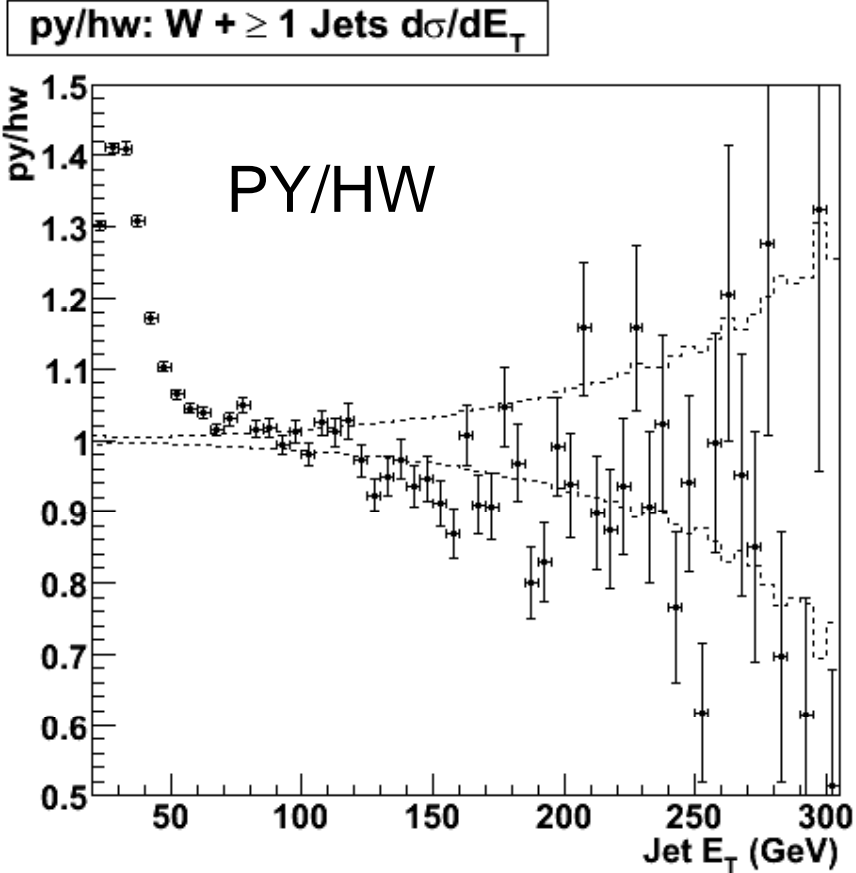
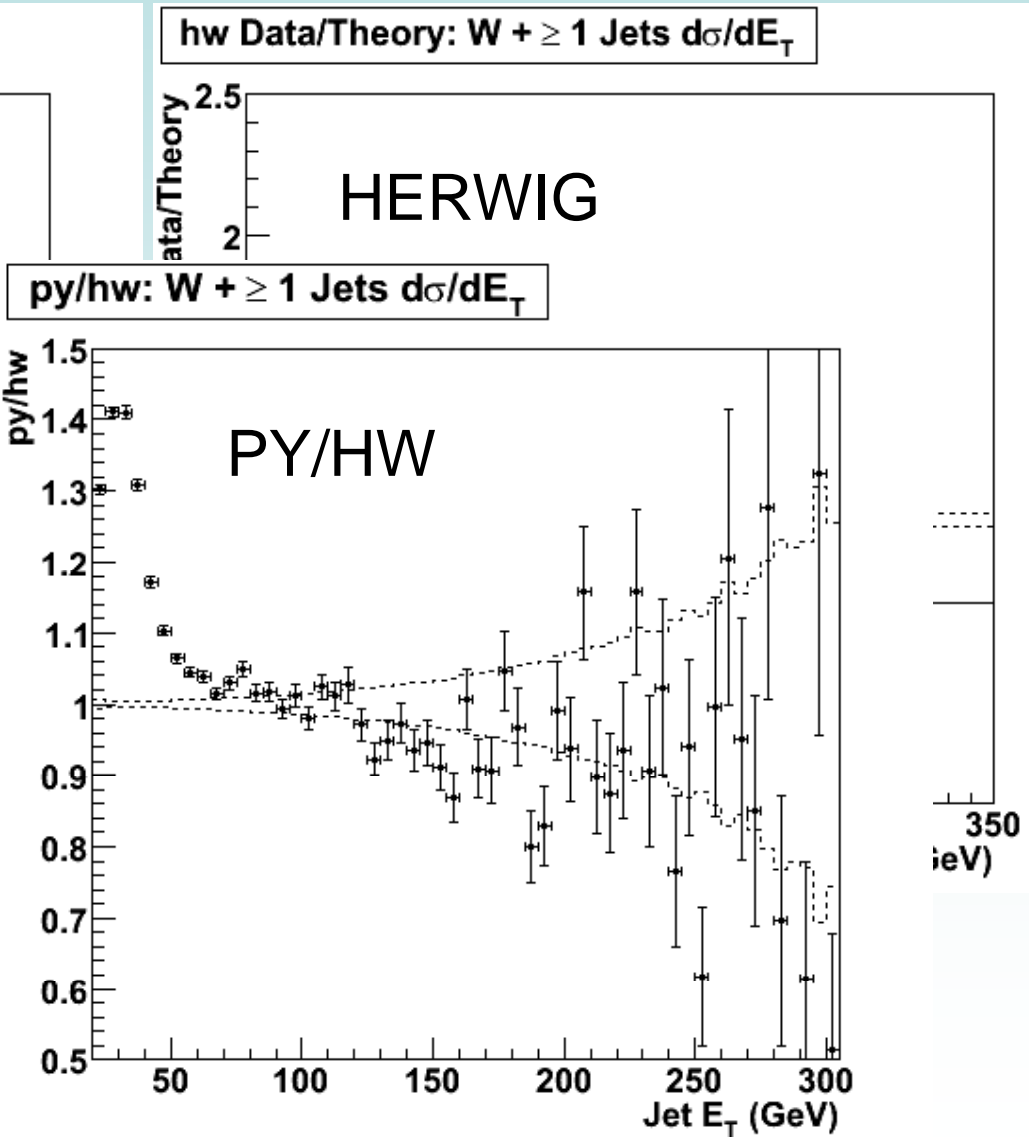
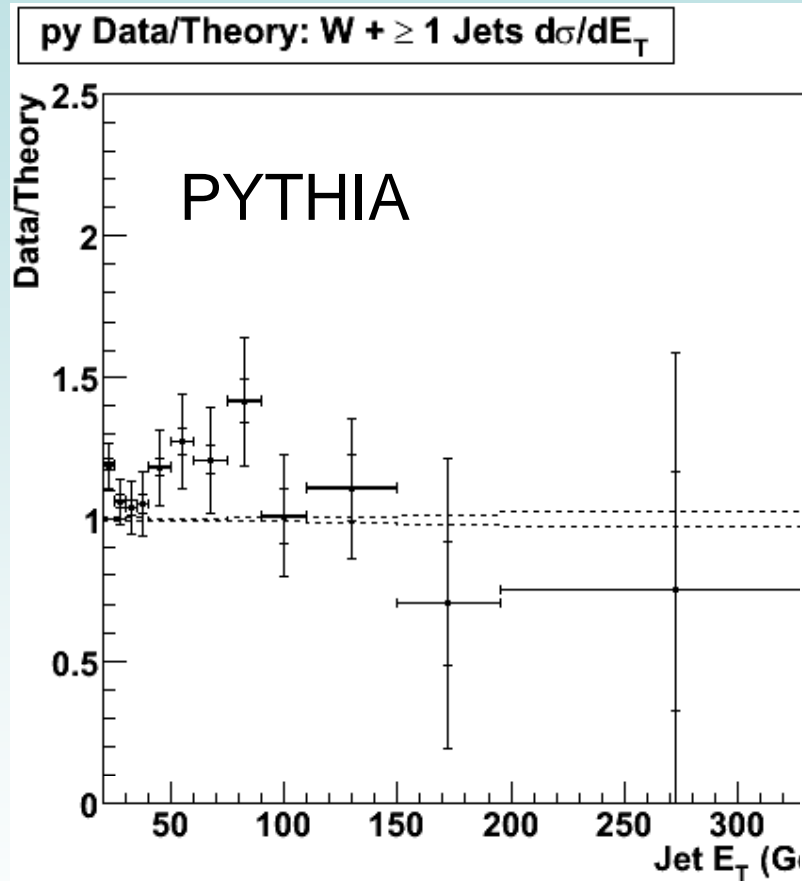
- Variables:
 - Parton shower: Pythia(v3.325) or Herwig(v6.510)
 - For Pythia MSTP(81) = 1 or MSTP(81) = 0
 - Parton P_T min generation cut
 - CKKW K_T factor
 - Fully matched or $W + np$ inclusive generation?
- Keys to different PS/UE generation:
 - “py” = Pythia 3.325 (calling PYEVNT, MSTP(81) = 1)
 - “hw” = Herwig 6.510 (default tuning - no Jimmy)
 - “pynoUE” = Pythia with MSTP(81) = 0
- UNLESS OTHERWISE STATED IT IS ALWAYS THE ALPGEN MATCHED PREDICTION.

Dependence on parton
shower/underlying event

Herwig & Pythia vs Data

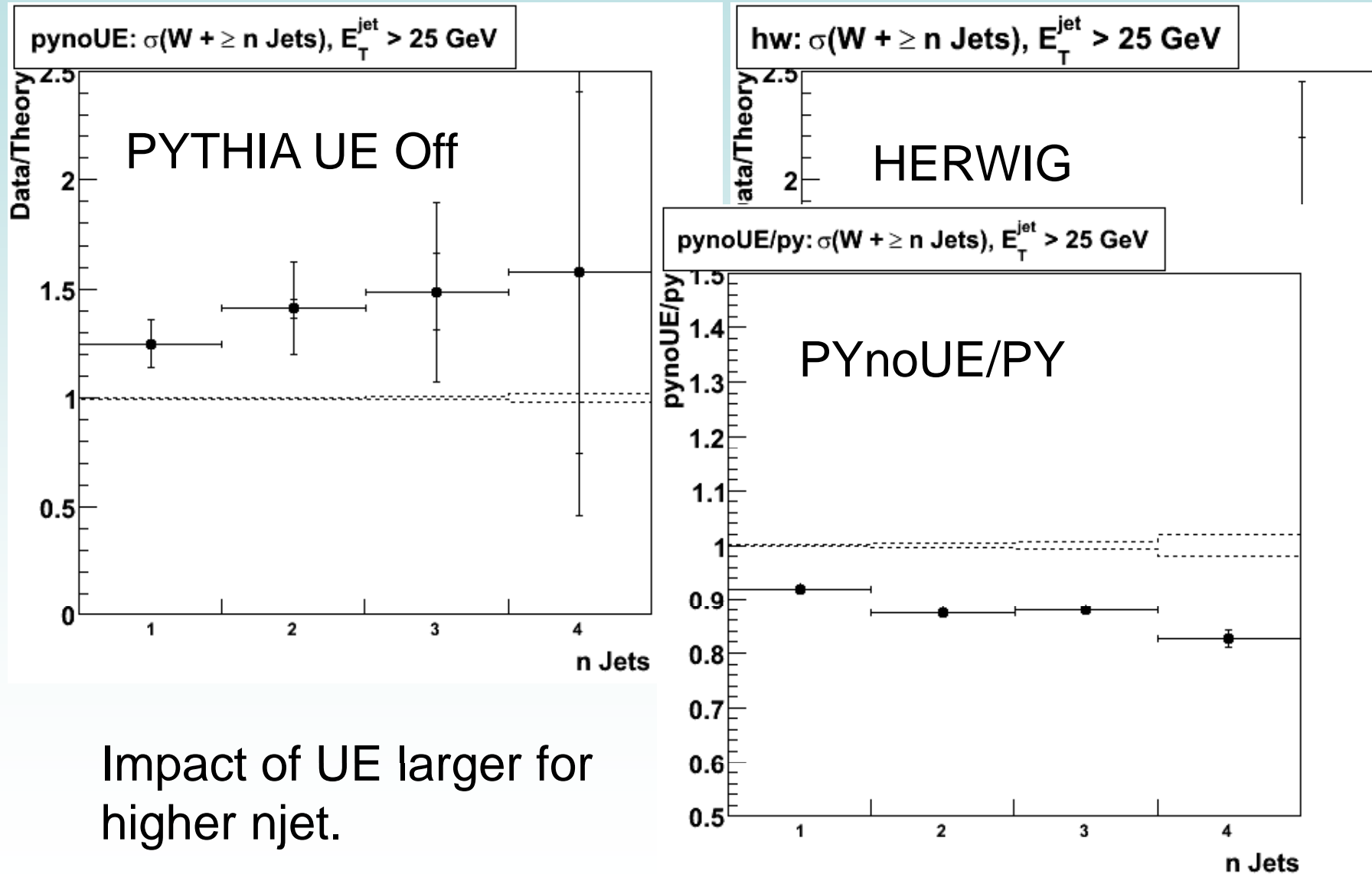


Herwig & Pythia vs Data



Substantial difference in predictions at low E_T

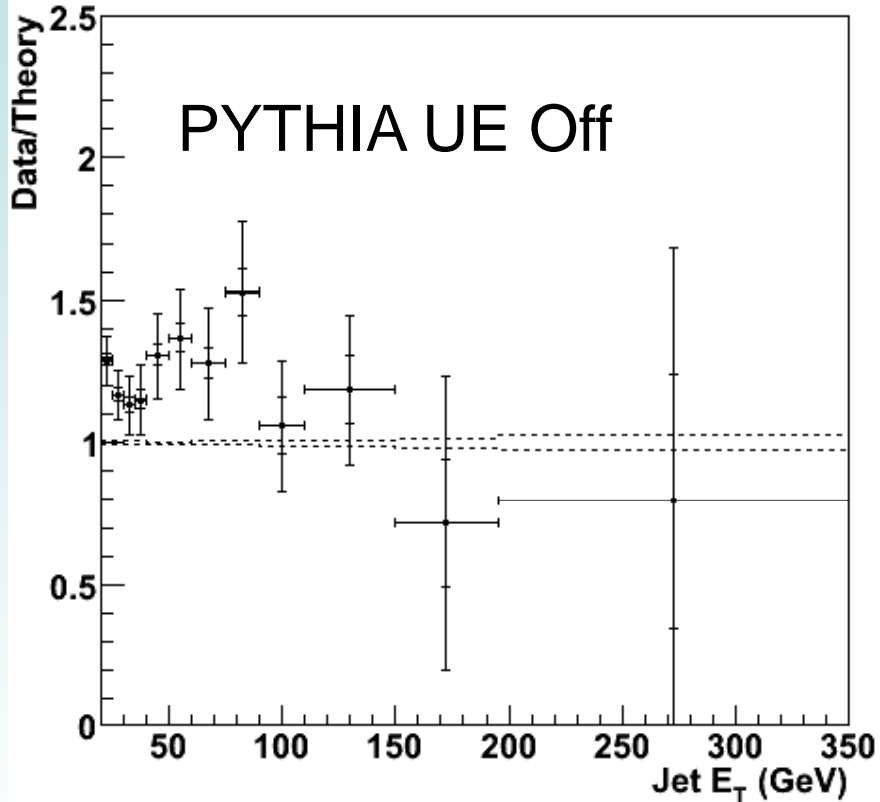
Turning UE “off” in Pythia



Impact of UE larger for higher n_{jet} .

Turning UE “off” in Pythia

pynoUE Data/Theory: $W + \geq 1$ Jets $d\sigma/dE_T$

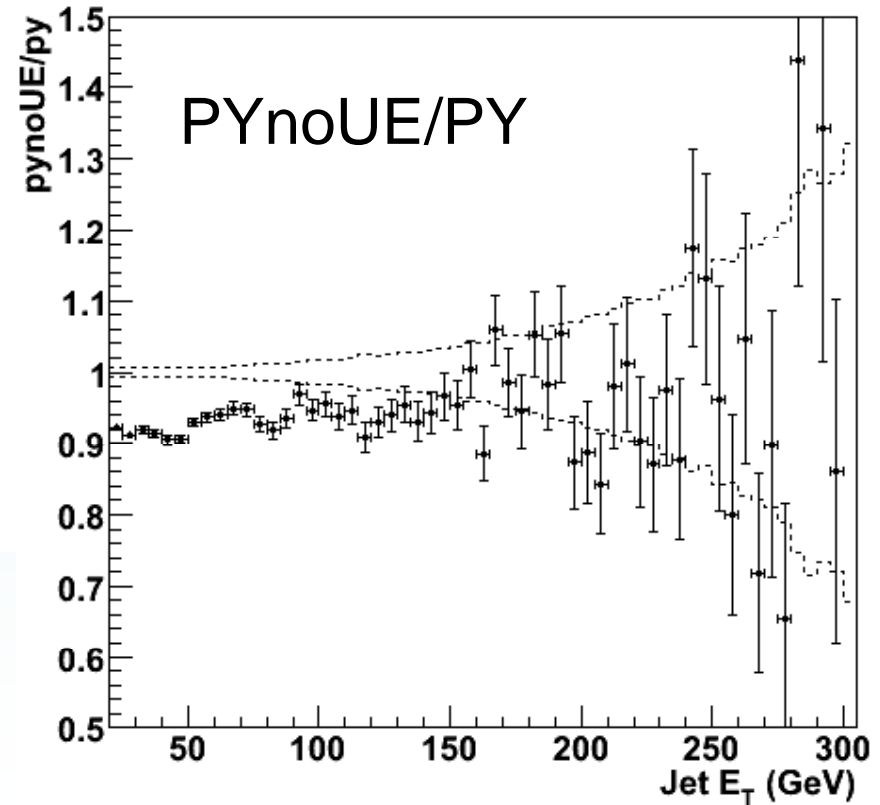


No significant shape change.

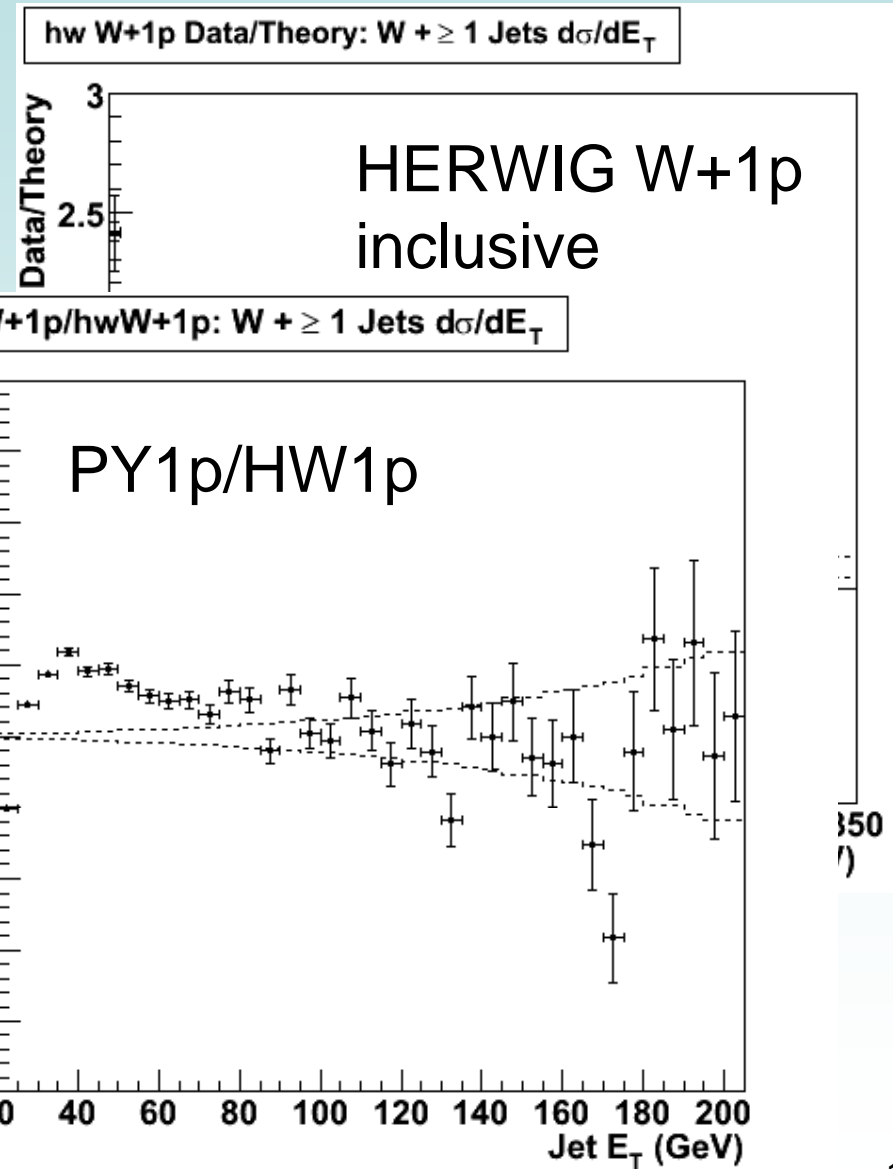
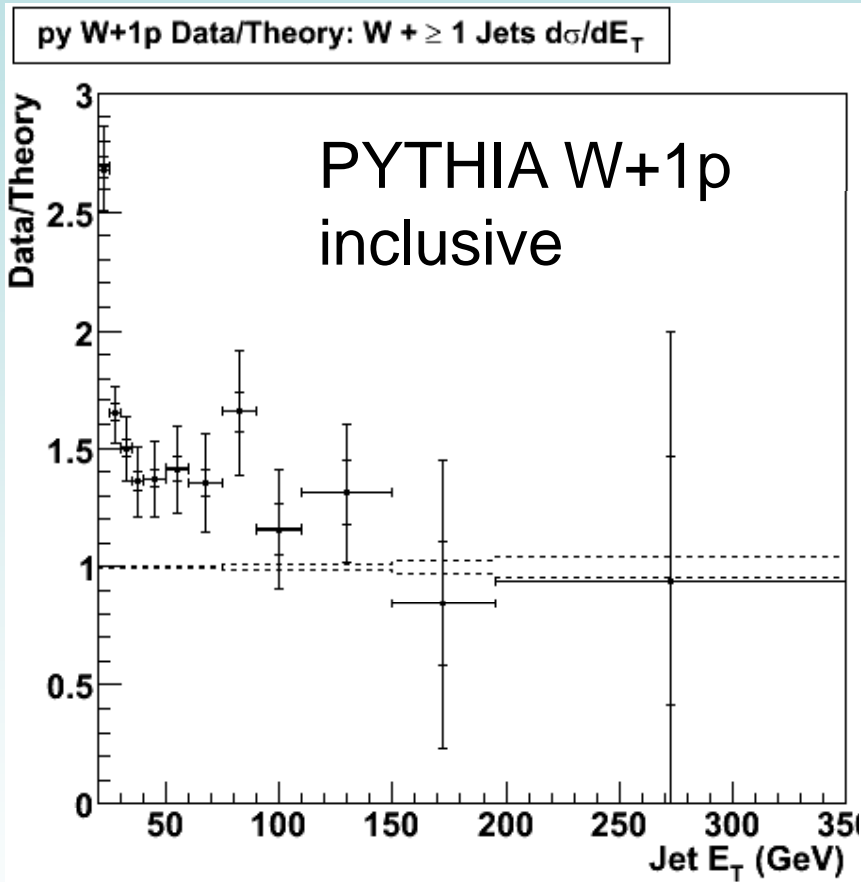
hw Data/Theory: $W + \geq 1$ Jets $d\sigma/dE_T$



pynoUE/py: $W + \geq 1$ Jets $d\sigma/dE_T$

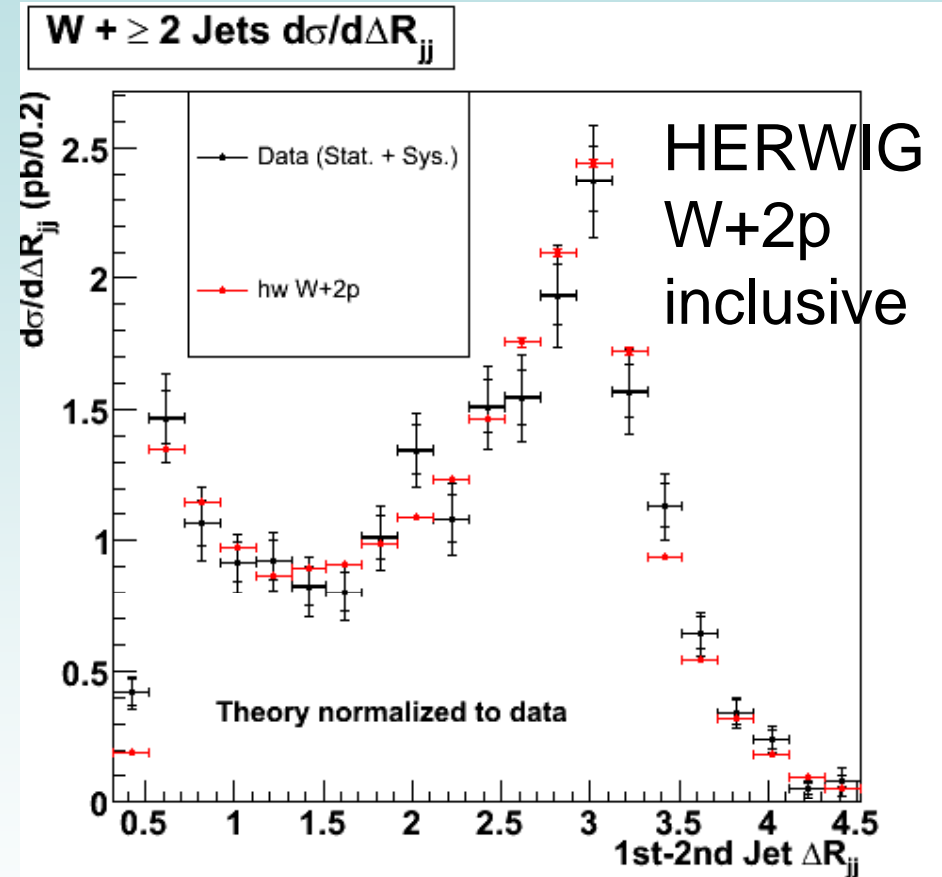
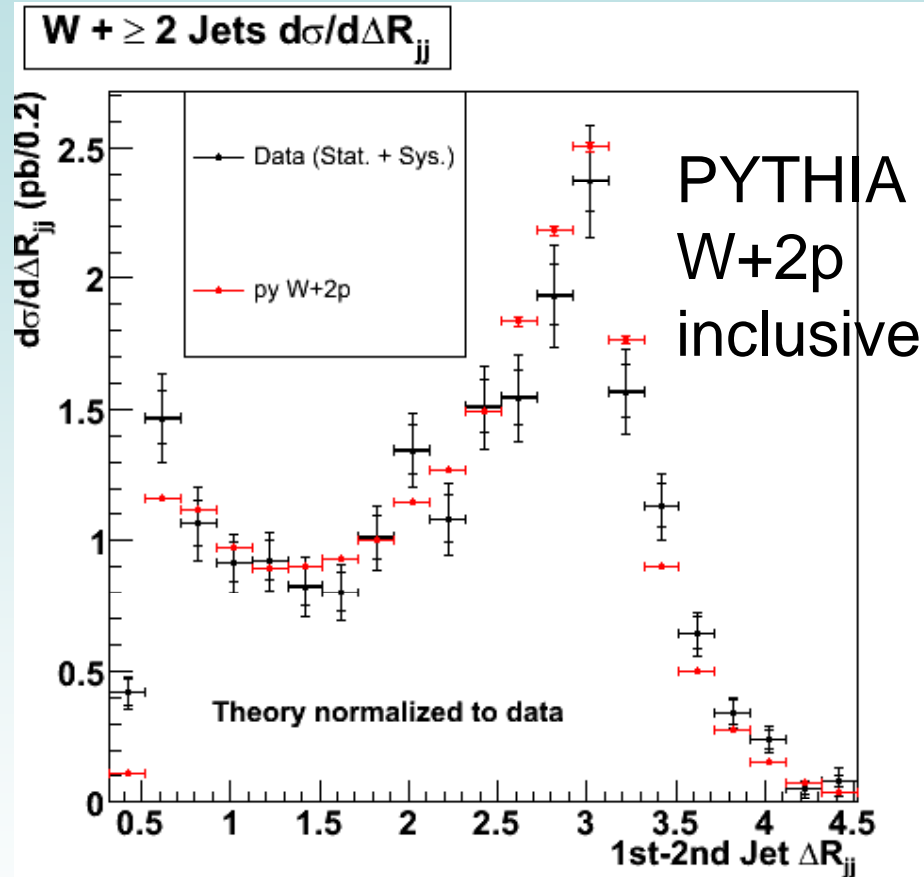


W+1p Inclusive Generation



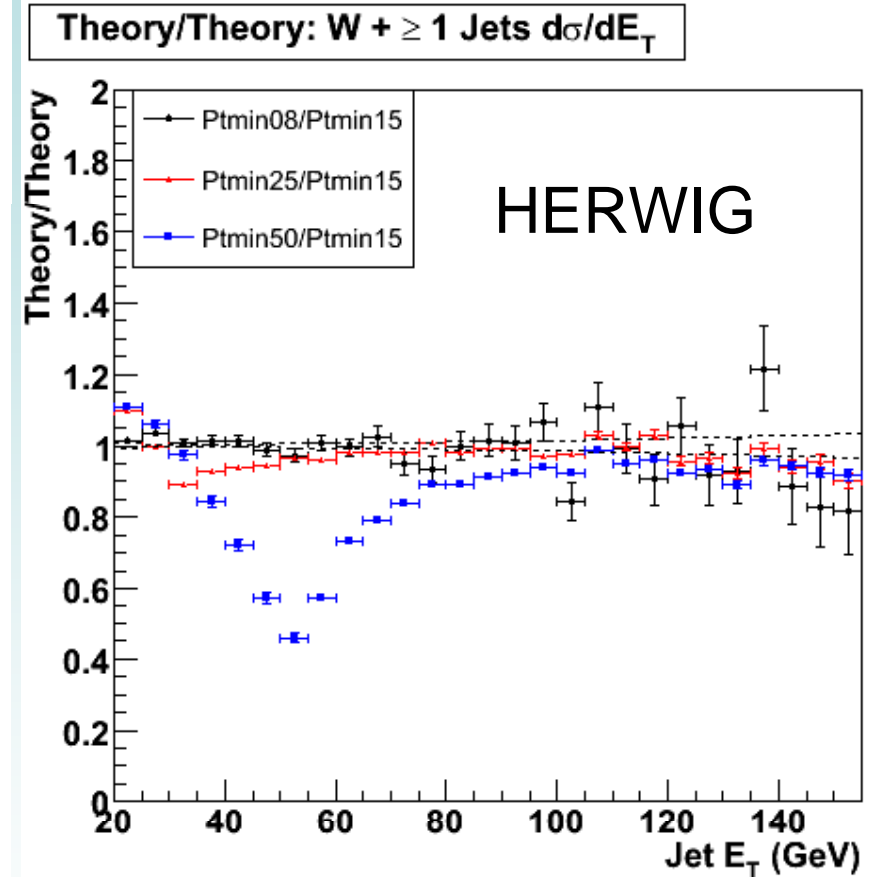
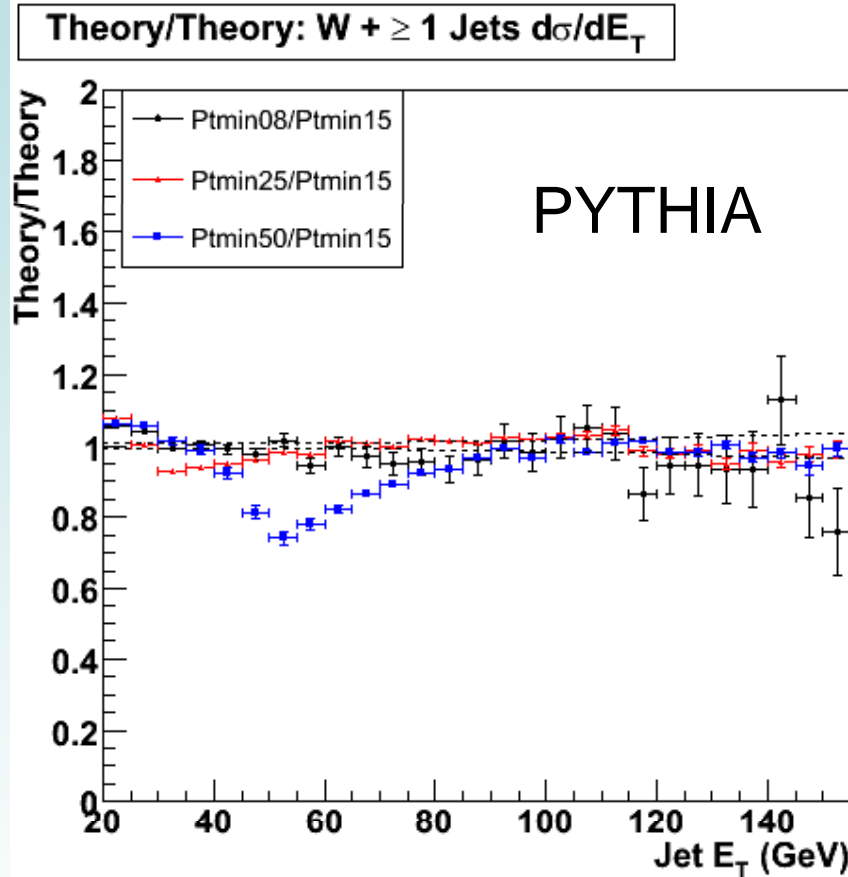
Pythia/Herwig differences
much smaller than for the
matched.

Herwig & Pythia vs Data: ΔR_{jj}

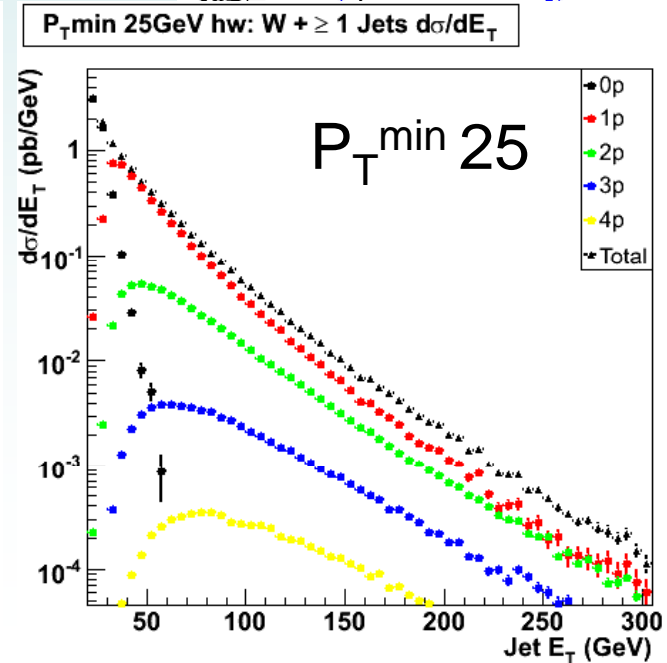
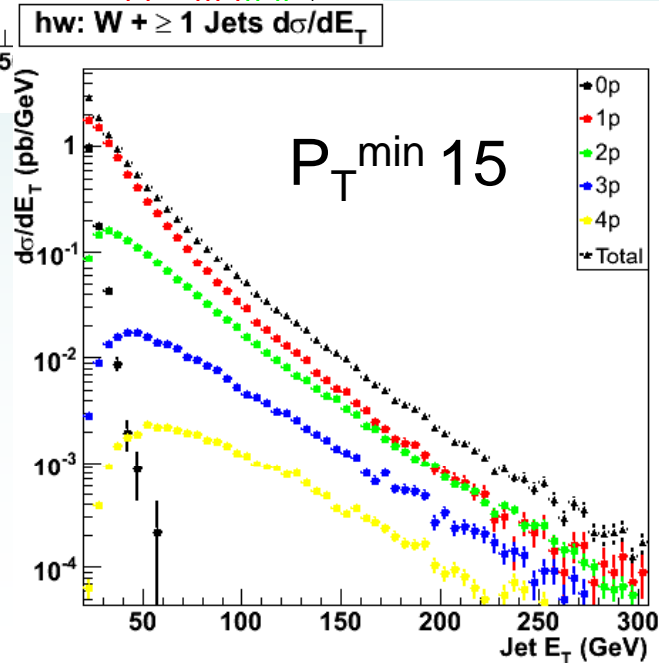
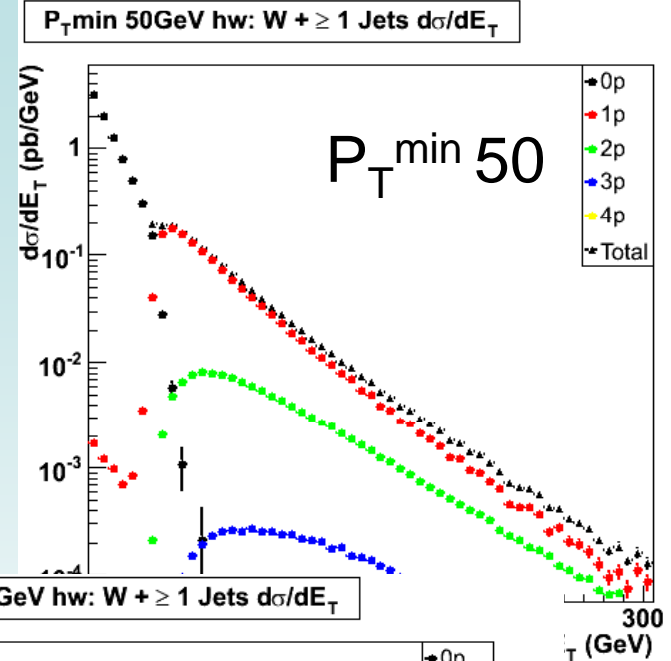
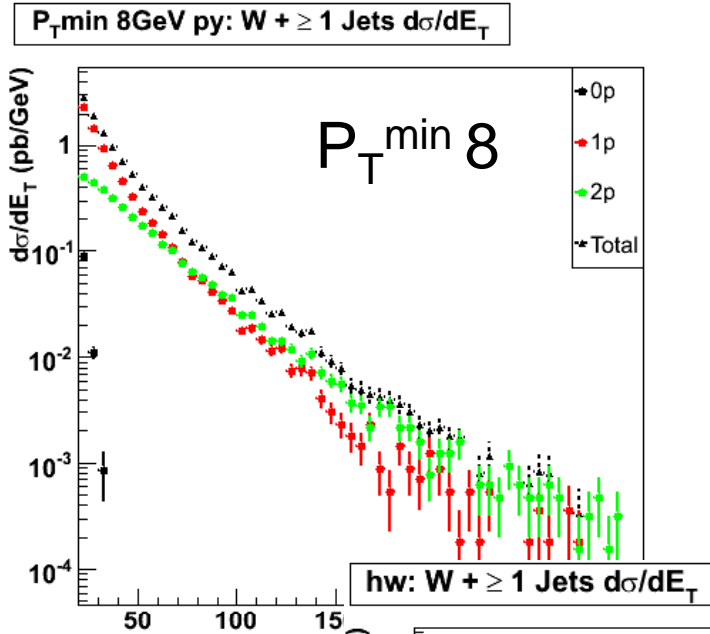


Dependence on parton P_T min
cut

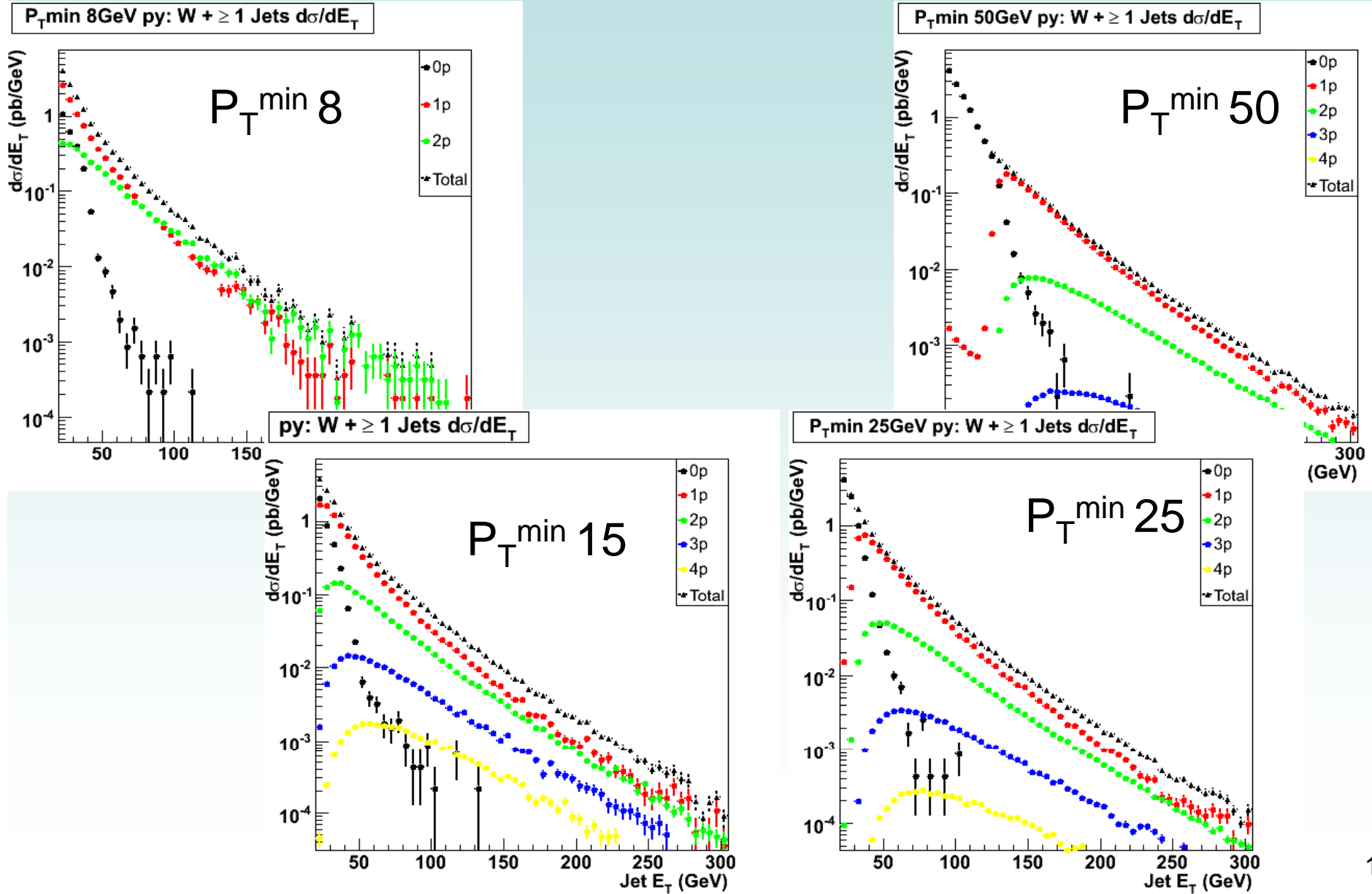
Lead $d\sigma/dE_T$: Pythia & Herwig



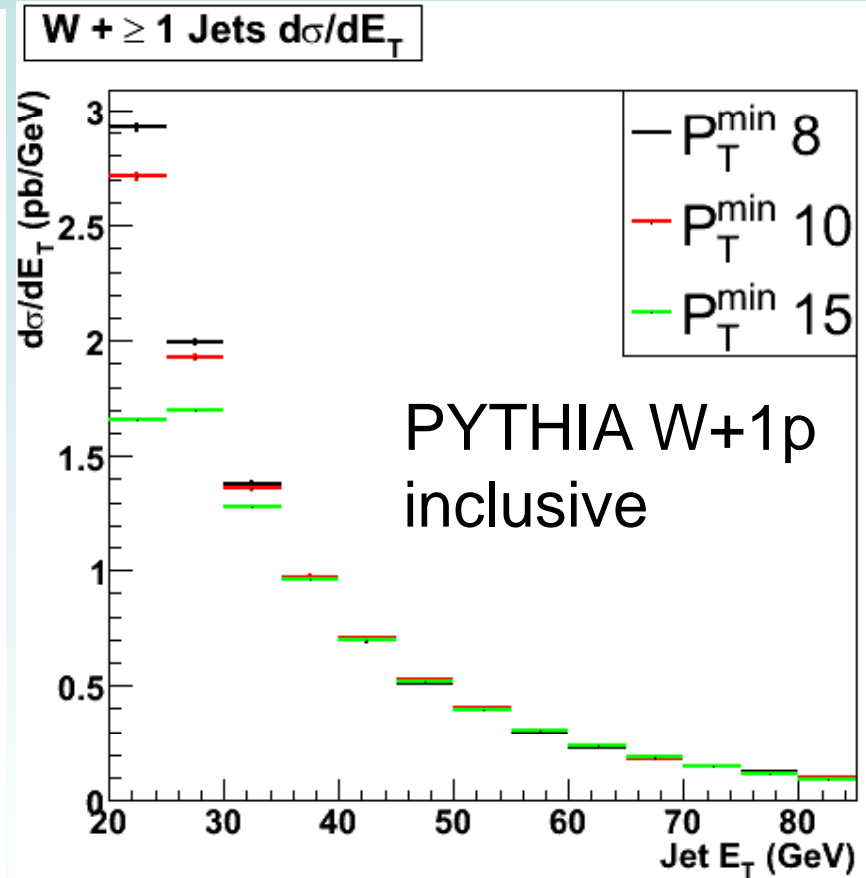
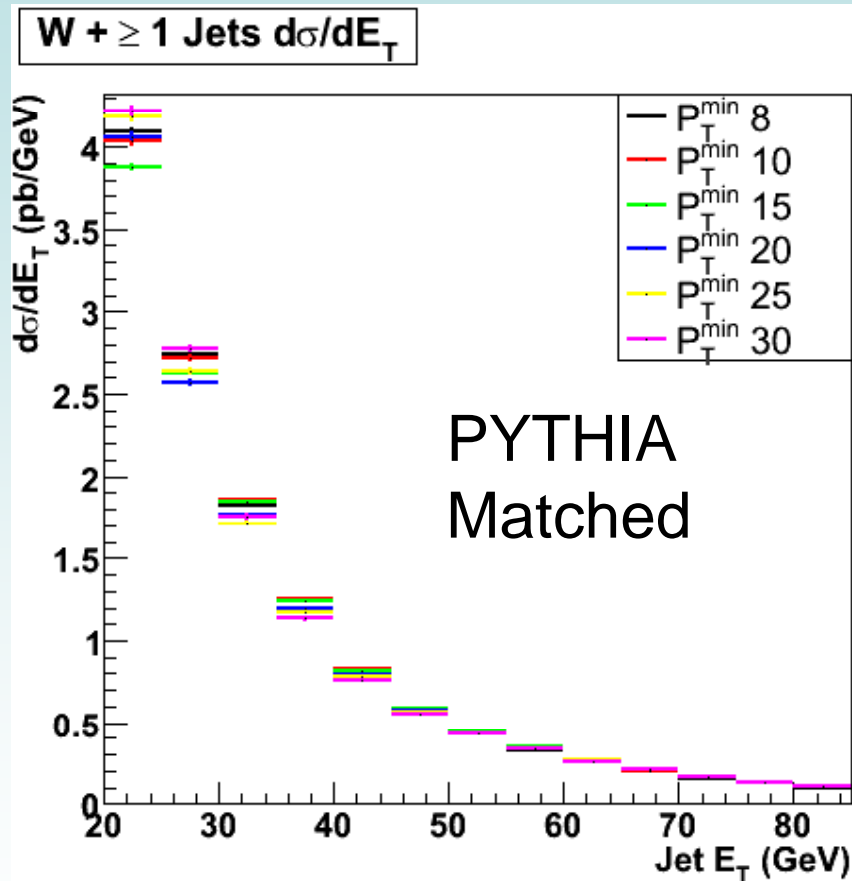
Herwig Stack Plots: Lead Jet E_T



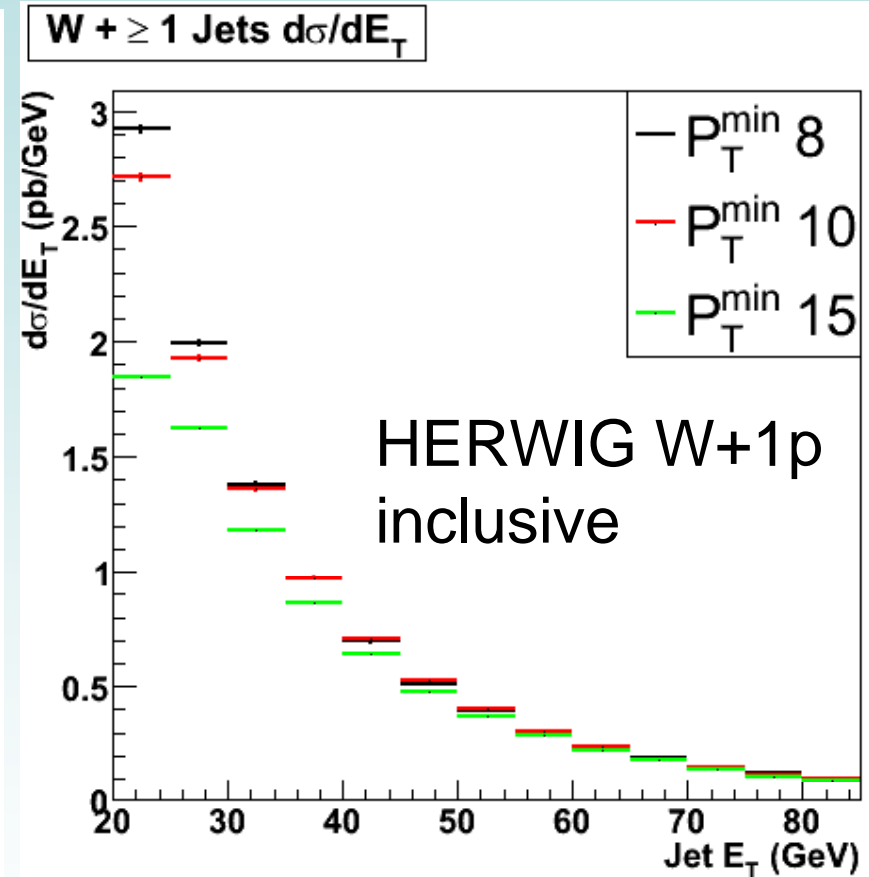
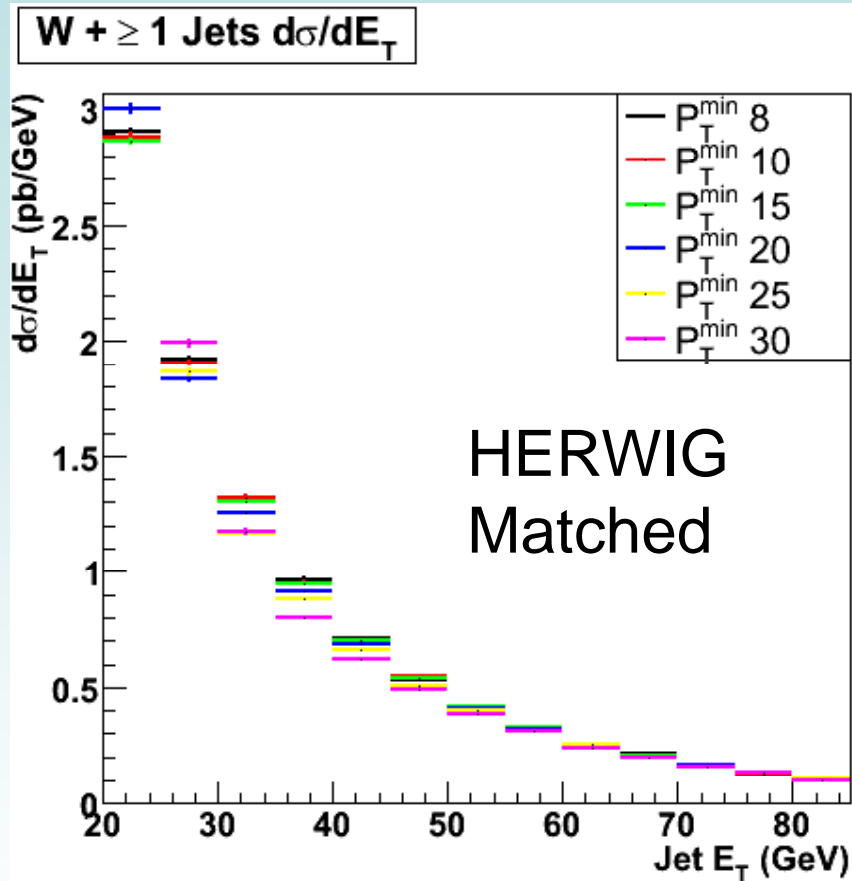
Pythia Stack Plots: Lead Jet E_T



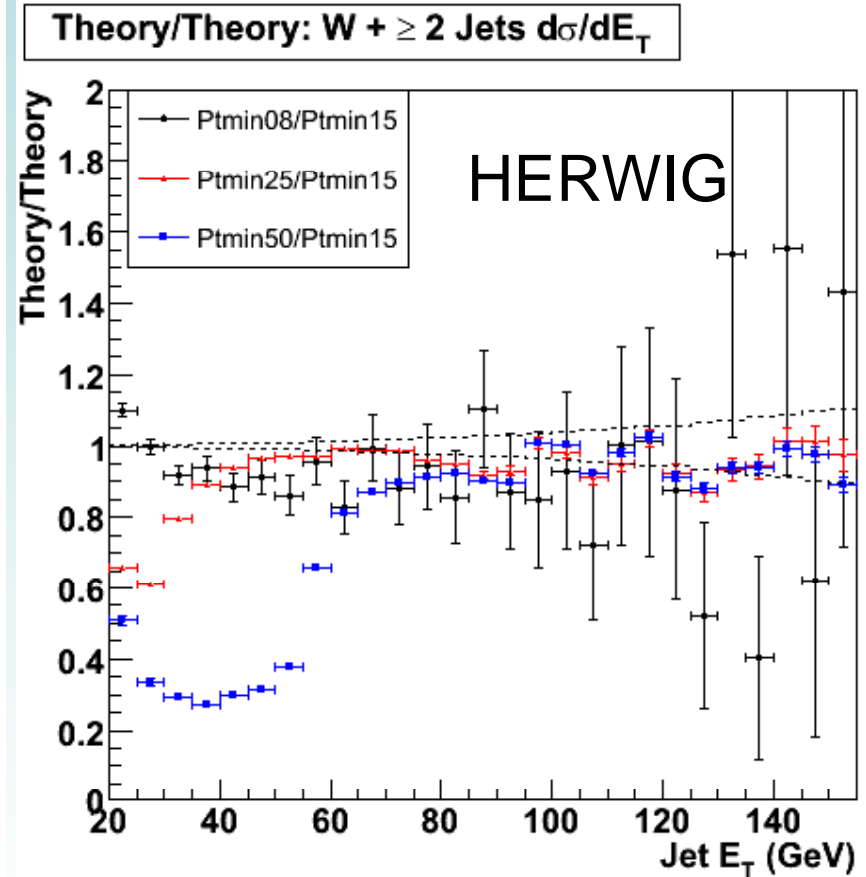
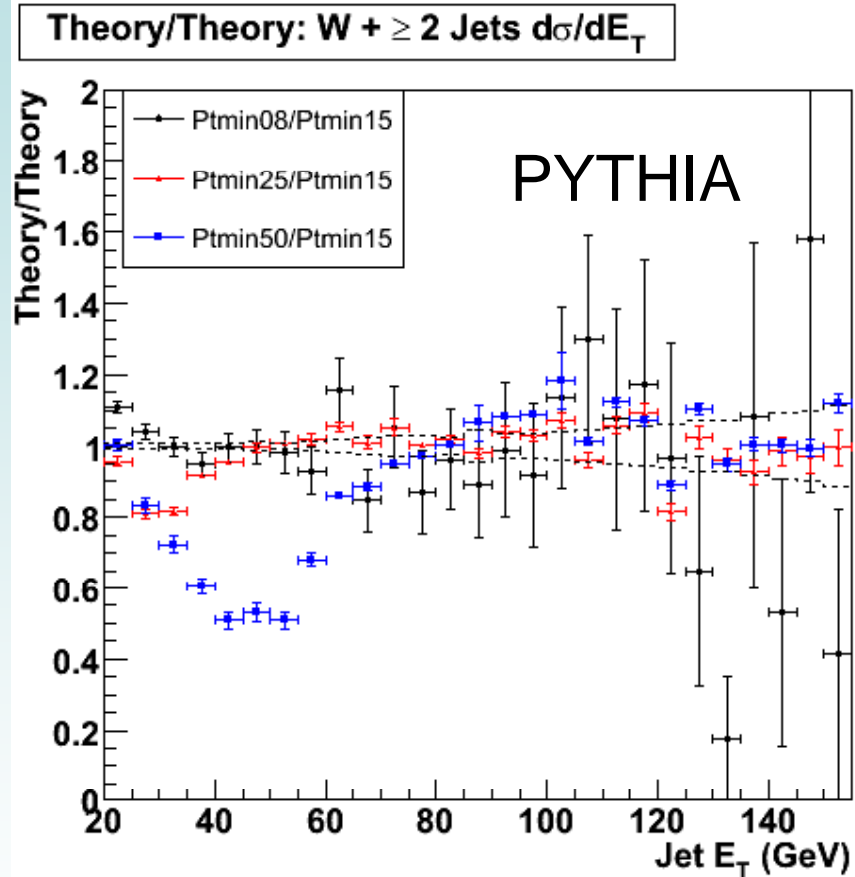
Lead Jet E_T : Scan of P_T^{\min}



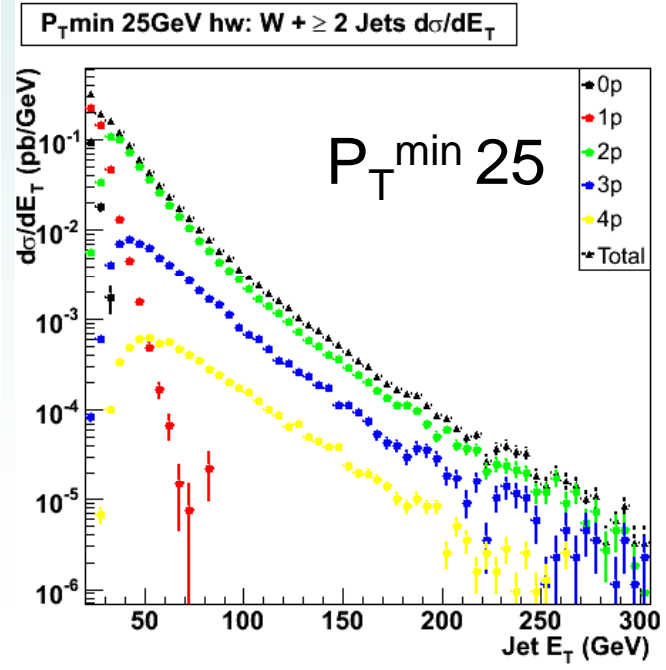
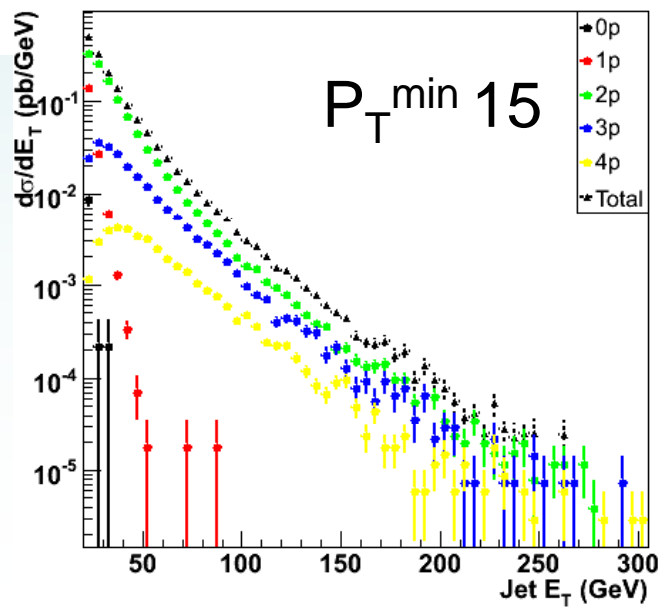
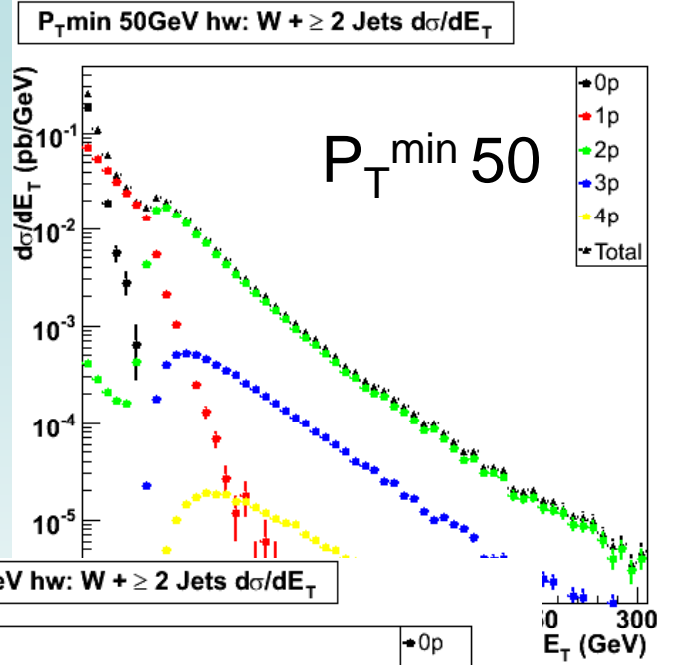
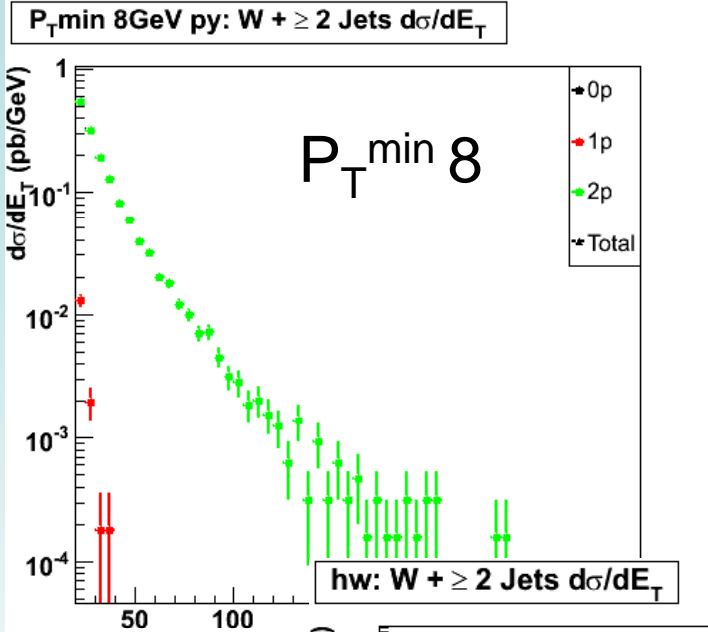
Lead Jet E_T : Scan of P_T^{\min}



2nd $d\sigma/dE_T$: Pythia & Herwig

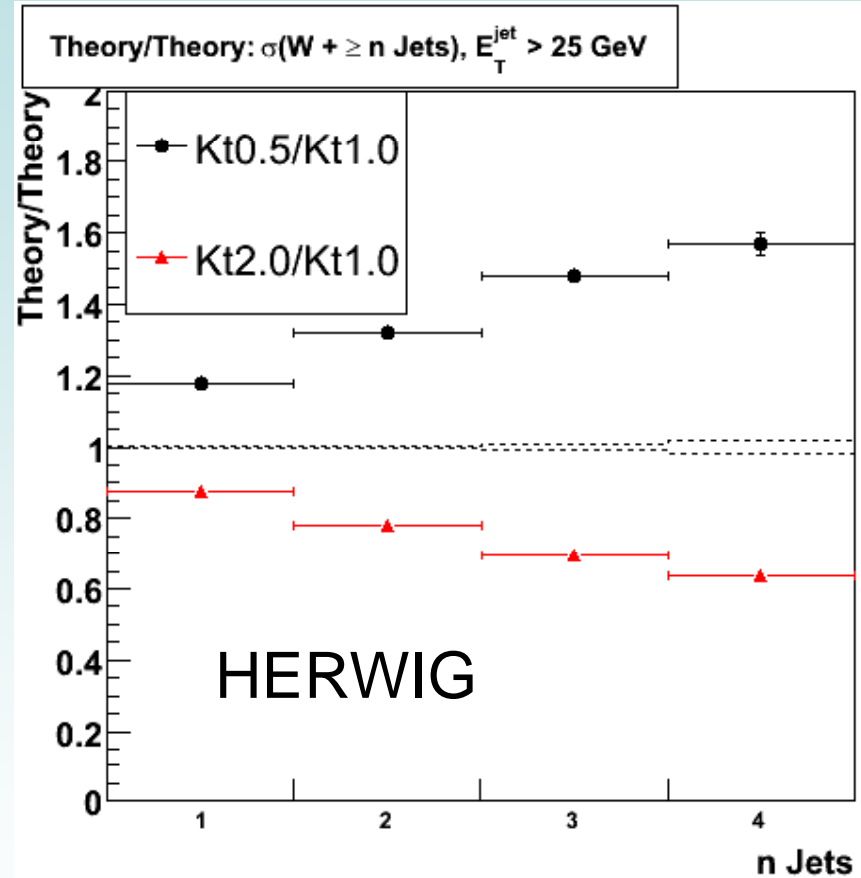
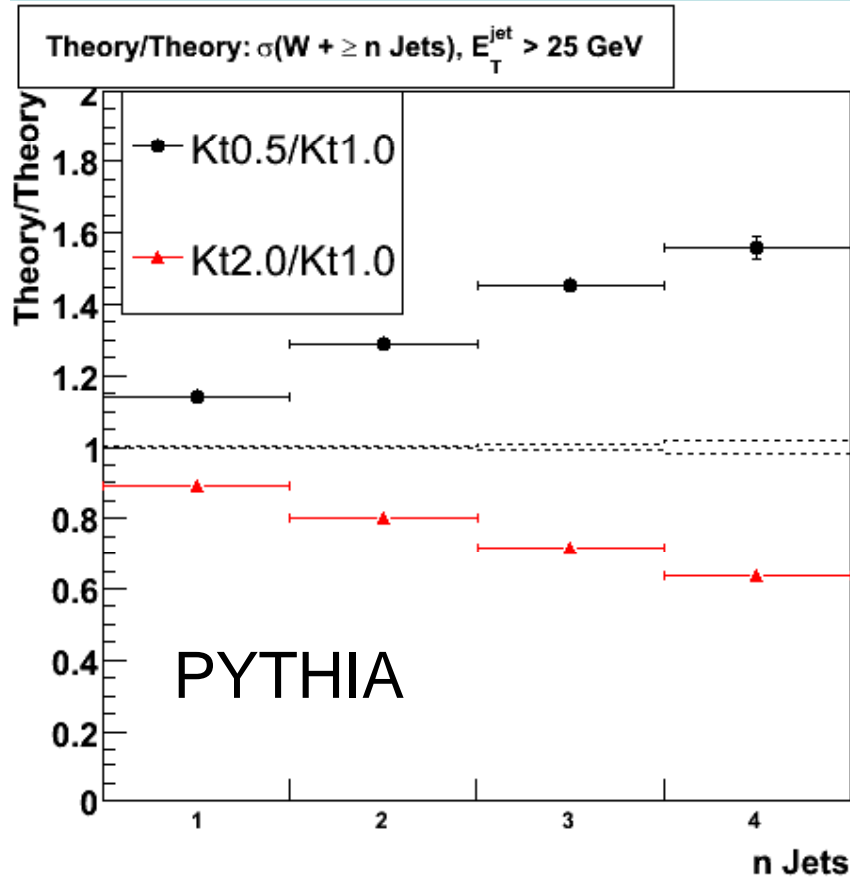


Herwig Stack Plots: 2nd Jet E_T



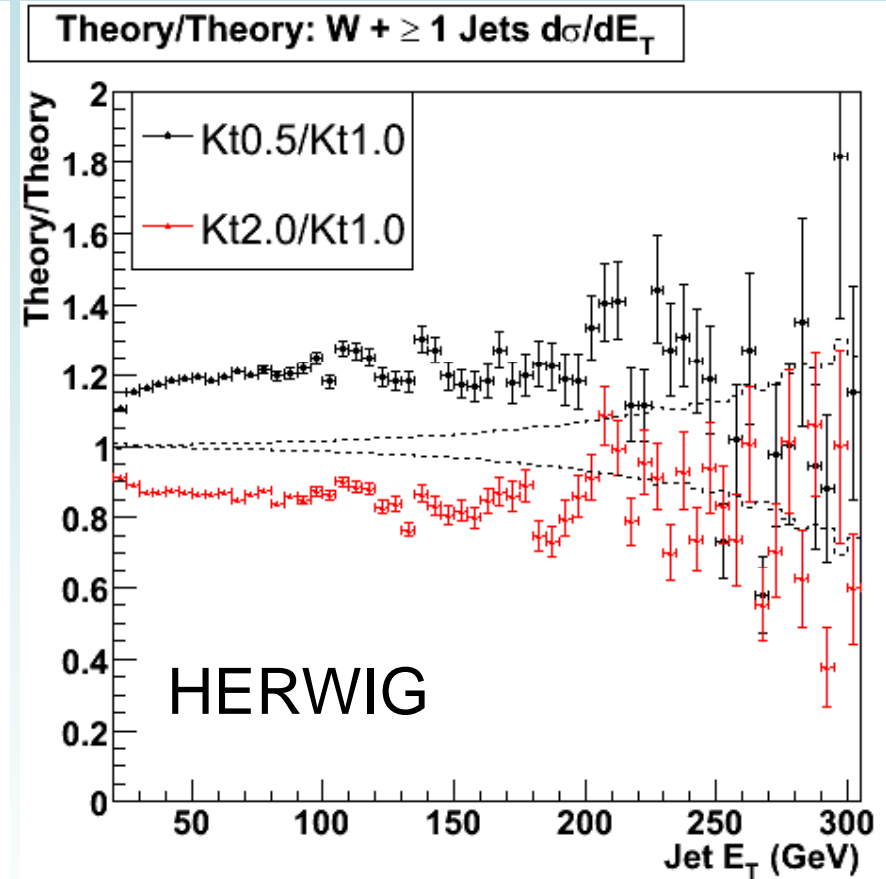
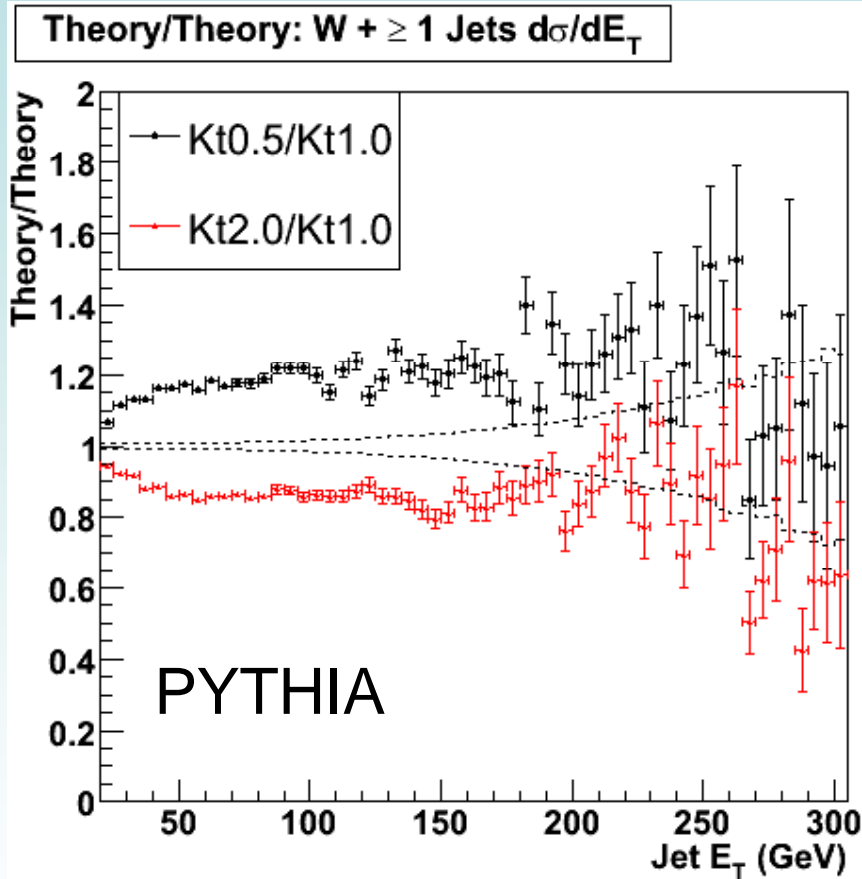
Dependence on CKKW vertex
 K_T factor

Comparing different K_T factors

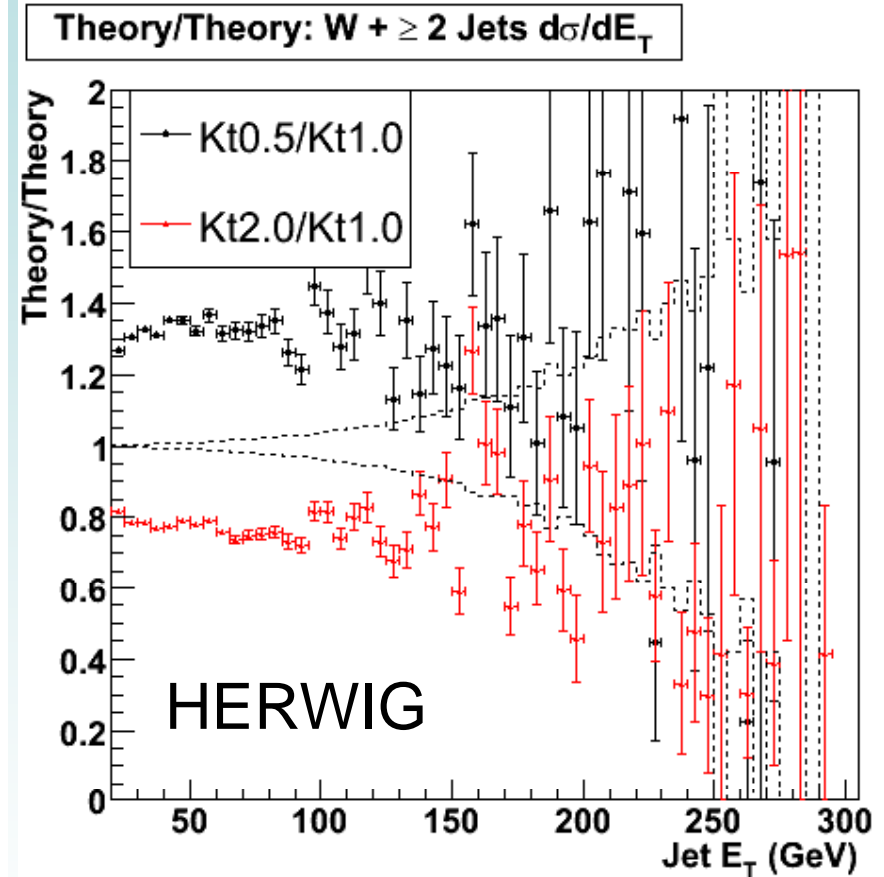
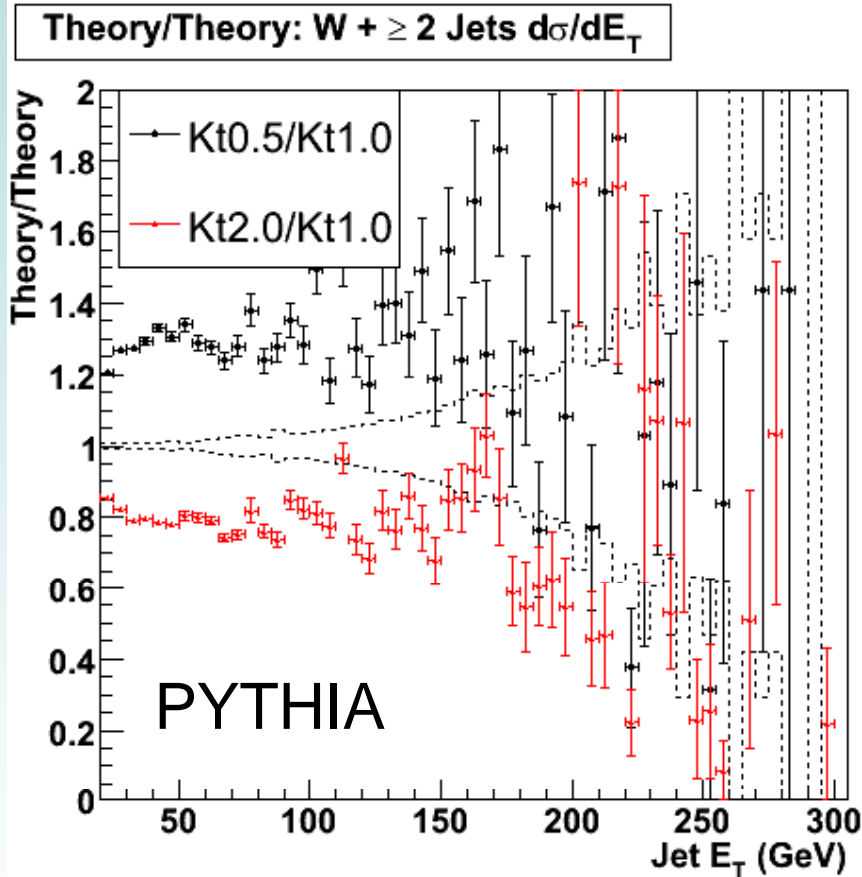


See change in njet rates - greater for larger njets

Comparing different K_T factors

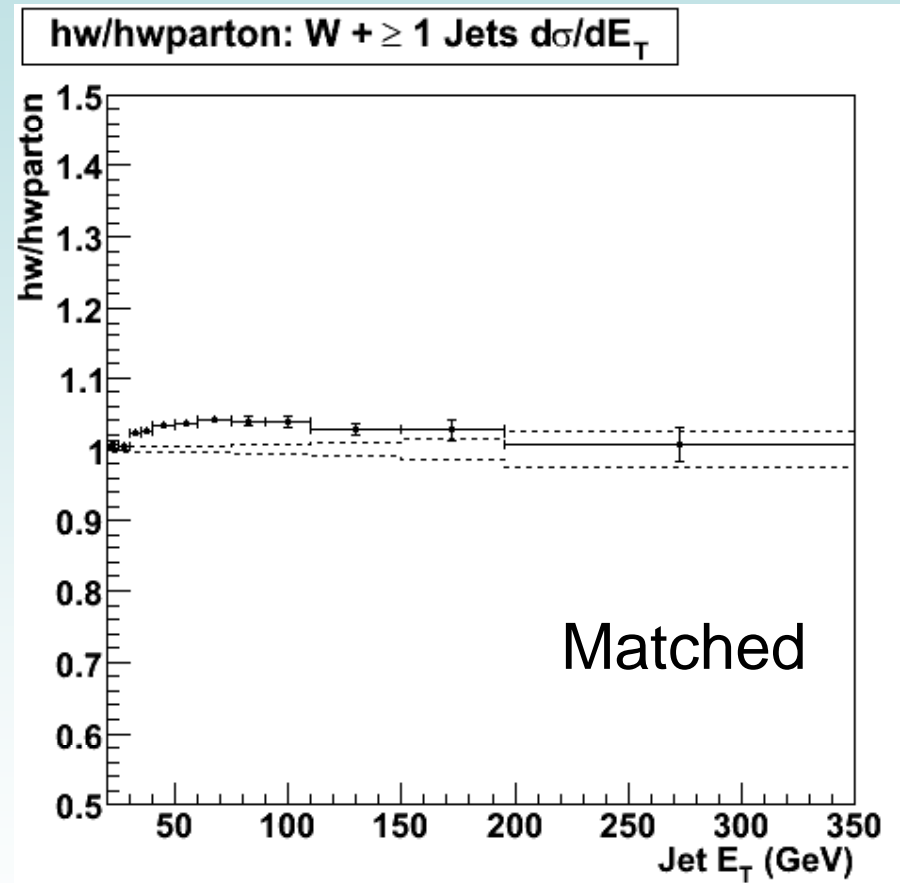
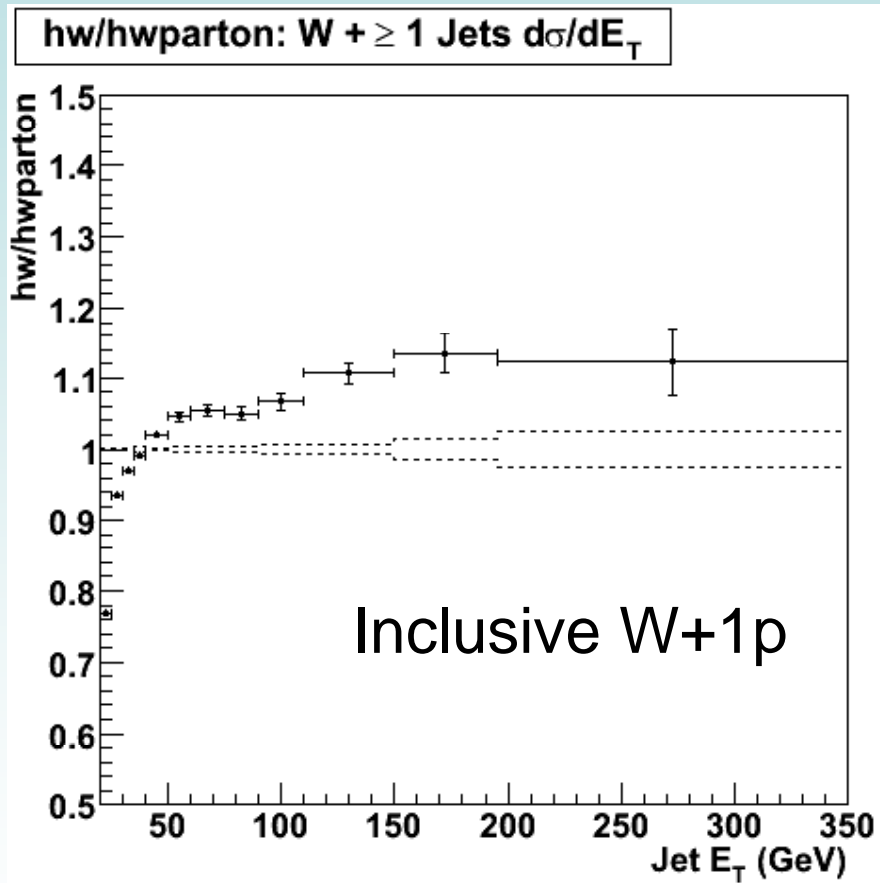


Comparing different K_T factors

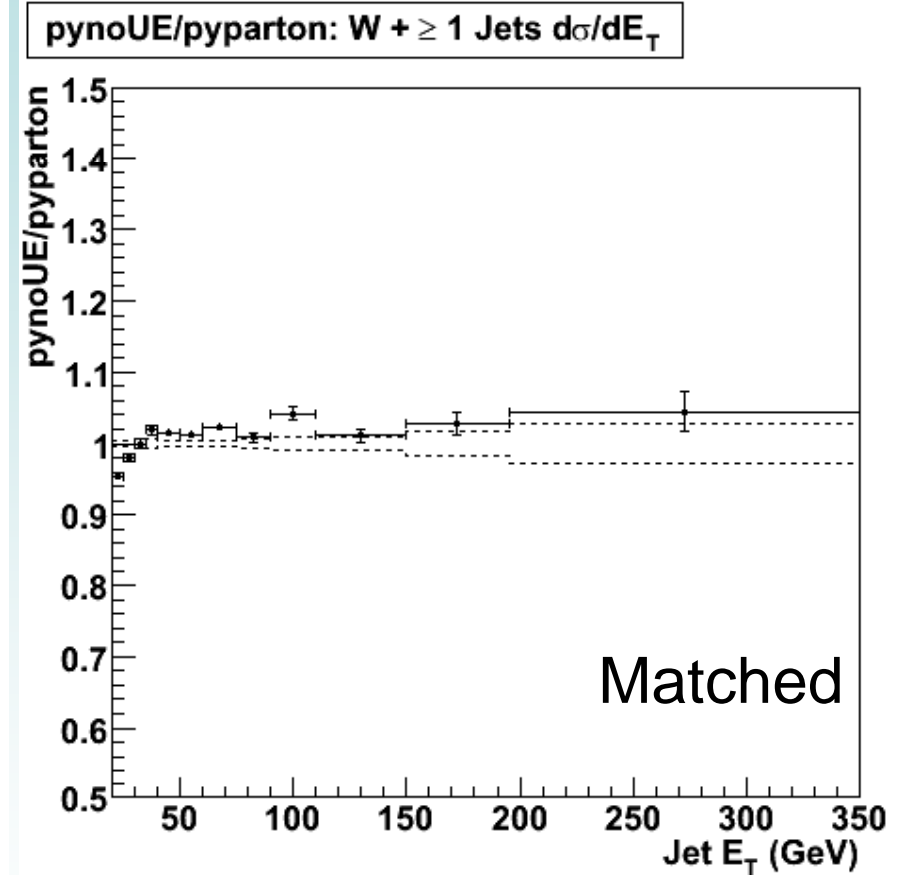
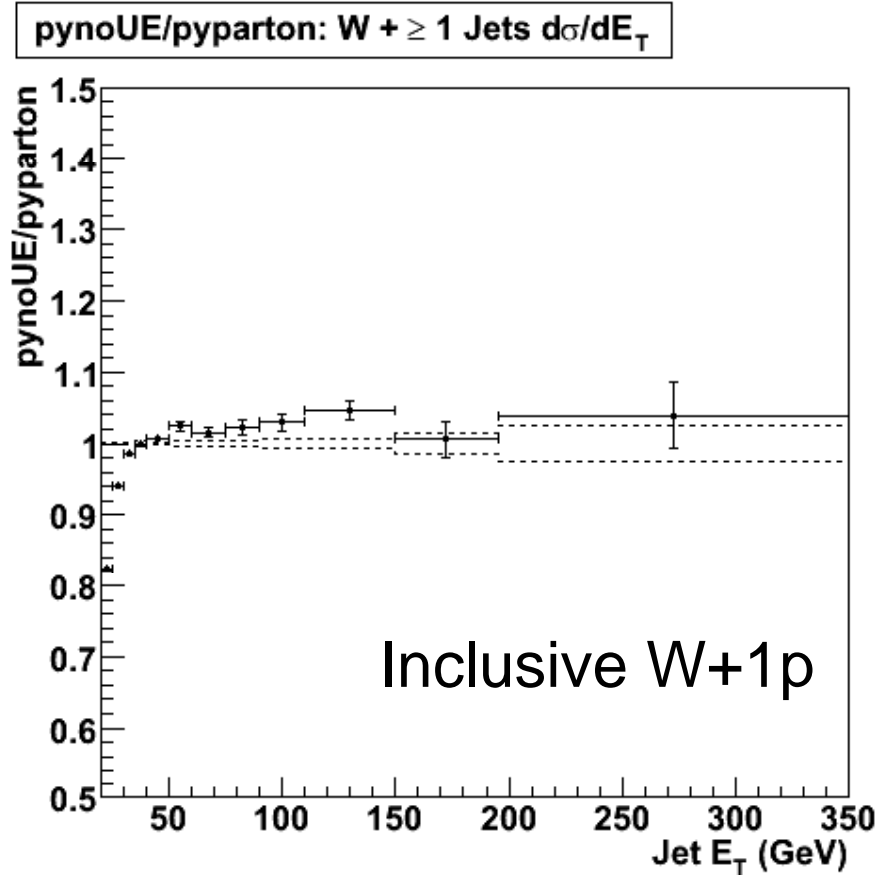


Hadron-level to Parton-level relationship

Herwig



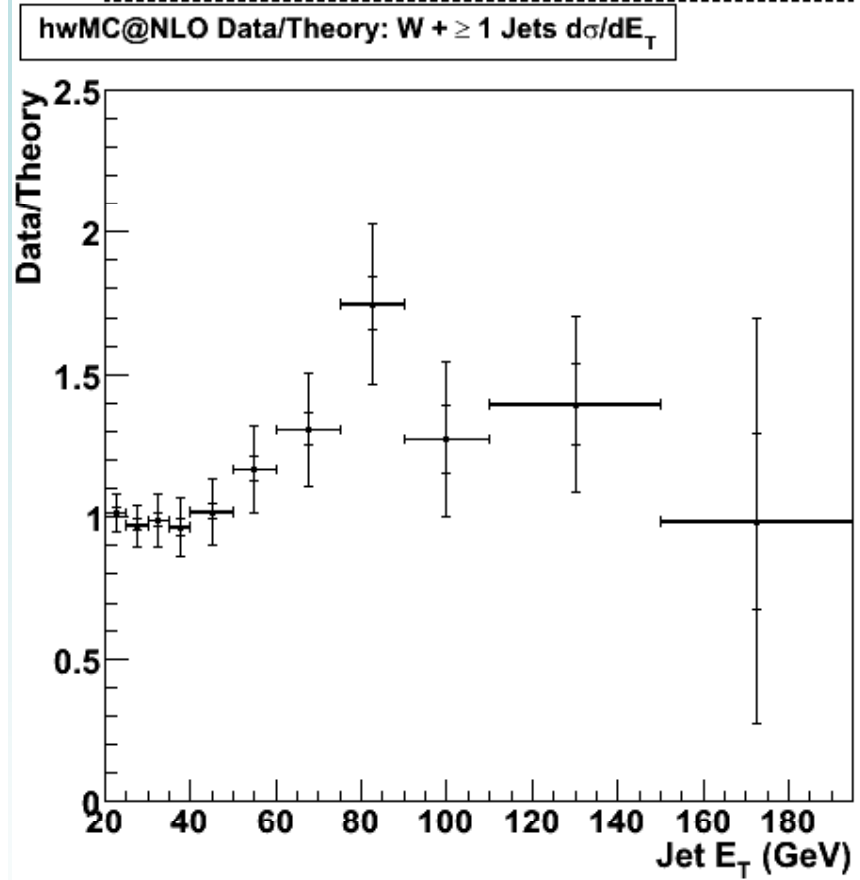
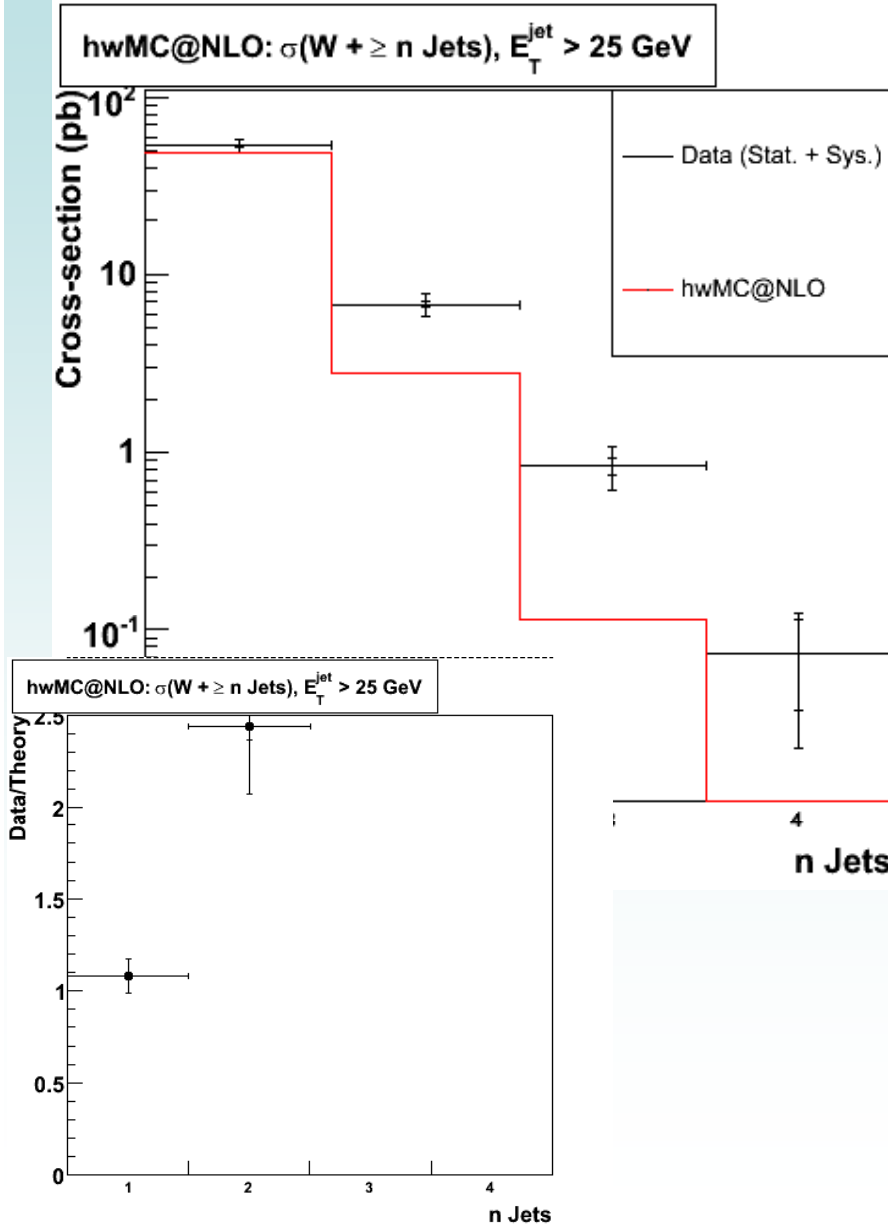
Pythia UE turned “off”



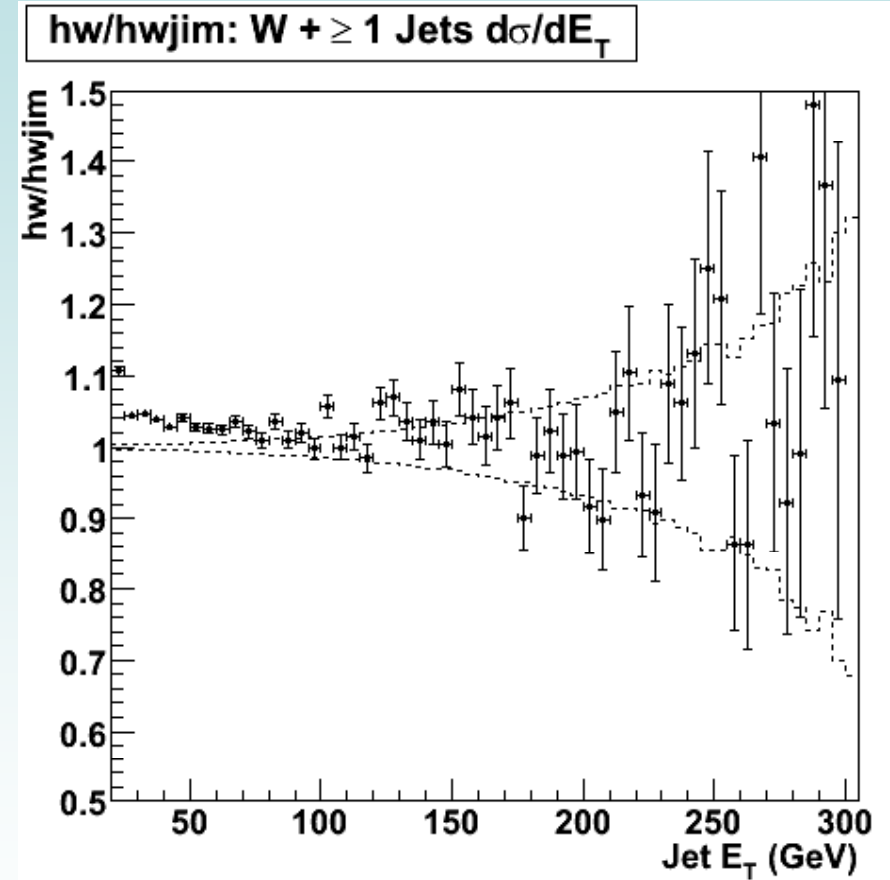
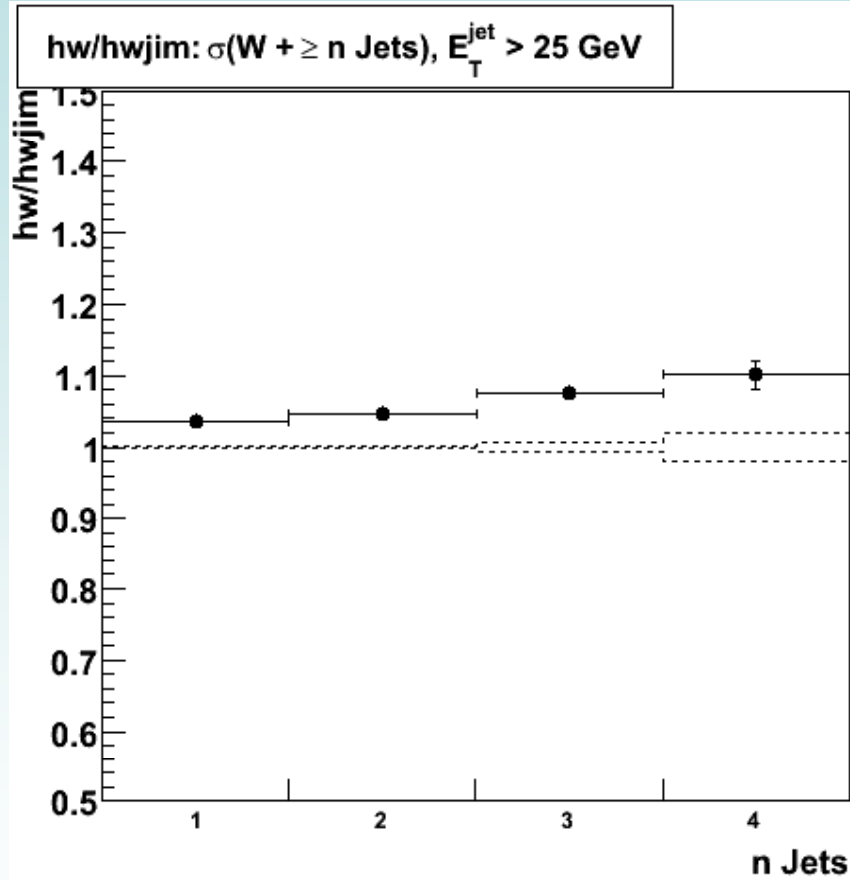
Work-In-Progress

Things we have tried but don't
fully understand yet.

MC@NLO Herwig



Herwig + Jimmy

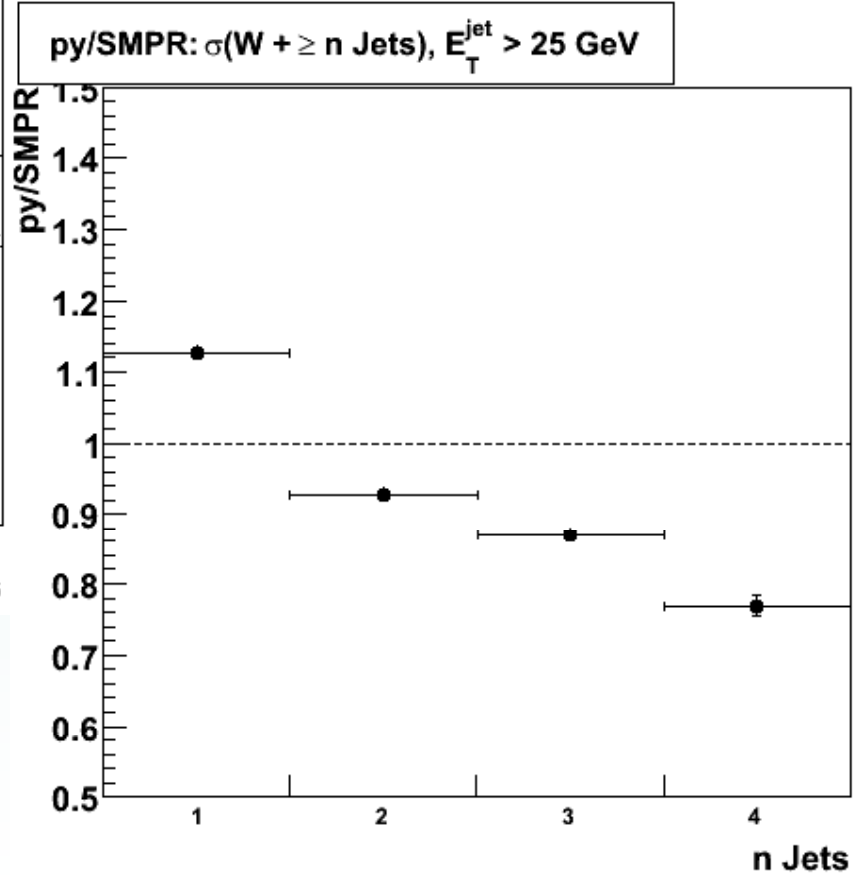
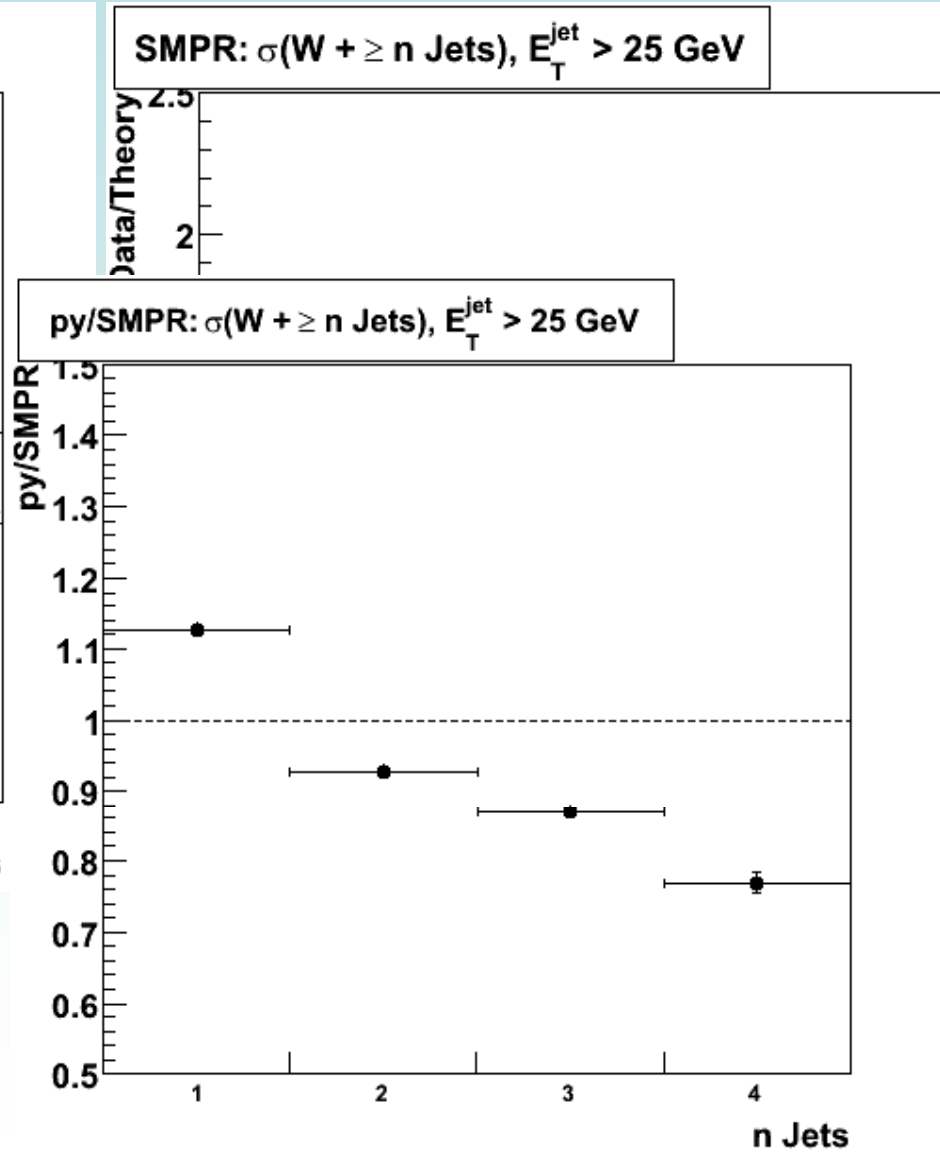
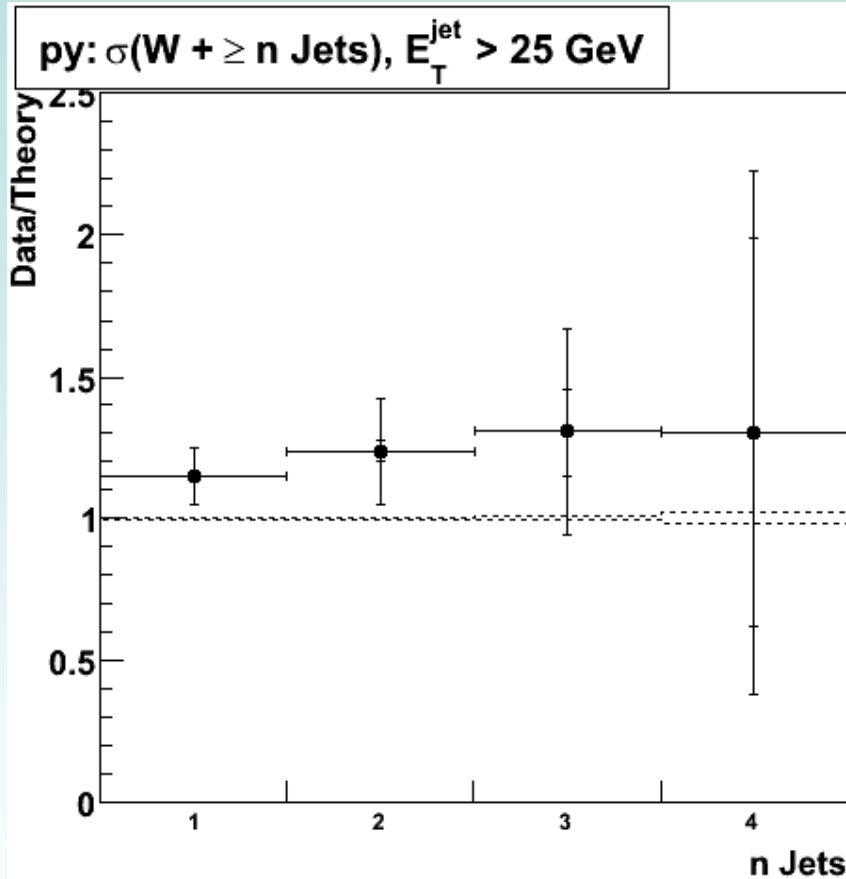


Future plans

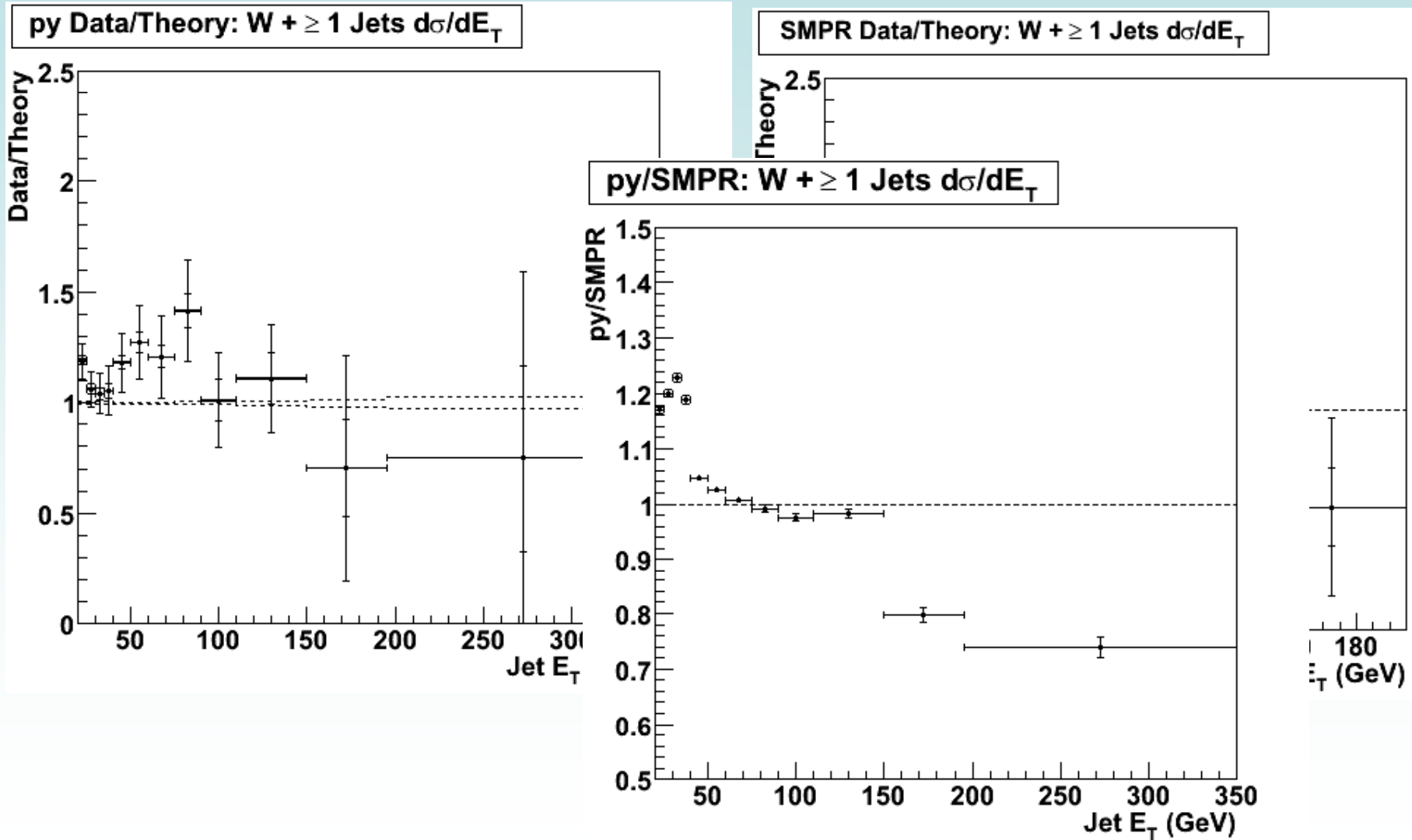
- What is the source of the difference between matched Pythia and Herwig?
- To what extent are matched predictions independent of generation cuts?
- Investigate different UE tunes - Pythia v2 Tunes, v3 tunes, Jimmy.
- Examine further ΔR_{jj} distributions.
- Look at different approaches: MadEvent, [MC@NLO](#), Sherpa.
- Repeat studies at LHC energies.

Backups

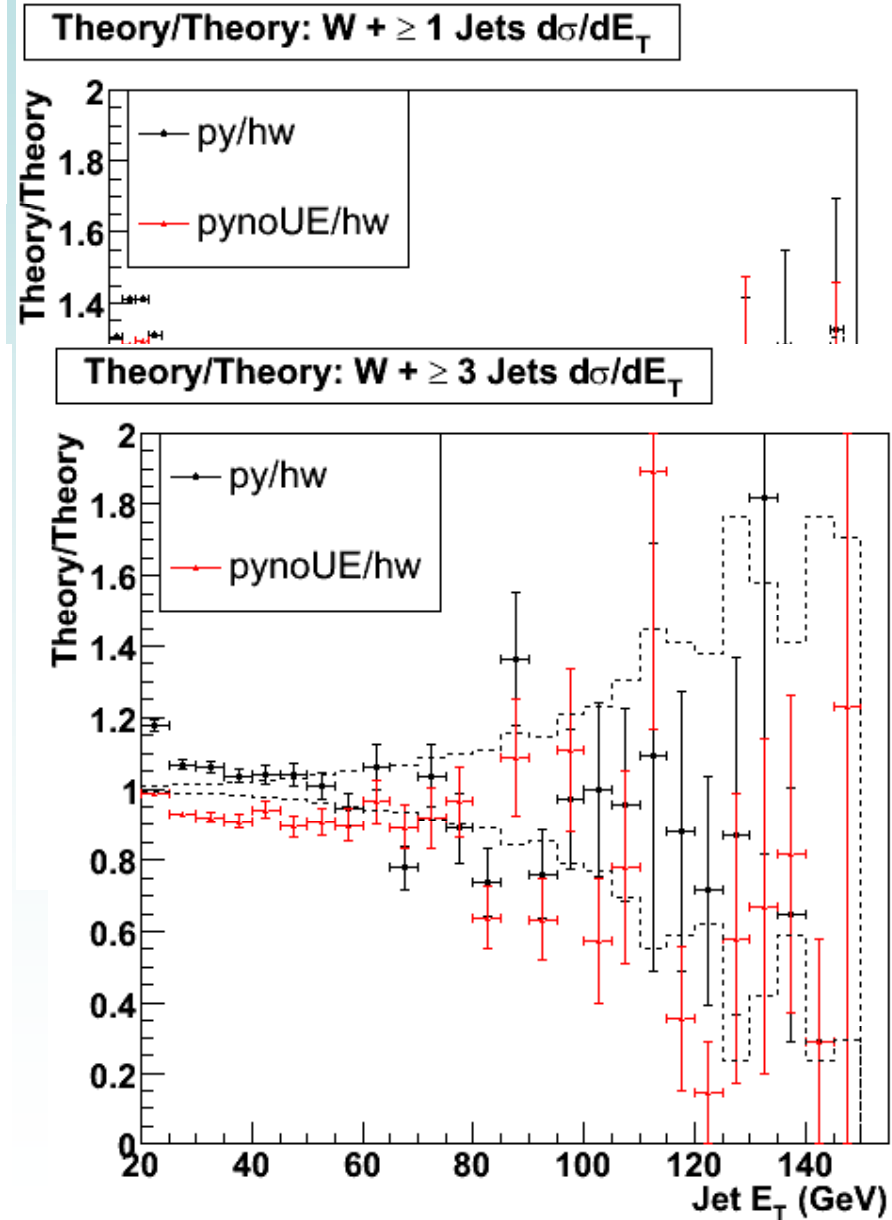
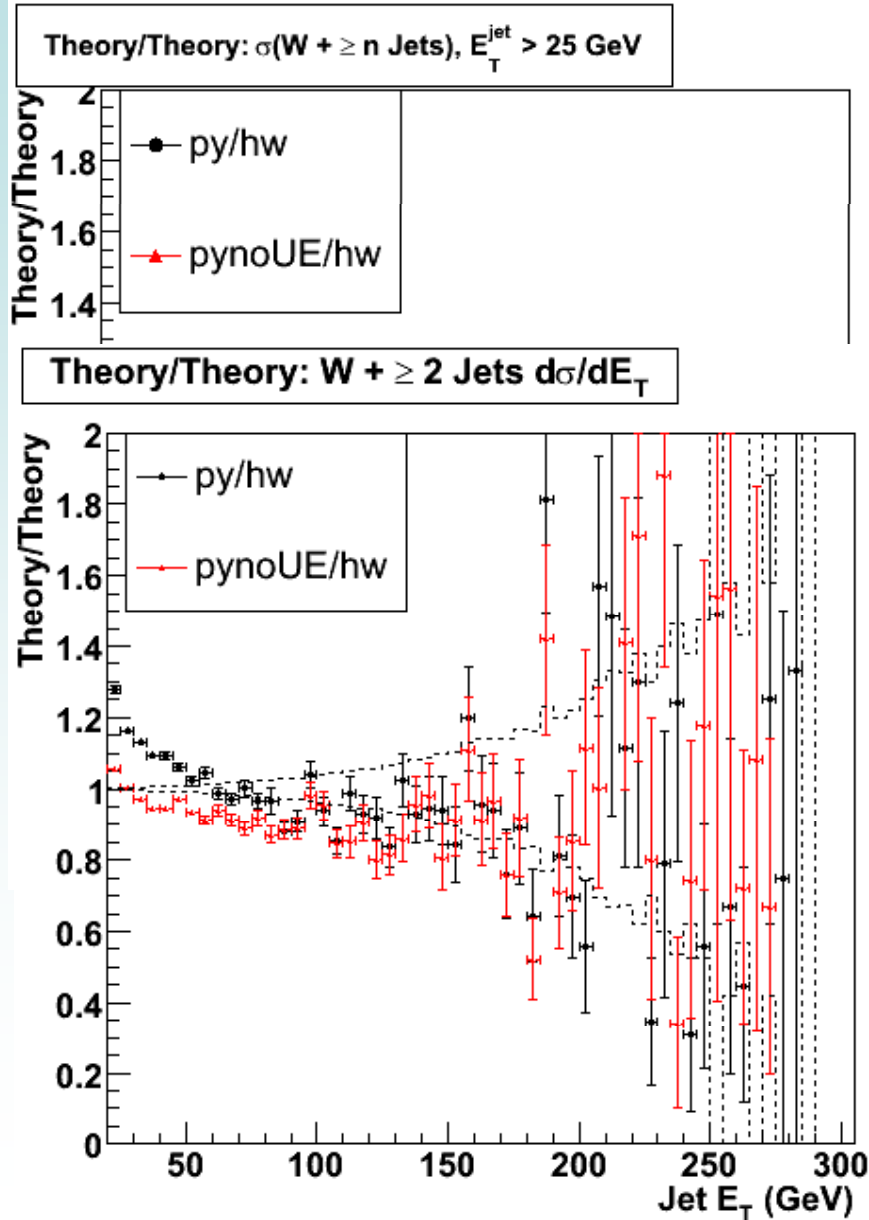
SMPR vs Alpgen + Pythia



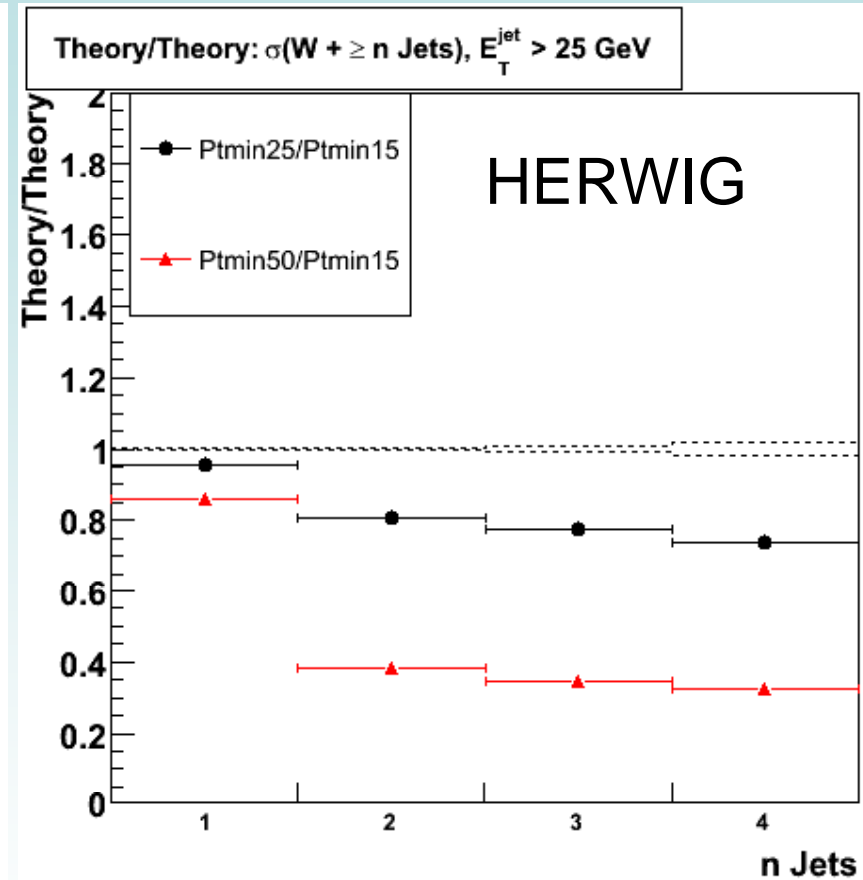
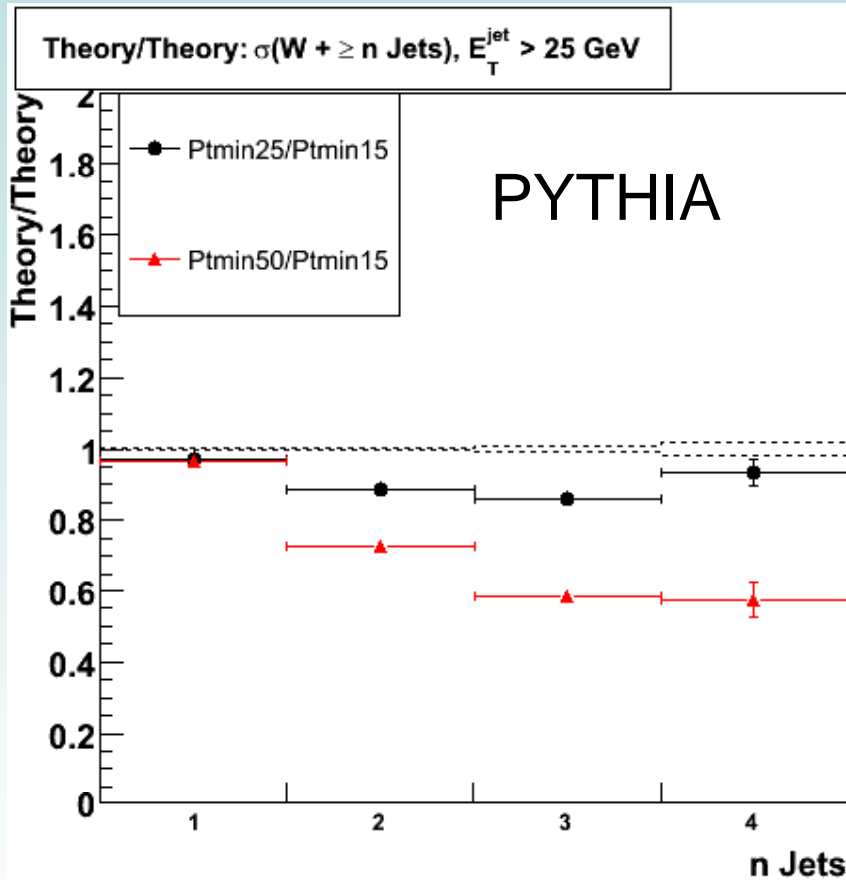
SMPR vs Alpgen + Pythia



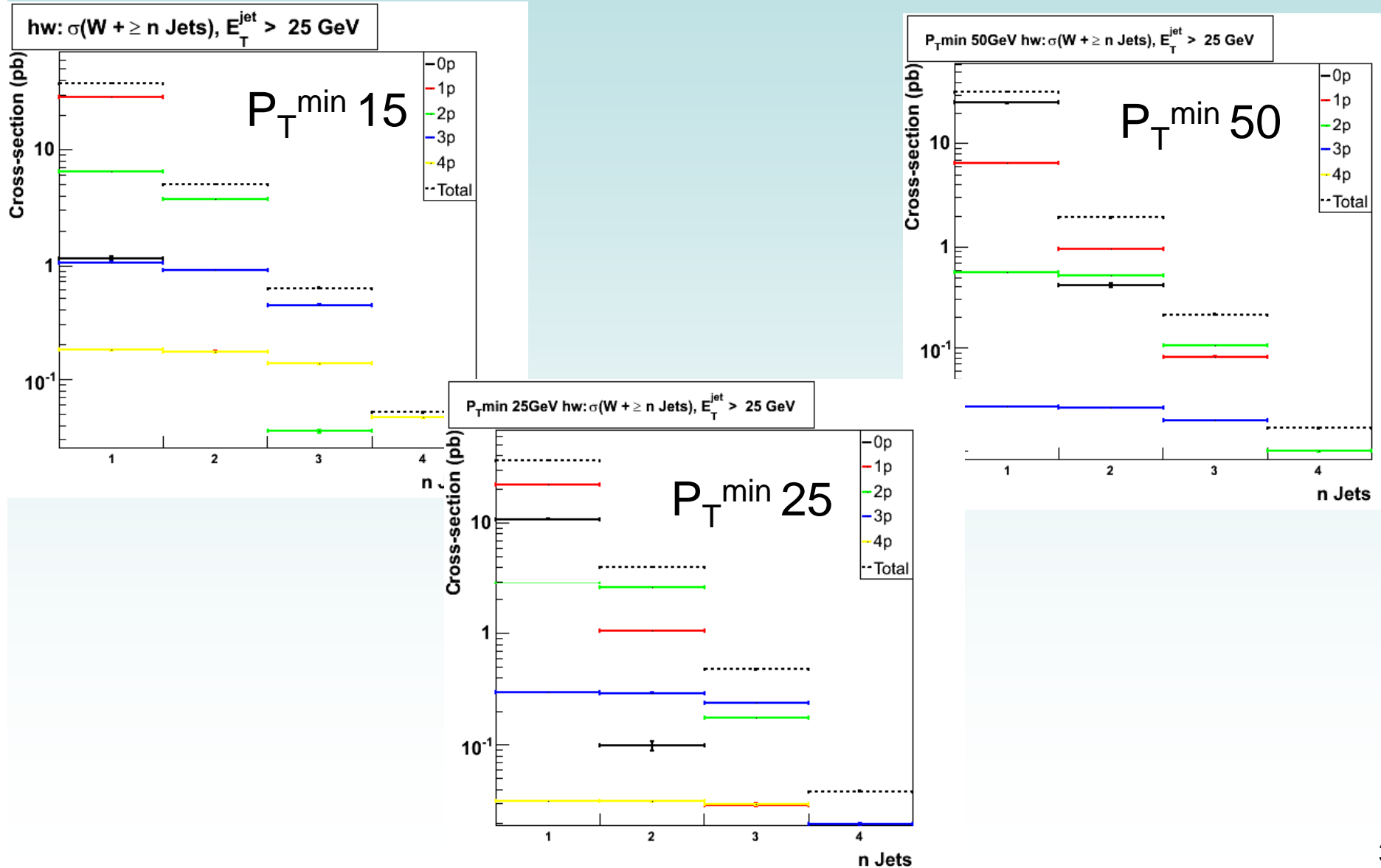
Turning UE “off” in Pythia



W + $\geq n$ jet Pythia & Herwig

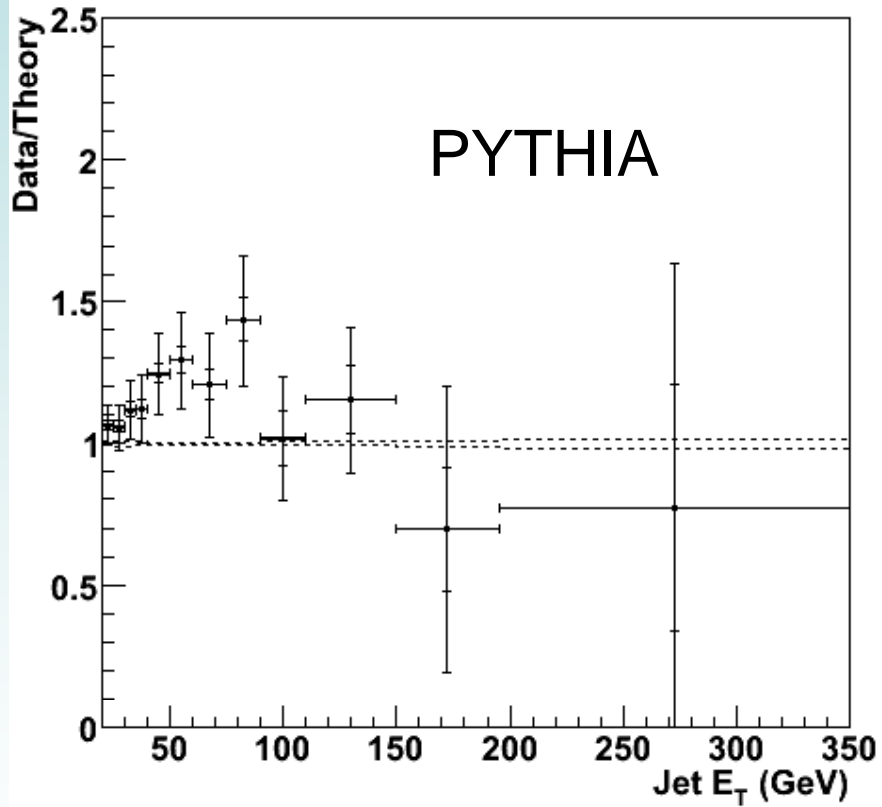


Herwig Stack Plots

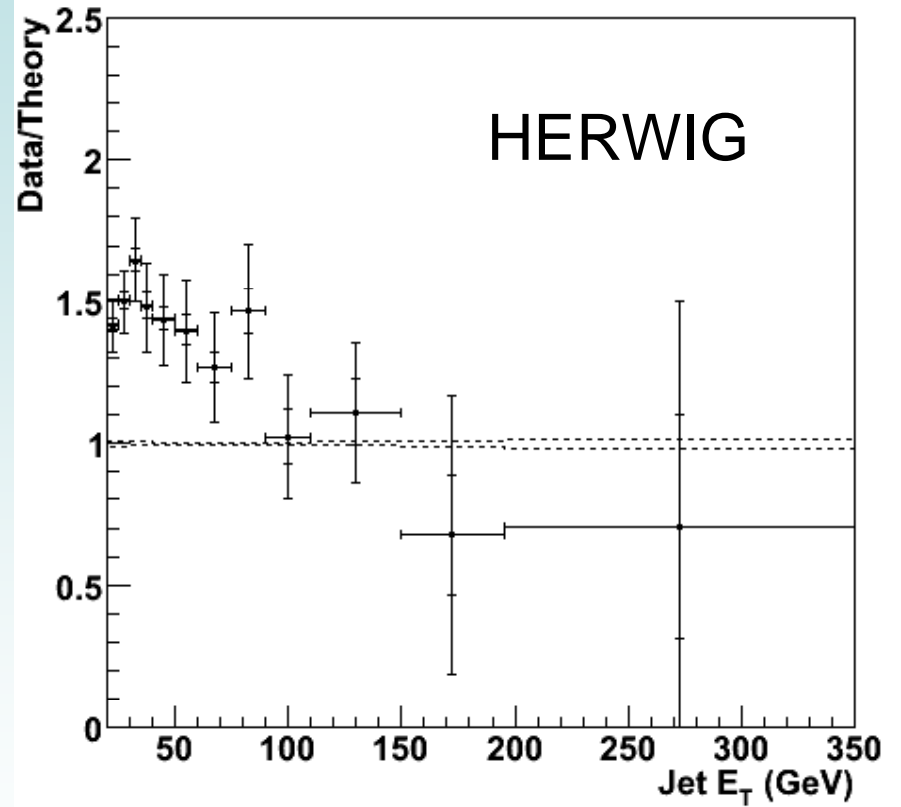


Ptmin 25 vs data

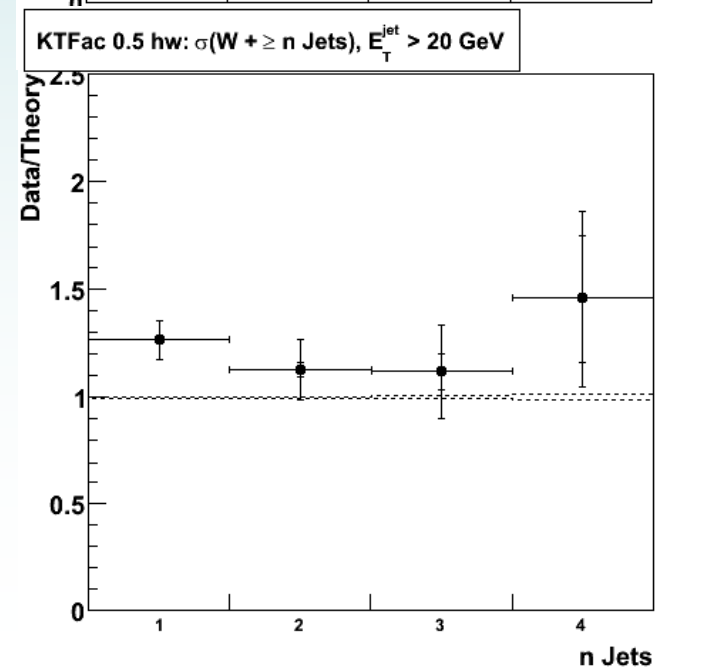
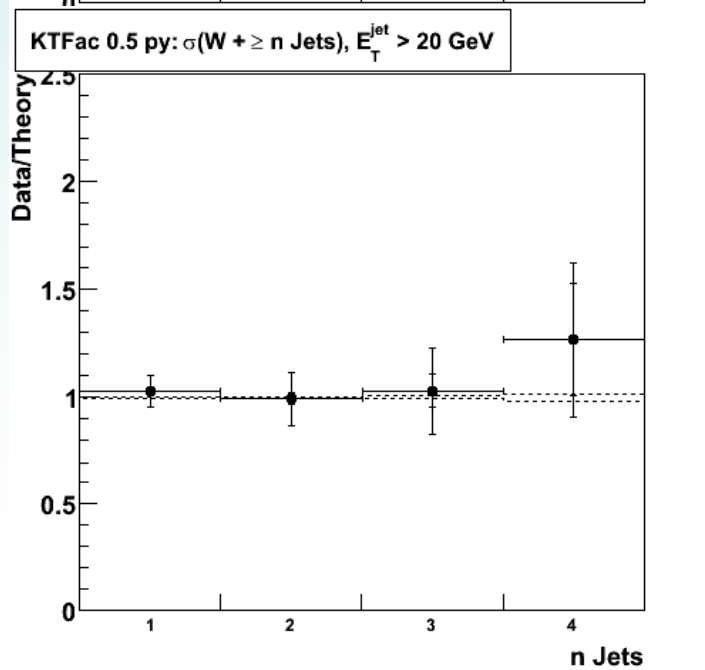
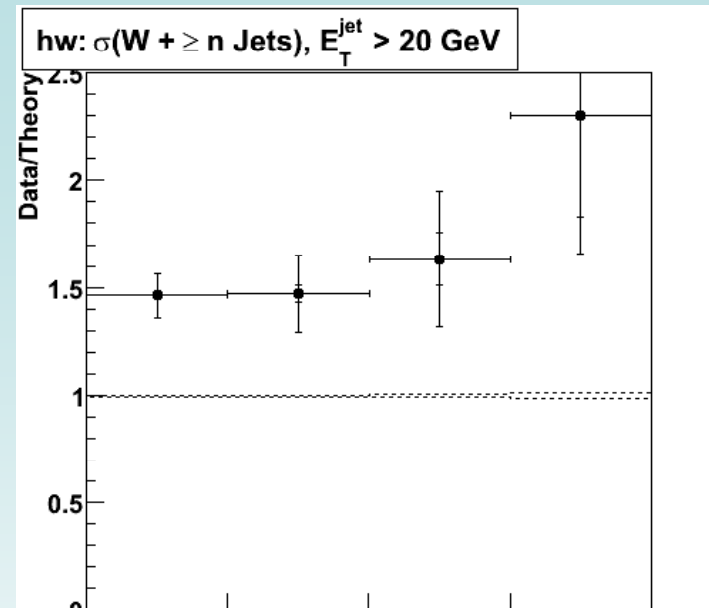
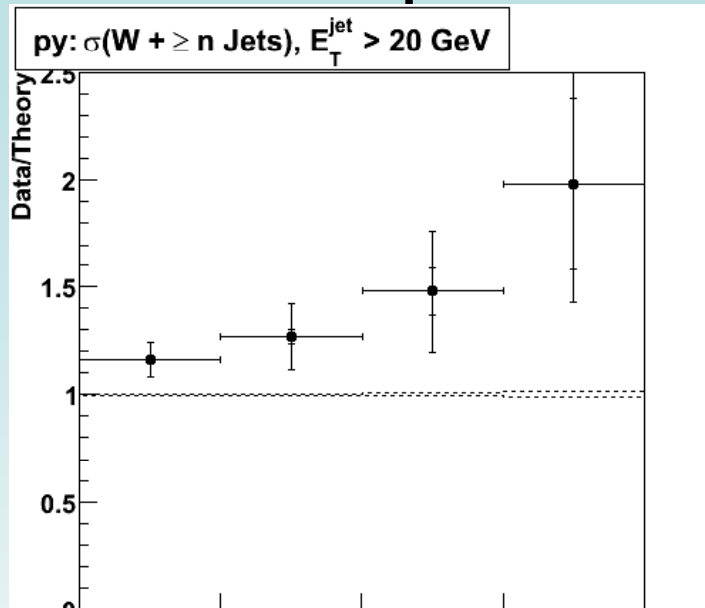
$P_{T, \text{min}} 25\text{GeV}$ py Data/Theory: $W + \geq 1$ Jets $d\sigma/dE_T$



$P_{T, \text{min}} 25\text{GeV}$ hw Data/Theory: $W + \geq 1$ Jets $d\sigma/dE_T$

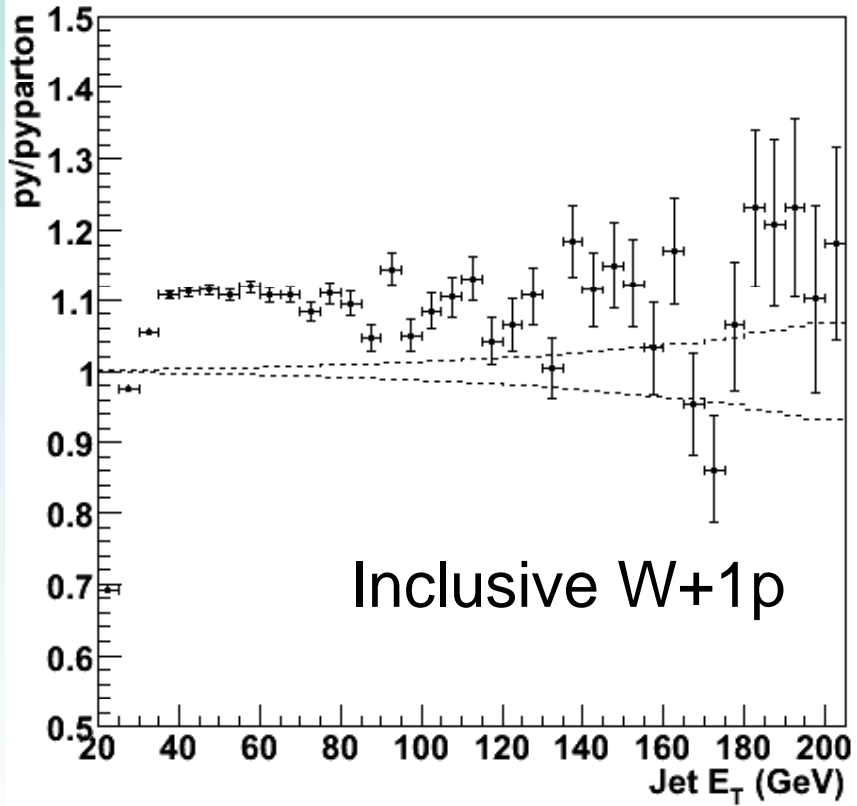


$E_T > 20$ Inclusive



Pythia

py/pyarton: W + ≥ 1 Jets $d\sigma/dE_T$



py/pyarton: W + ≥ 1 Jets $d\sigma/dE_T$

