W/Z p_T with Powheg-Box + Pythia8 / HW++

keith hamilton

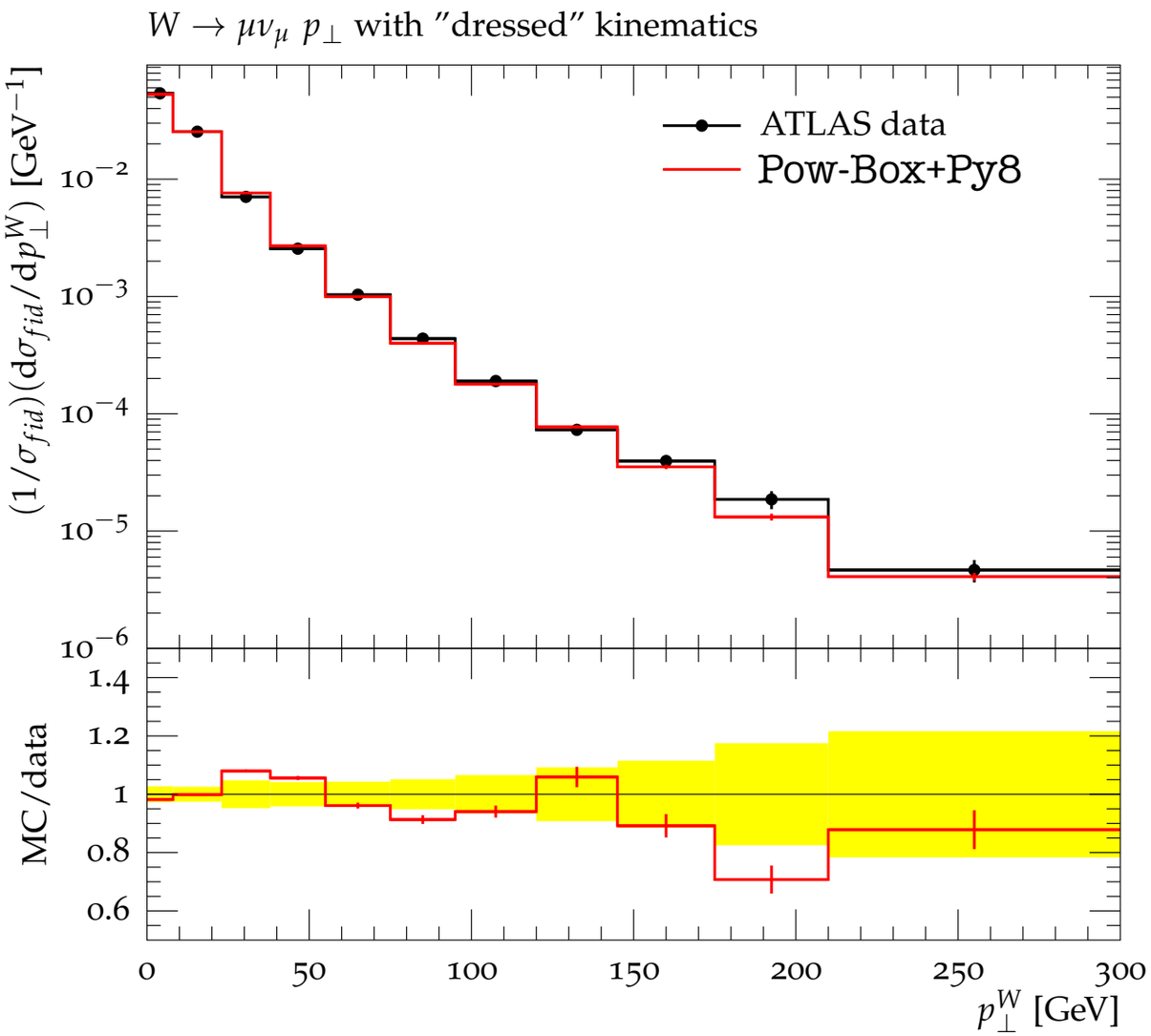
for the Powheg-Box team

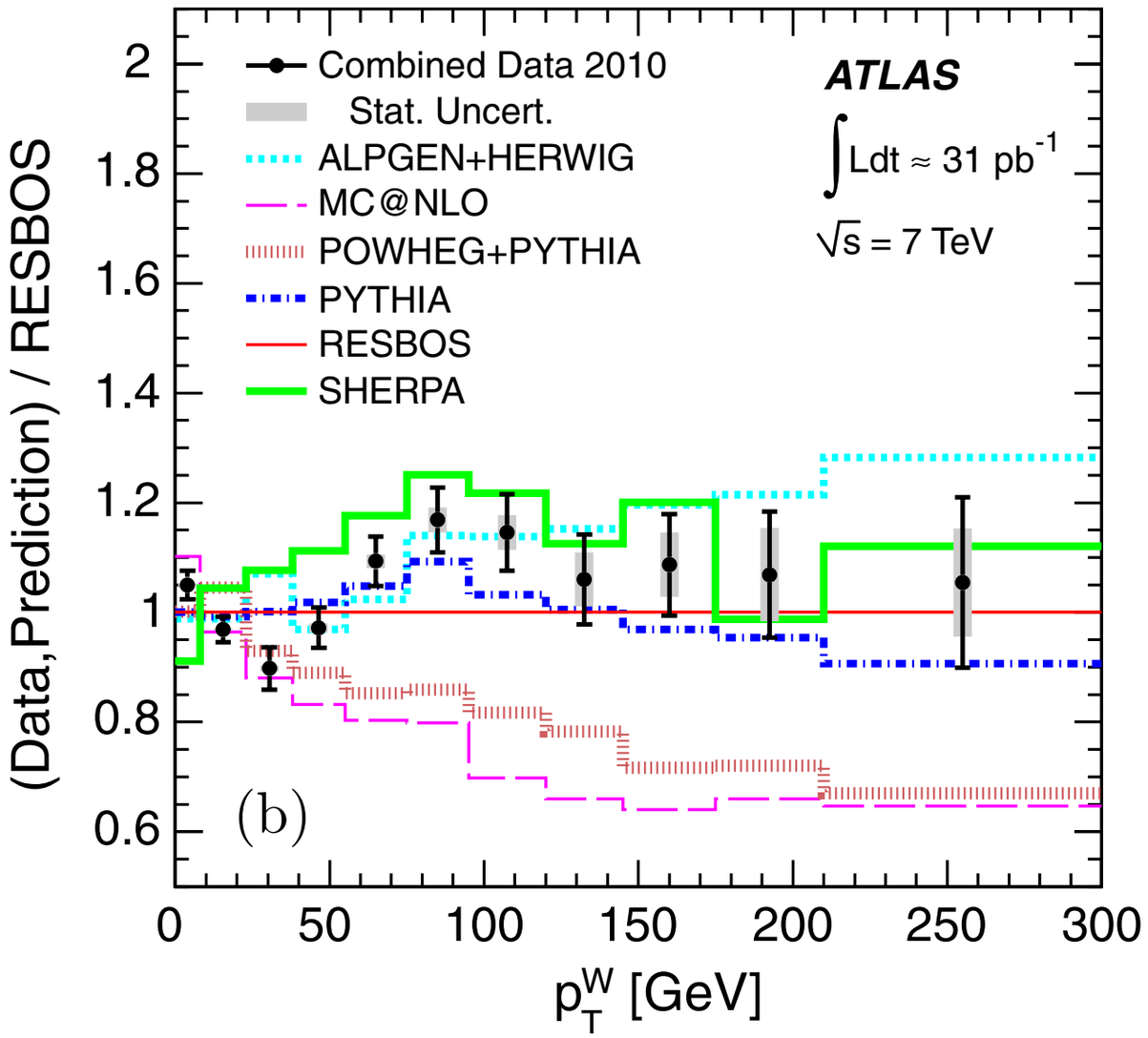
Outline:

- Powheg-Box W / Z + Pythia 8 p_T spectrum
- Contributions to the p_T spectrum
- Changing the shower

- Used Powheg-Box v1.0 event files from early summer 2011
  [Alioli, Nason, Oleari, Re - JHEP 0807 (2008) 060]
- Differences in this v.quick study w.r.t ATLAS analysis:
  - Used CTEQ6m in Powheg at variance with ATLAS paper
  - To ease comparison to data used C++ shower MC ...
  - Generated the W^+ & W^- LH files separately - combined using my own program for that

Powheg-Box W / Z programs + Pythia 8

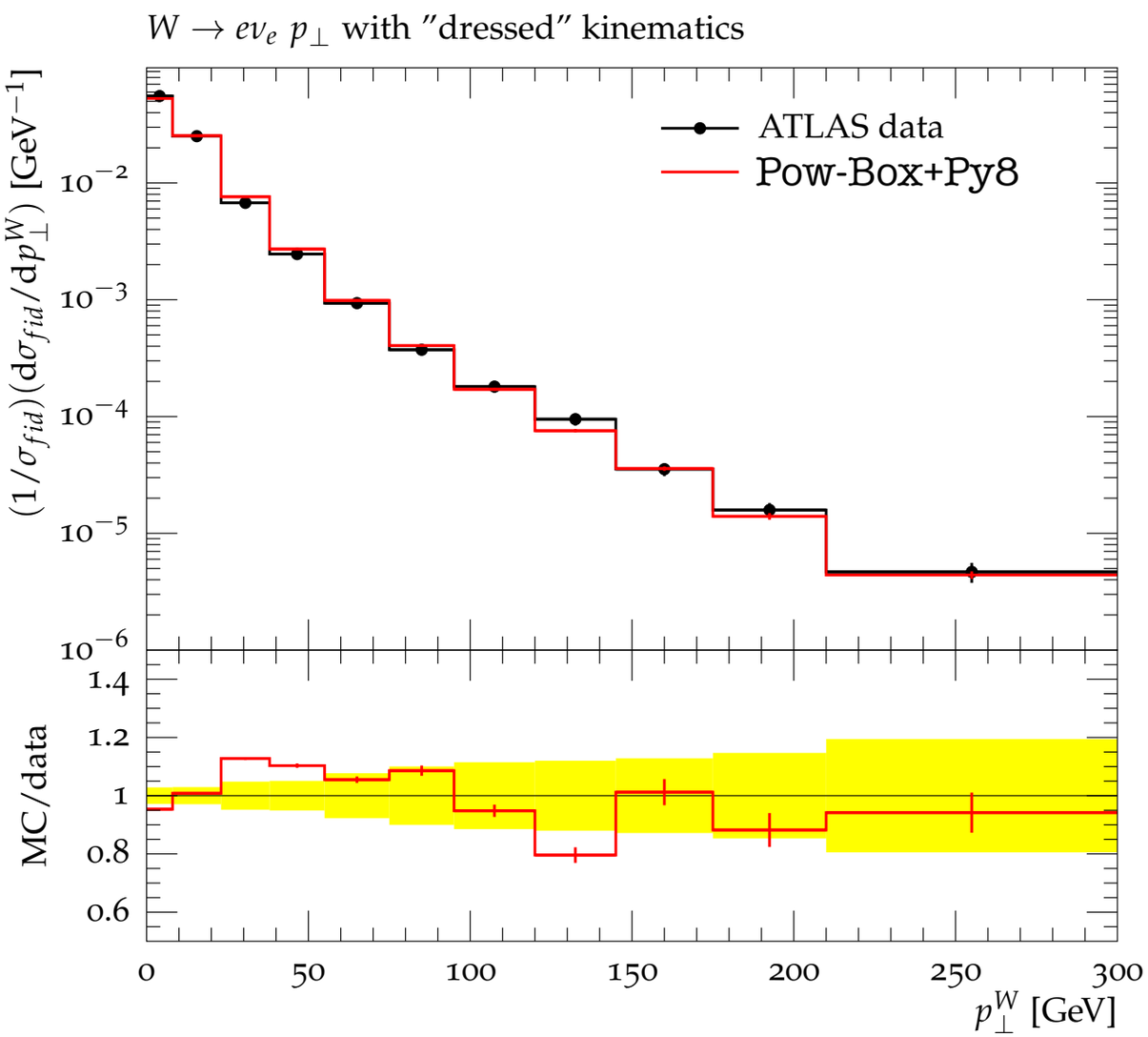


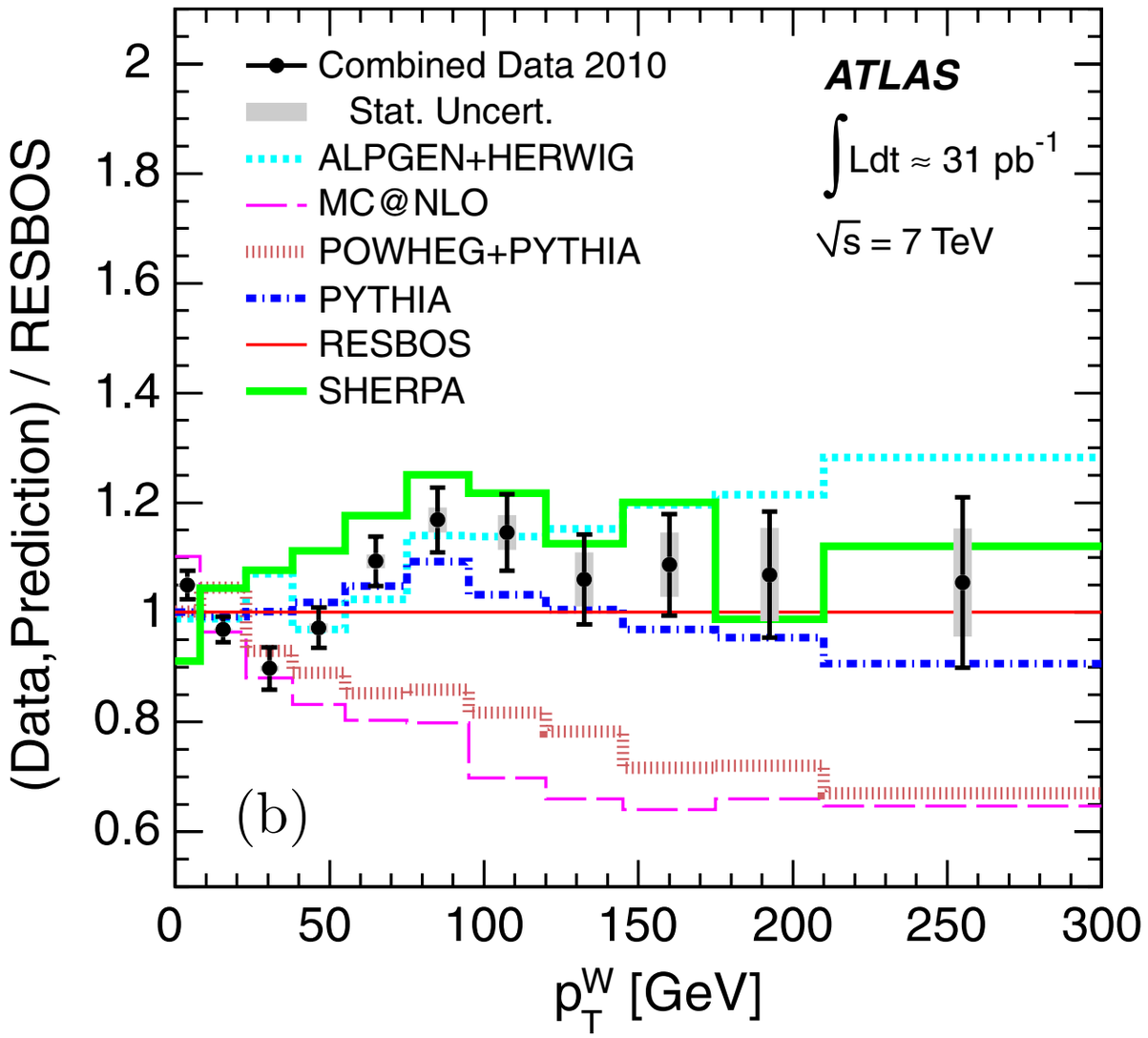


- W→μν p_T
- Powheg-Box + Pythia8, hadron level + U.E.
- Powheg w. CTEQ6m, Pythia 8.150 w. def. tune [CTEQ6L1]

* Rivet analyses by E.Yatsenko & J.Katzy

Powheg-Box W / Z programs + Pythia 8





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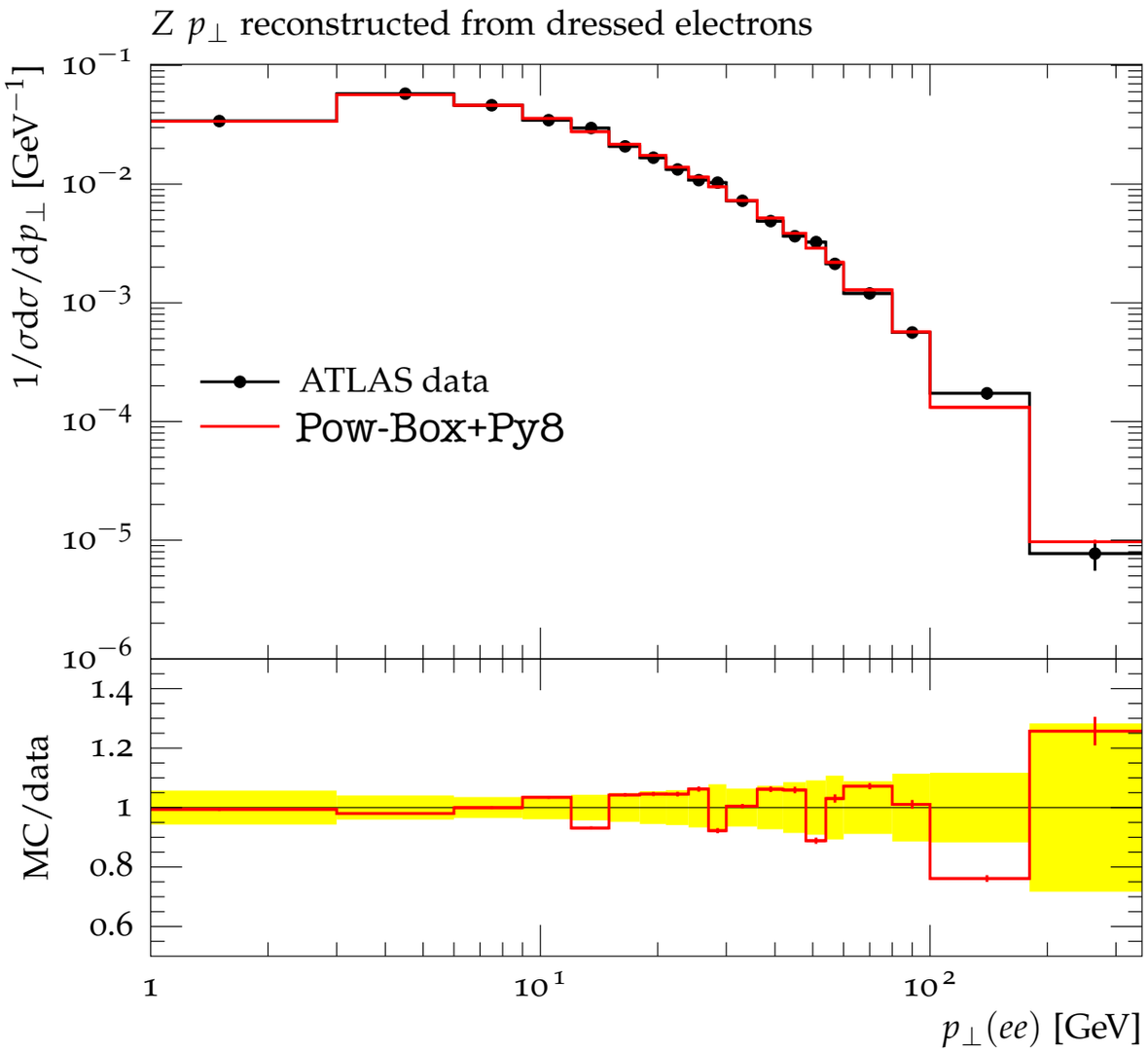
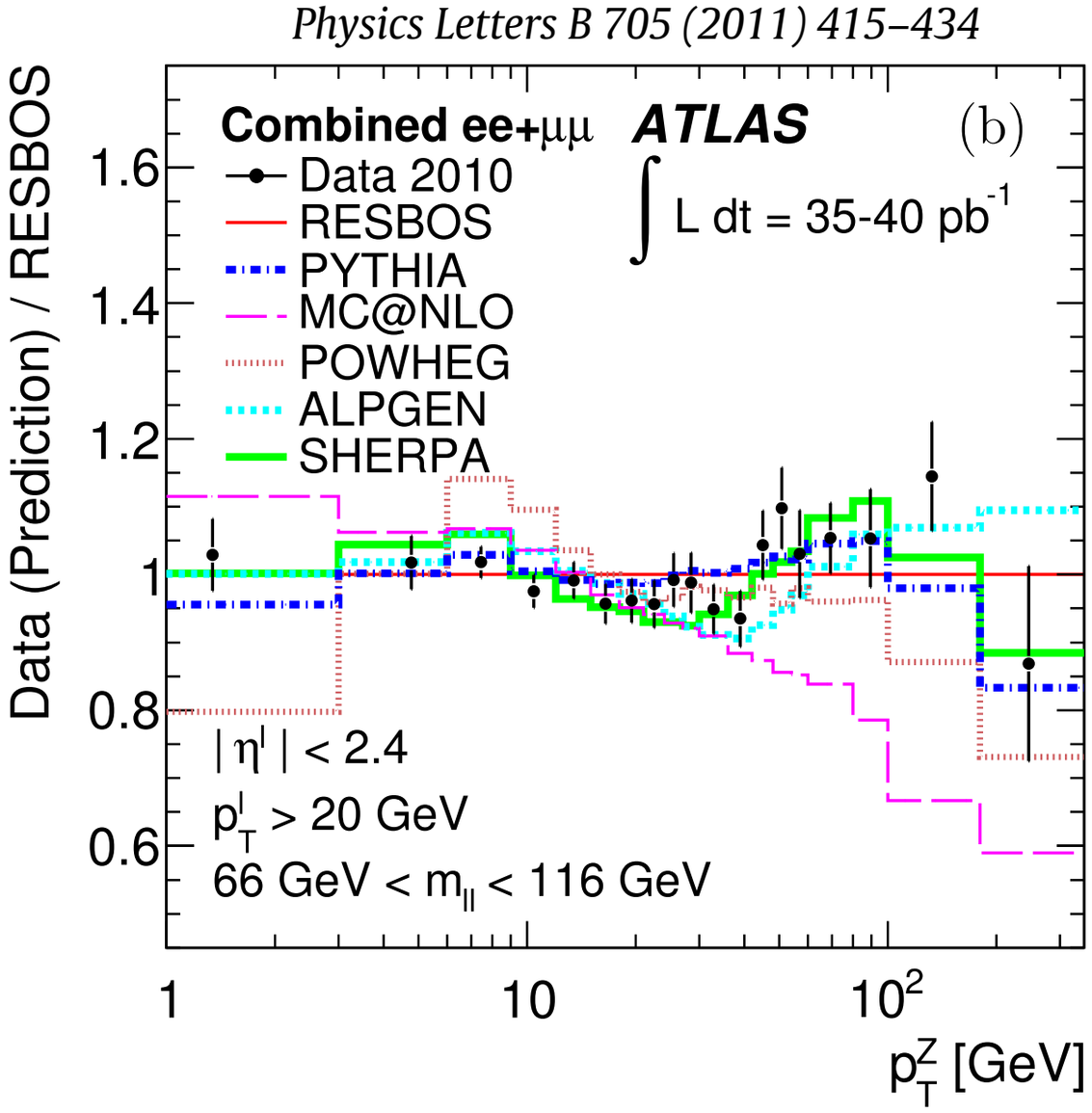
Powheg-Box W / Z programs + Pythia 8





- Z→ee p_T
- Powheg-Box + Pythia8, hadron level + U.E.
- Powheg w. CTEQ6m, Pythia 8.150 w. def. tune [CTEQ6L1]

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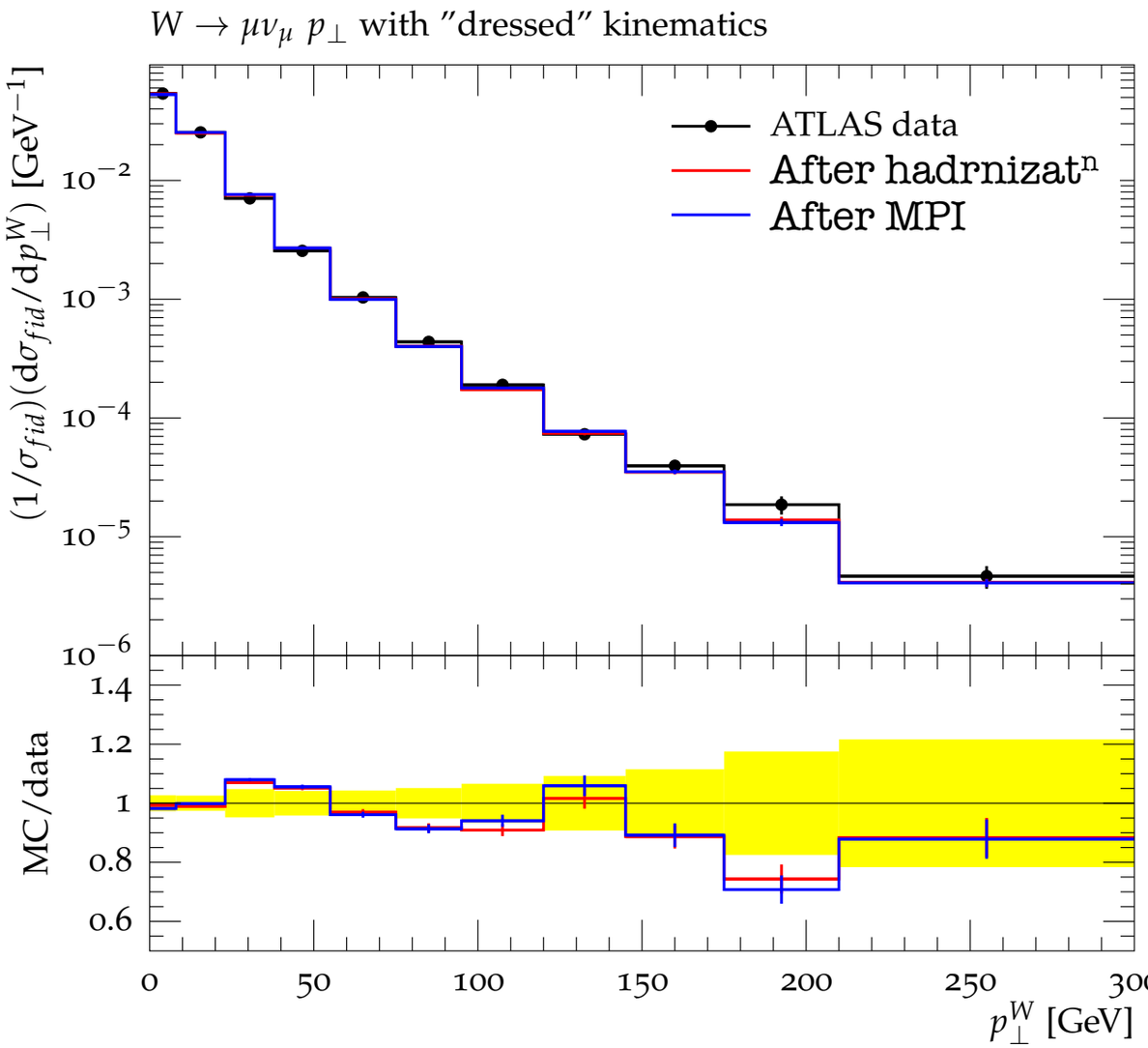
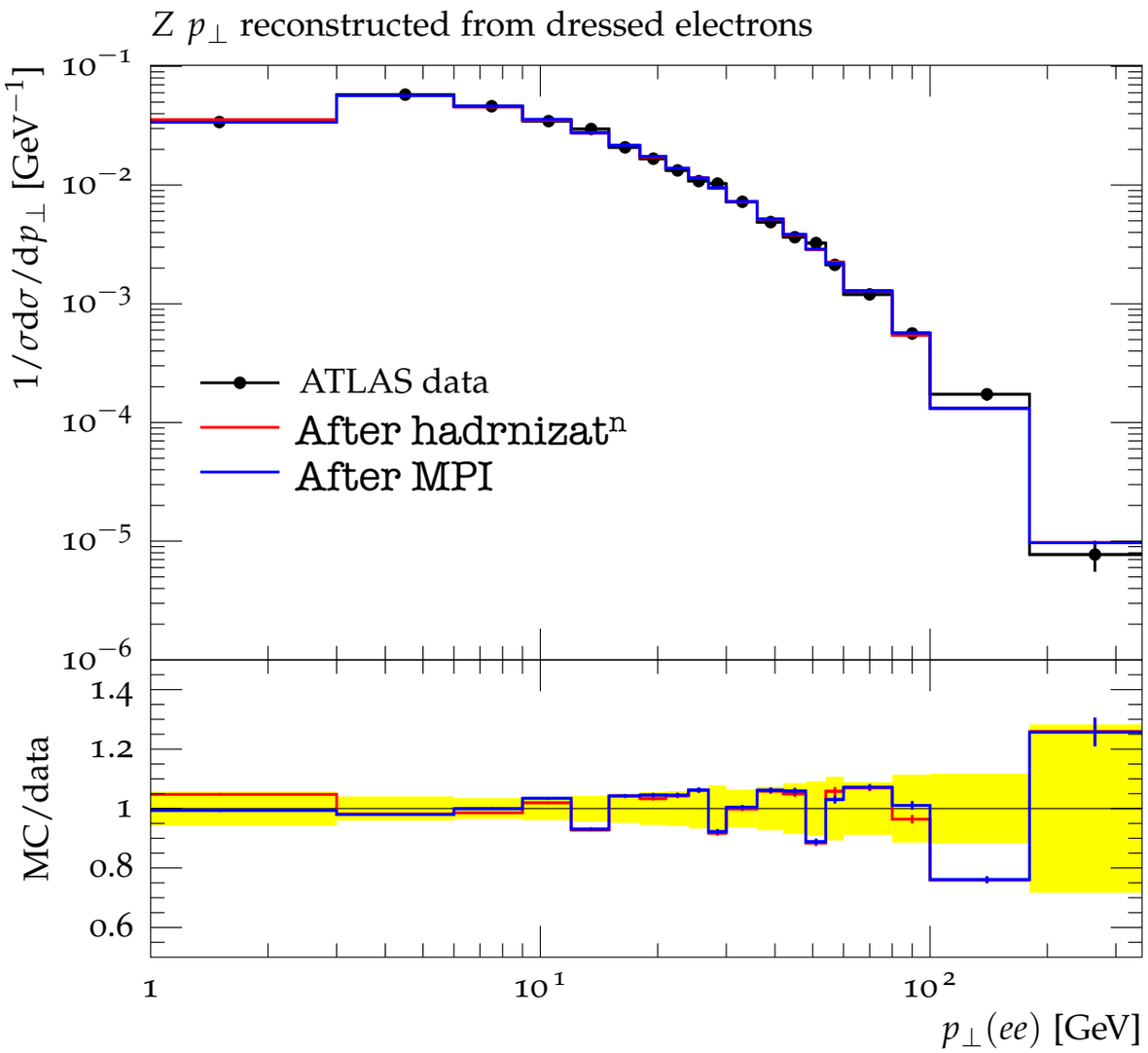
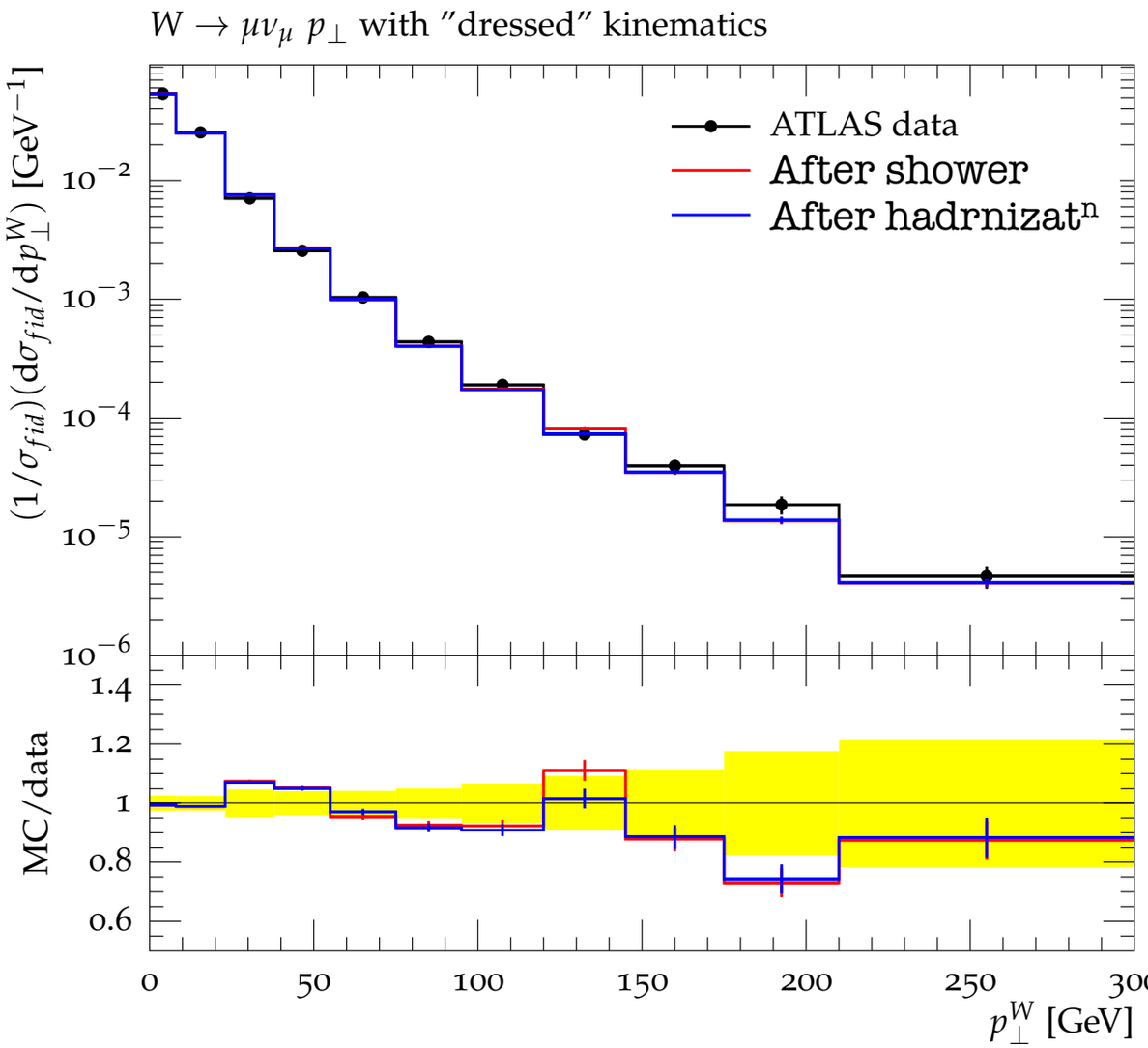
MPI effects

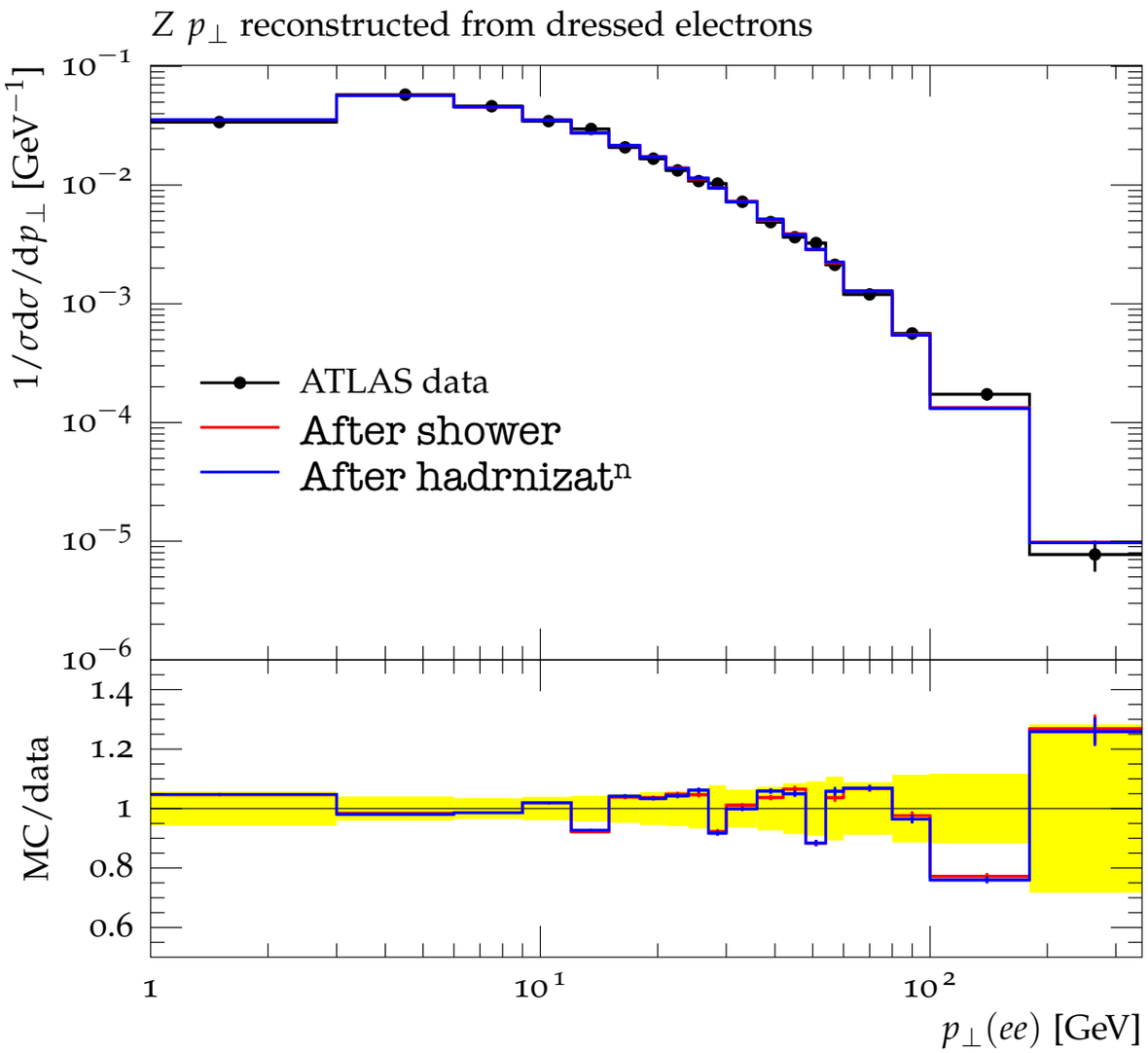




- No MPI [hadron level] events vs. MPI events
- Inclusive w.r.t QCD radiation, MPI effect near negligible
- Goes for W p_T, Z p_T , electrons / muons, dressed / bare kin.

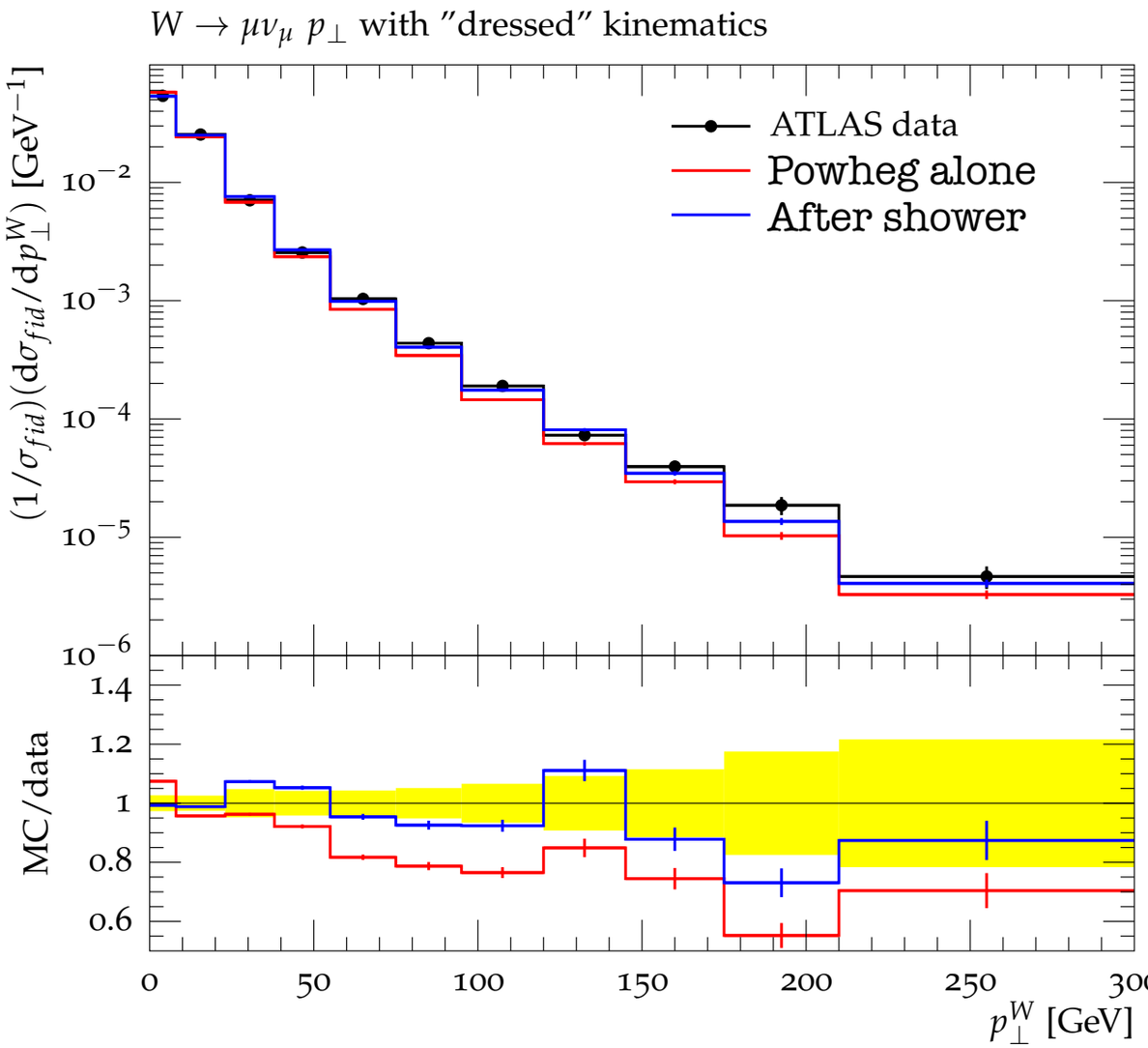
Hadronization effects

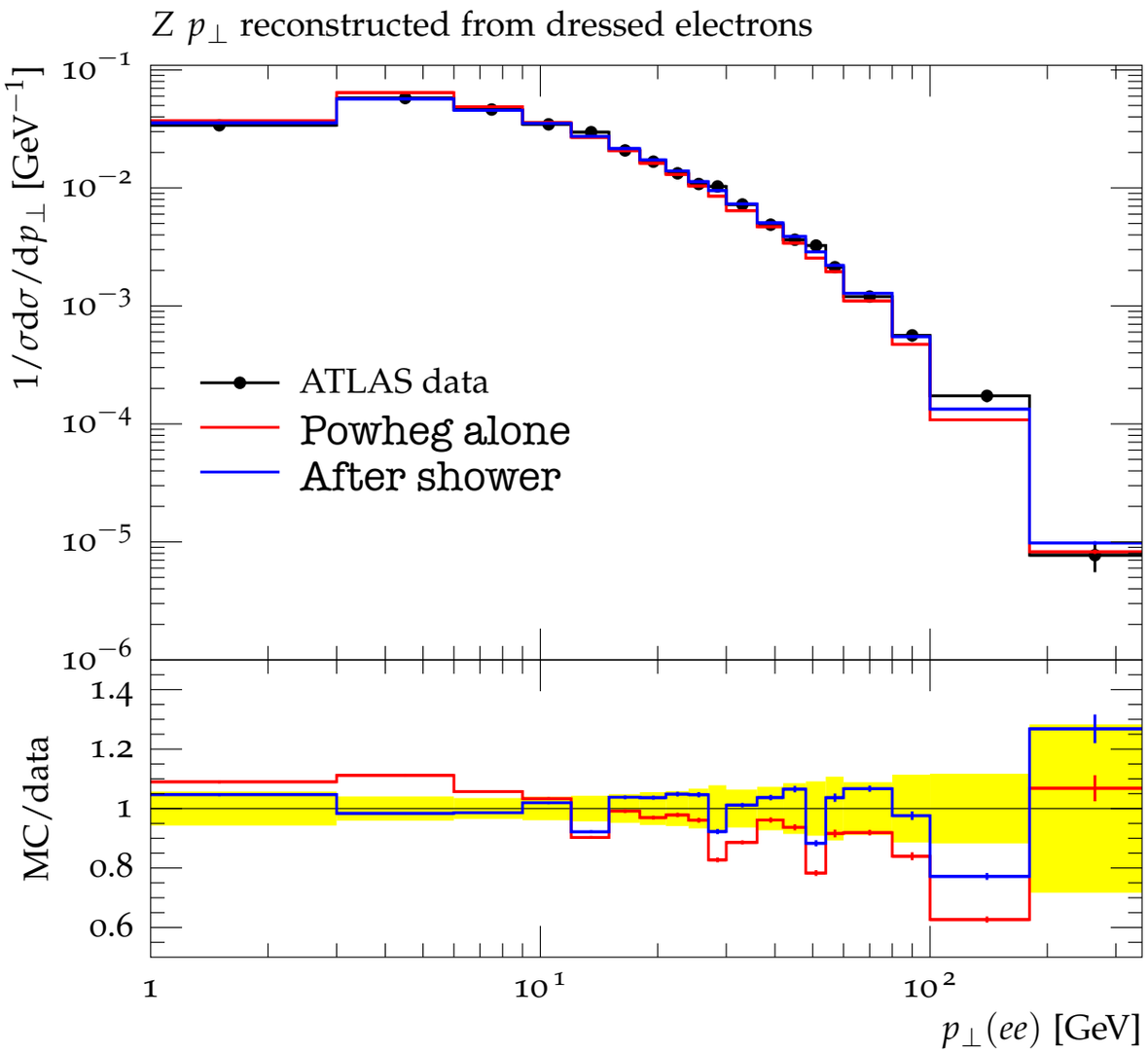




- Showered vs. hadronised events
- Inclusive w.r.t QCD radiation, hadr. effect near negligible
- Goes for W p_T, Z p_T , electrons / muons, dressed / bare kin.

Single vs. multiple parton emissions





- Les Houches [single emission] vs. showered events
- Sizeable phase space for secondary radiations
- Same size correction in W p_T in electron channel

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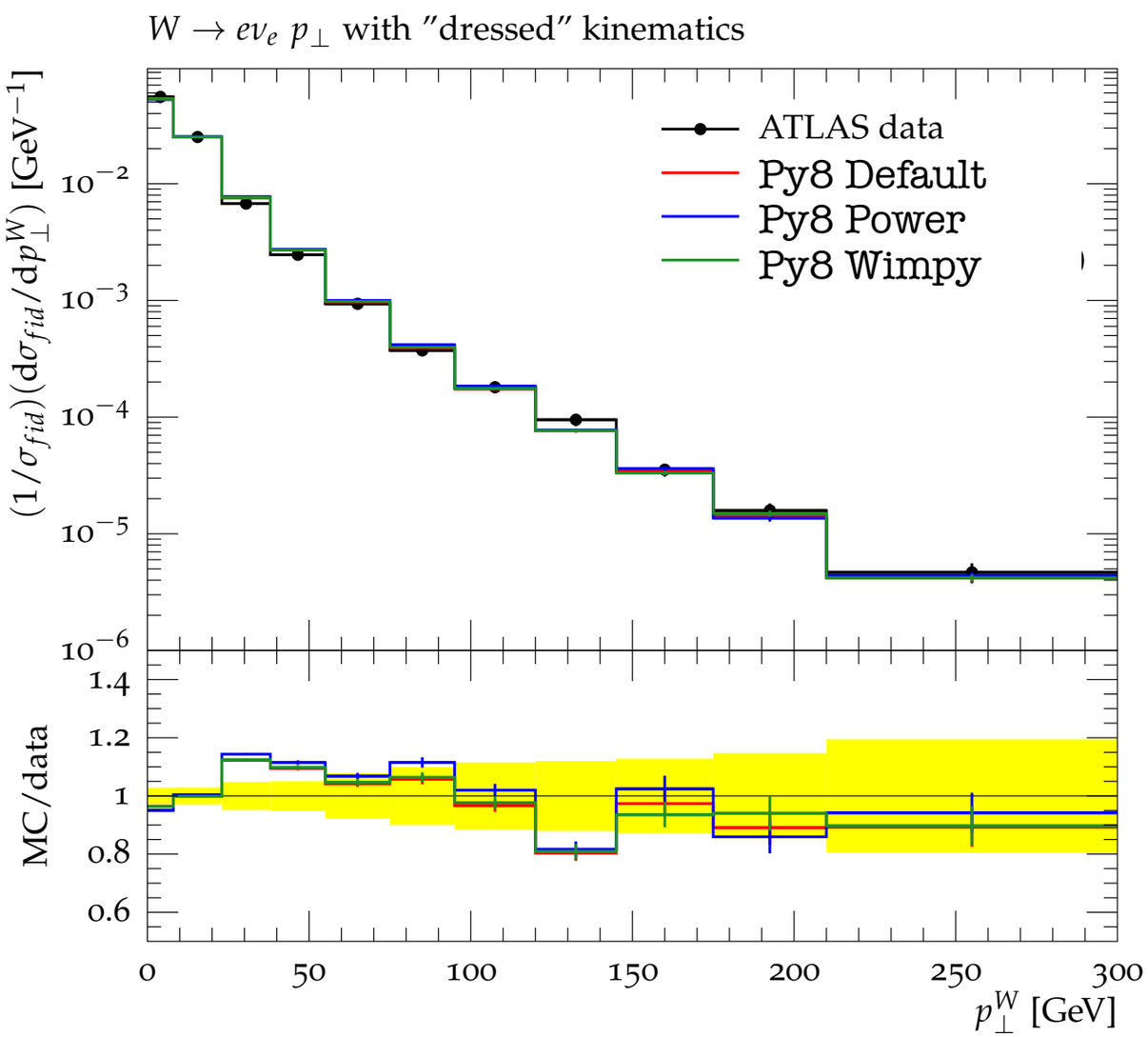
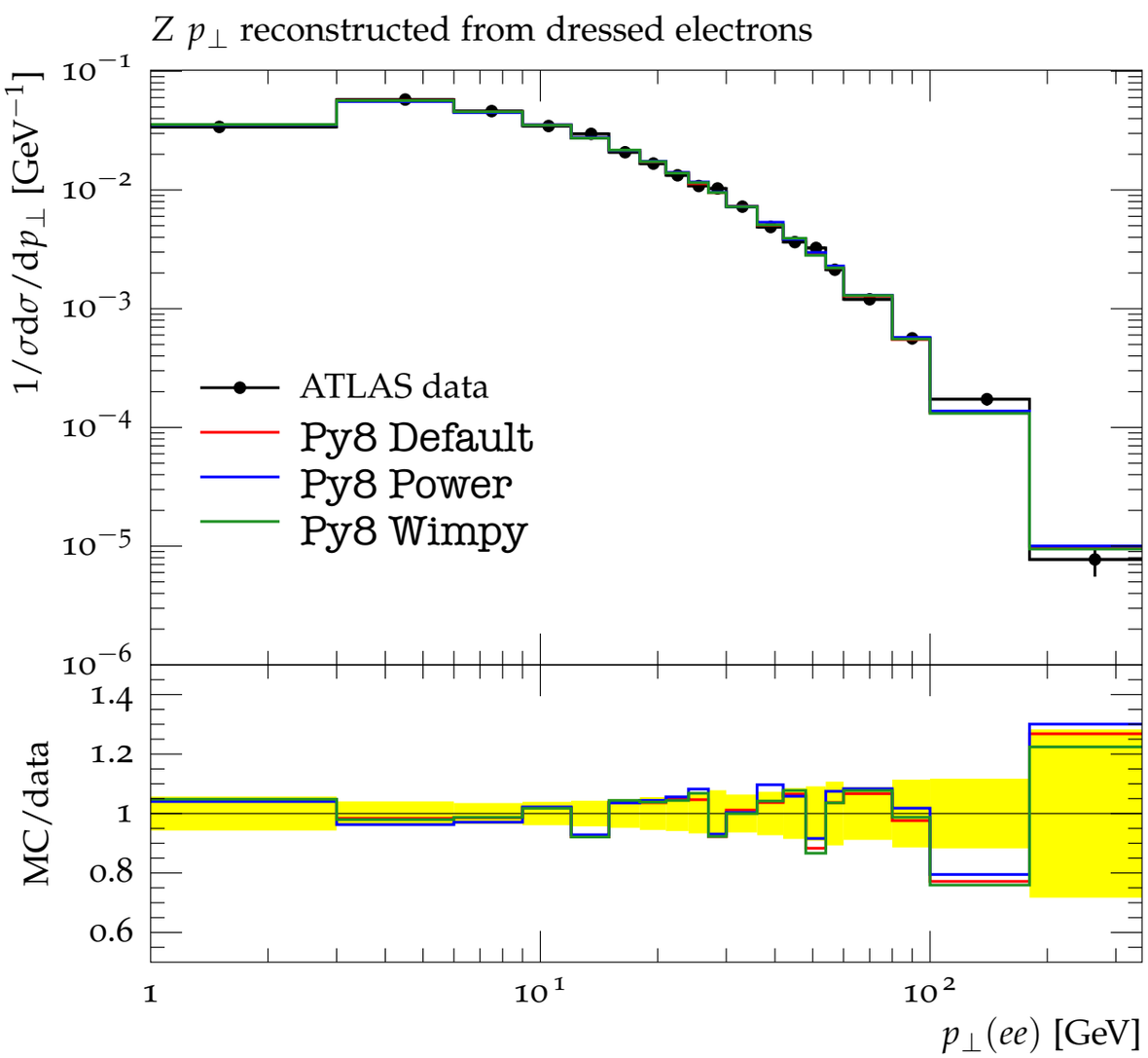
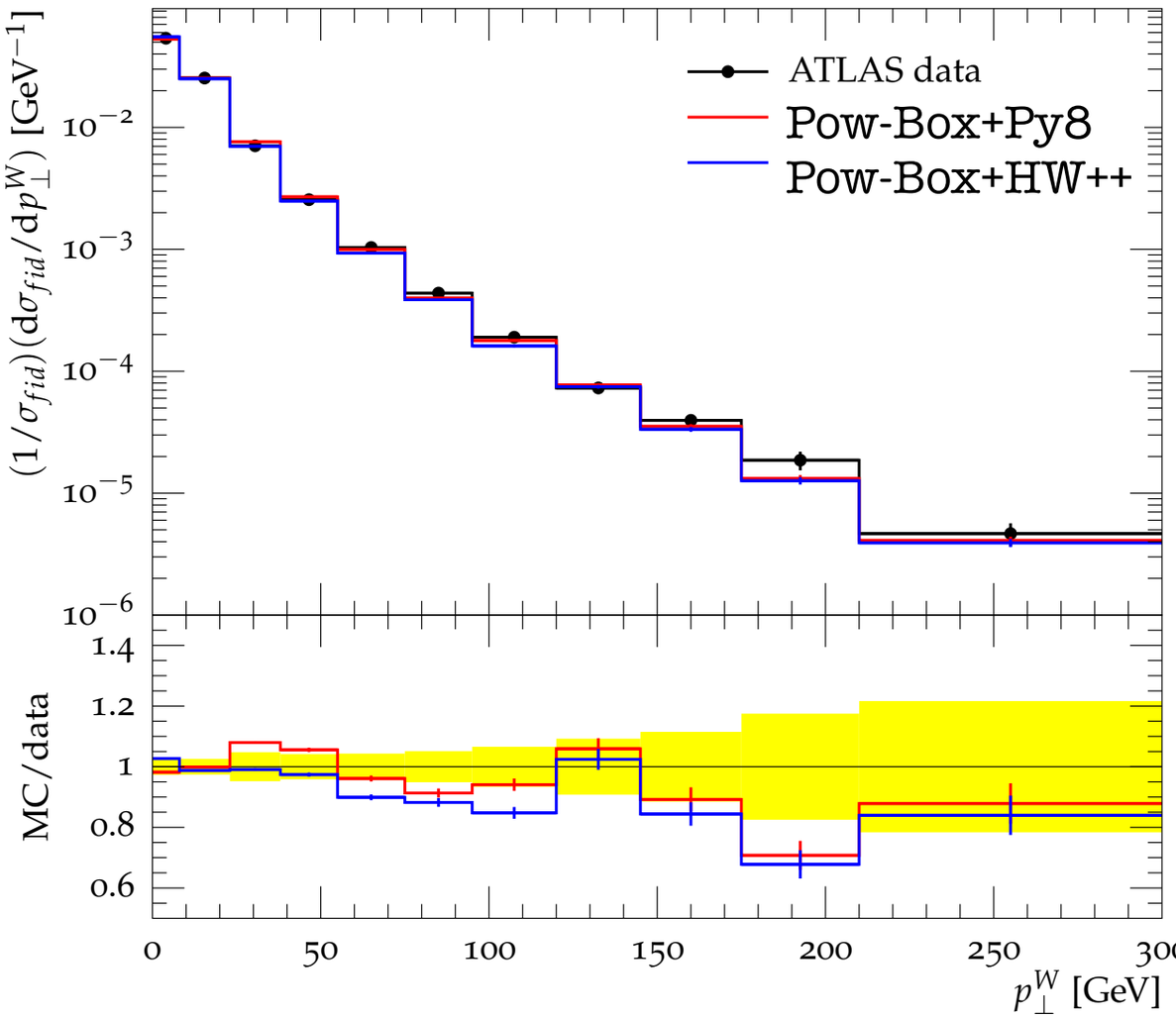
Default shower vs. Power shower vs Wimpy shower

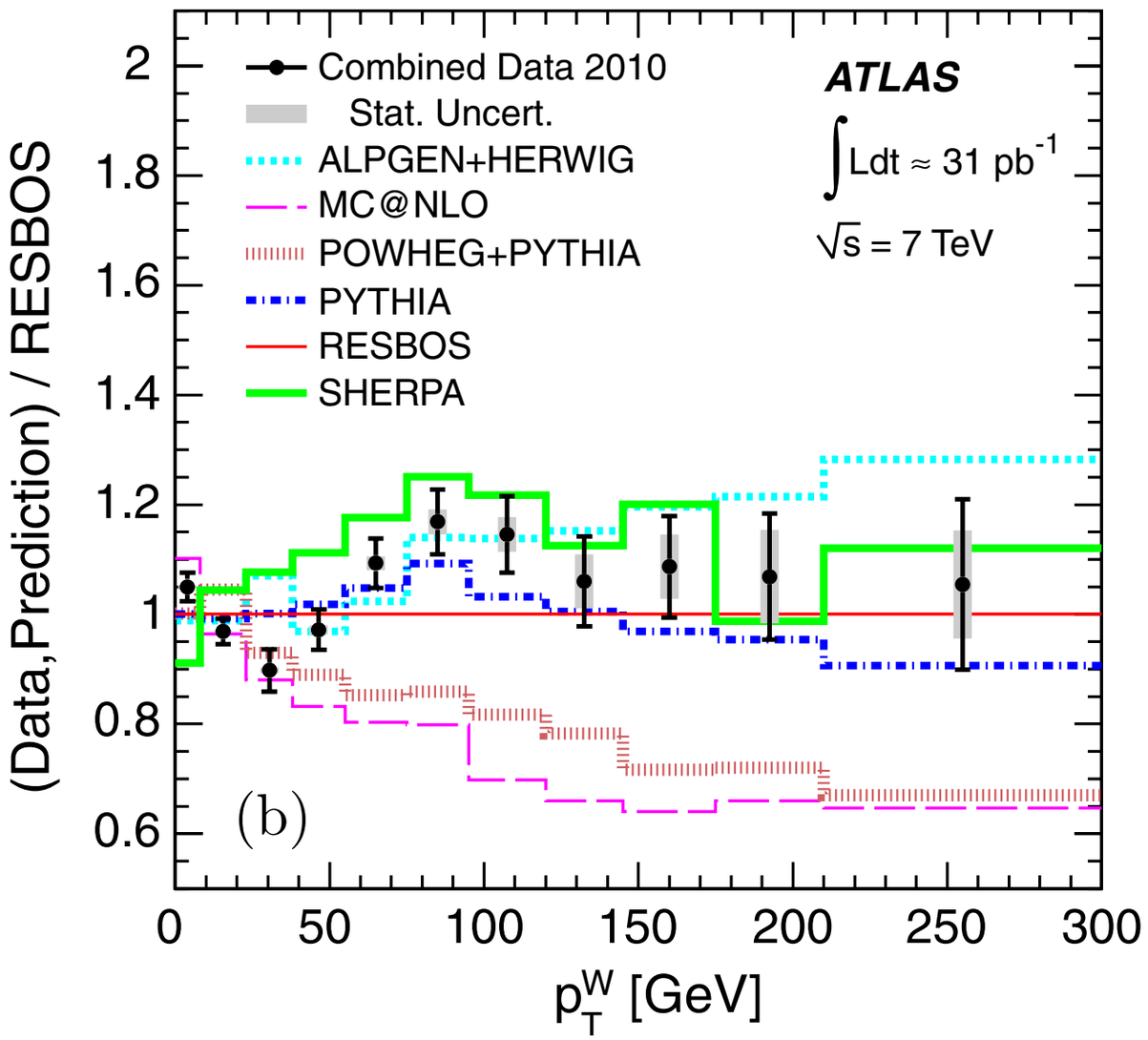




- W p_T left, Z p_T left: Powheg-Box W/Z + Py8, parton level
- Marginal softening: power → default → wimpy shower
- Also for W→μν & bare kinematics

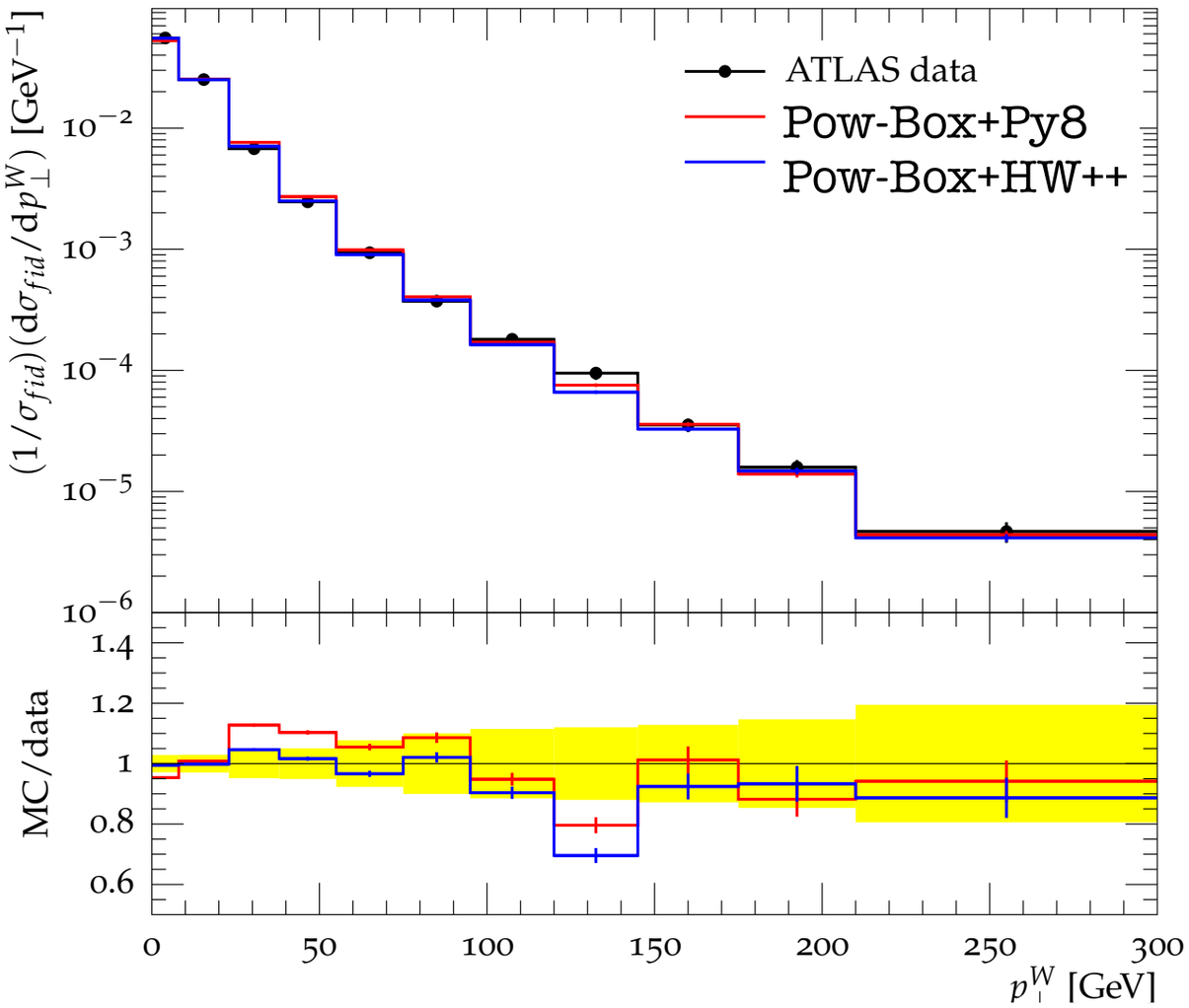
Powheg-Box W / Z programs + Herwig++ [+ MRSTLOMC]

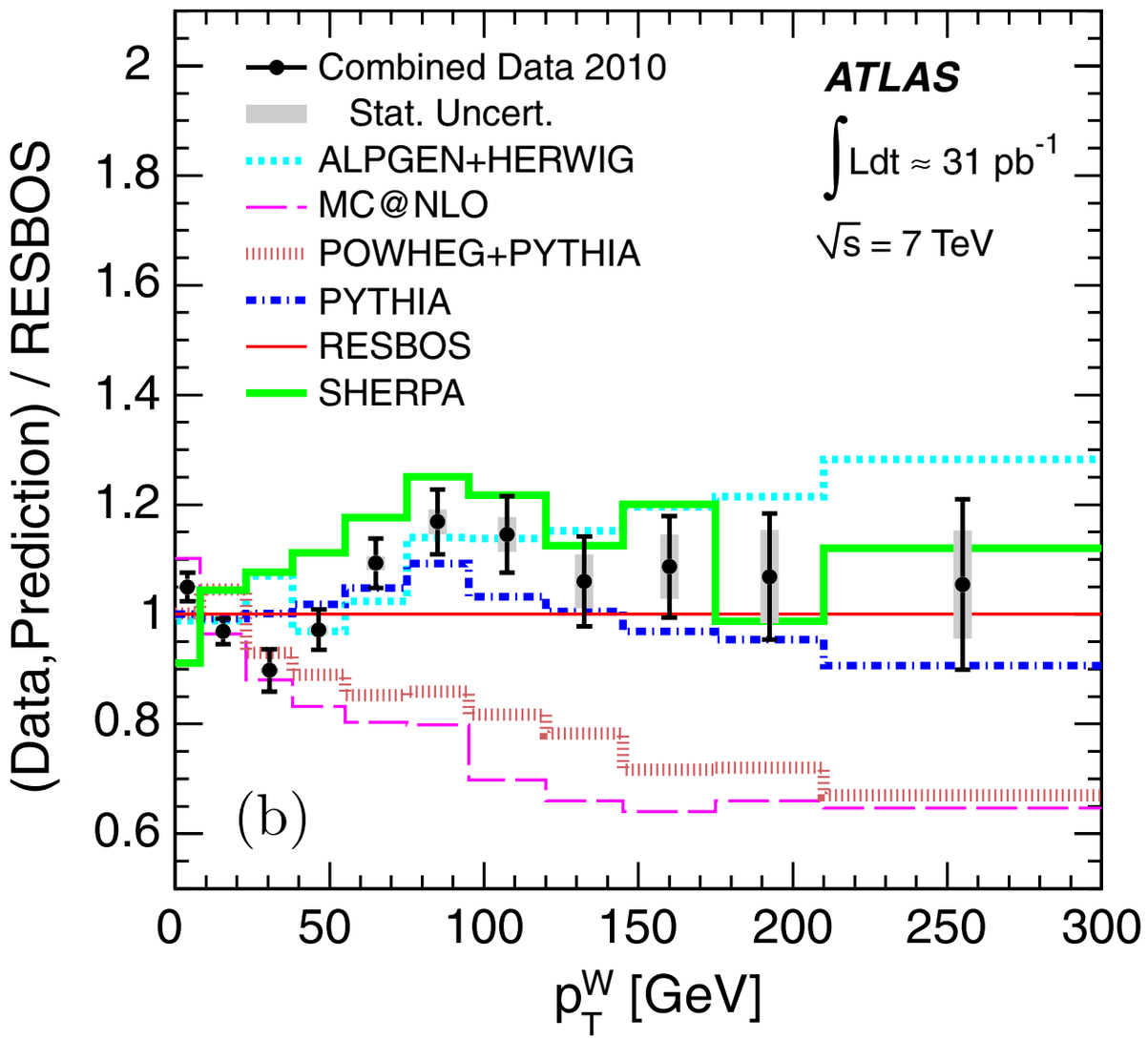




- W→μν p_T
- Powheg-Box + Pythia 8 & Herwig++, hadron level + U.E.
- Powheg w. CTEQ6m, Py8 as before, HW++ has MRSTLOMC

Powheg-Box W / Z programs + Herwig++ [+ MRSTLOMC]





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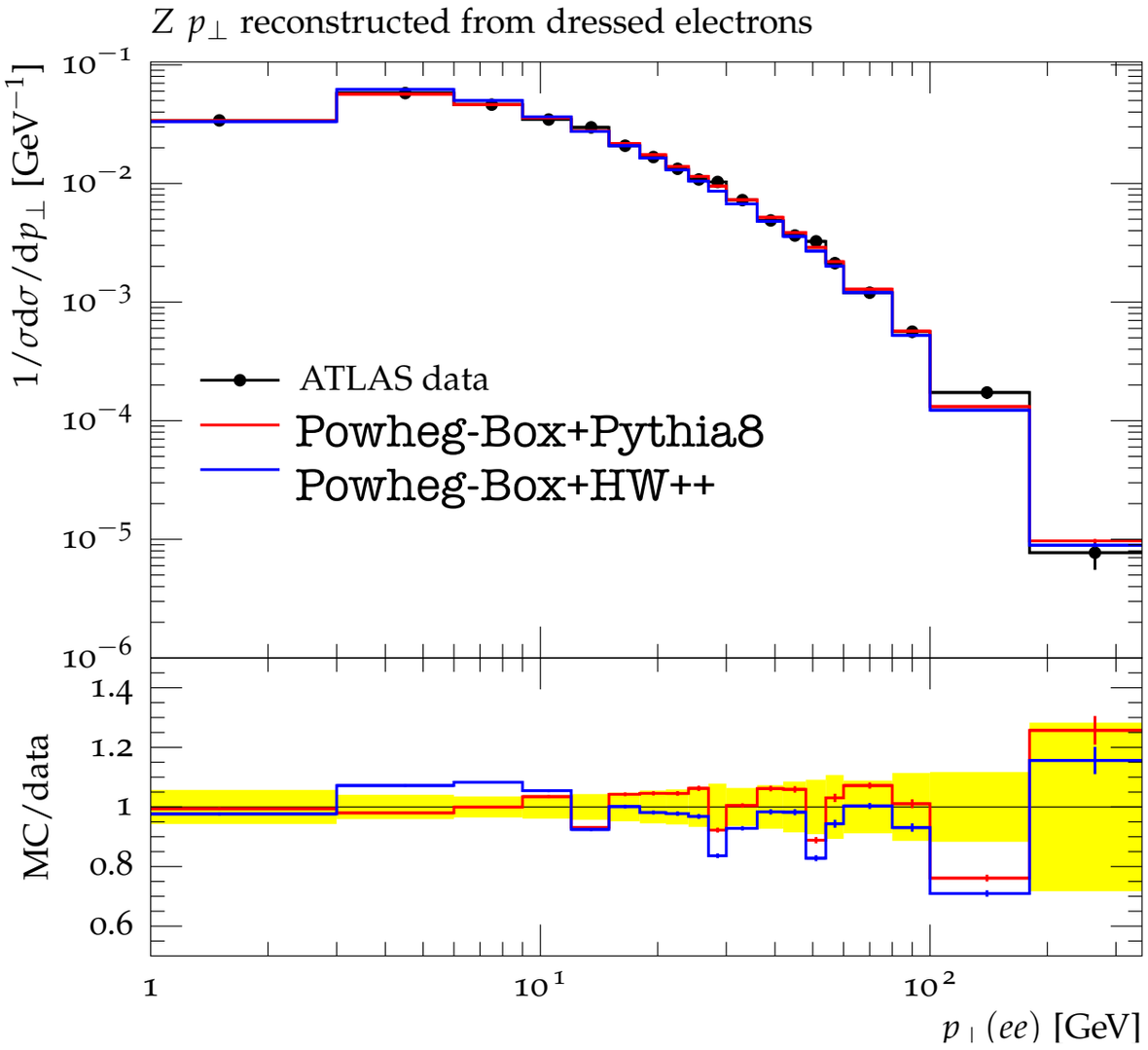
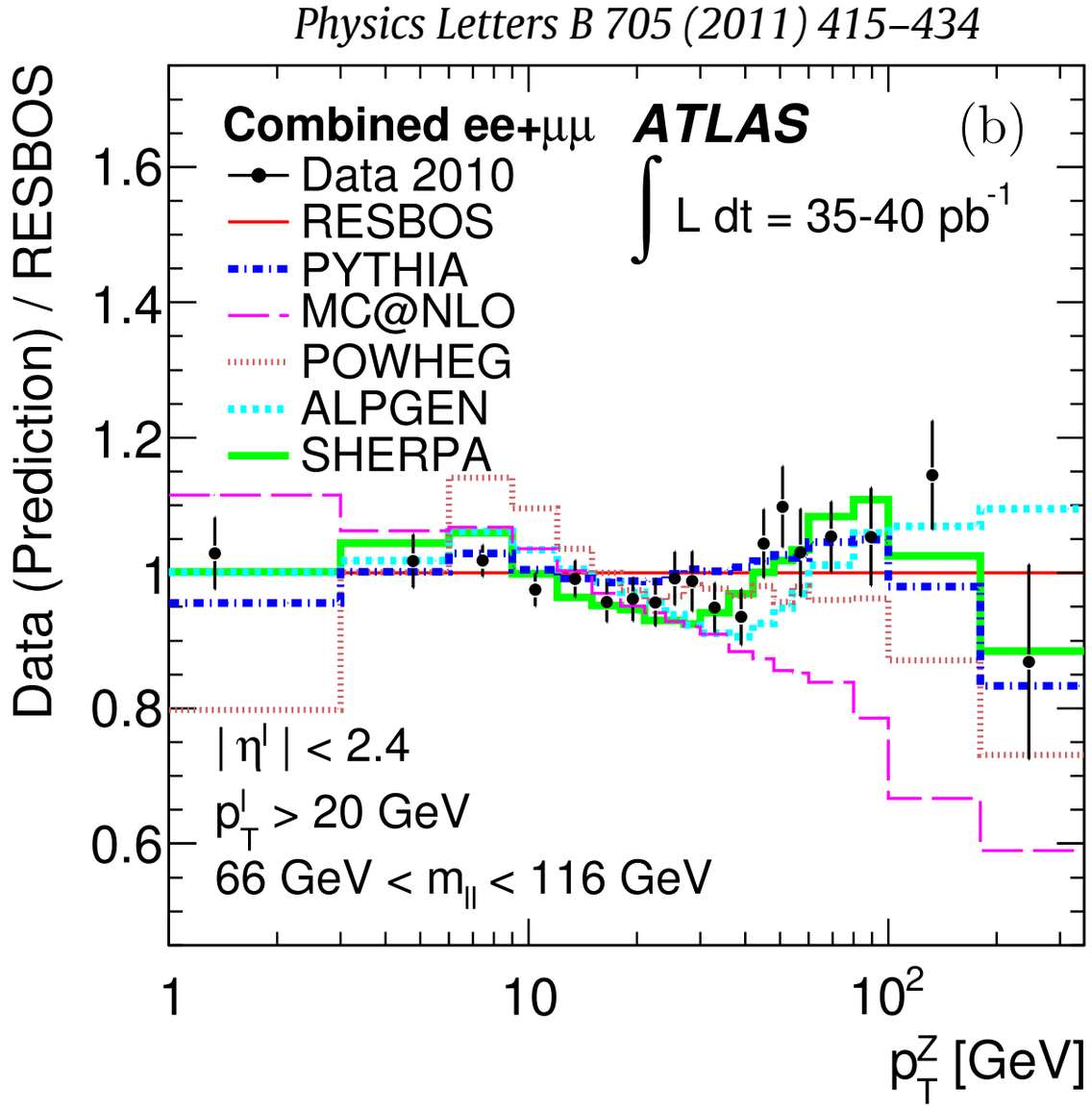
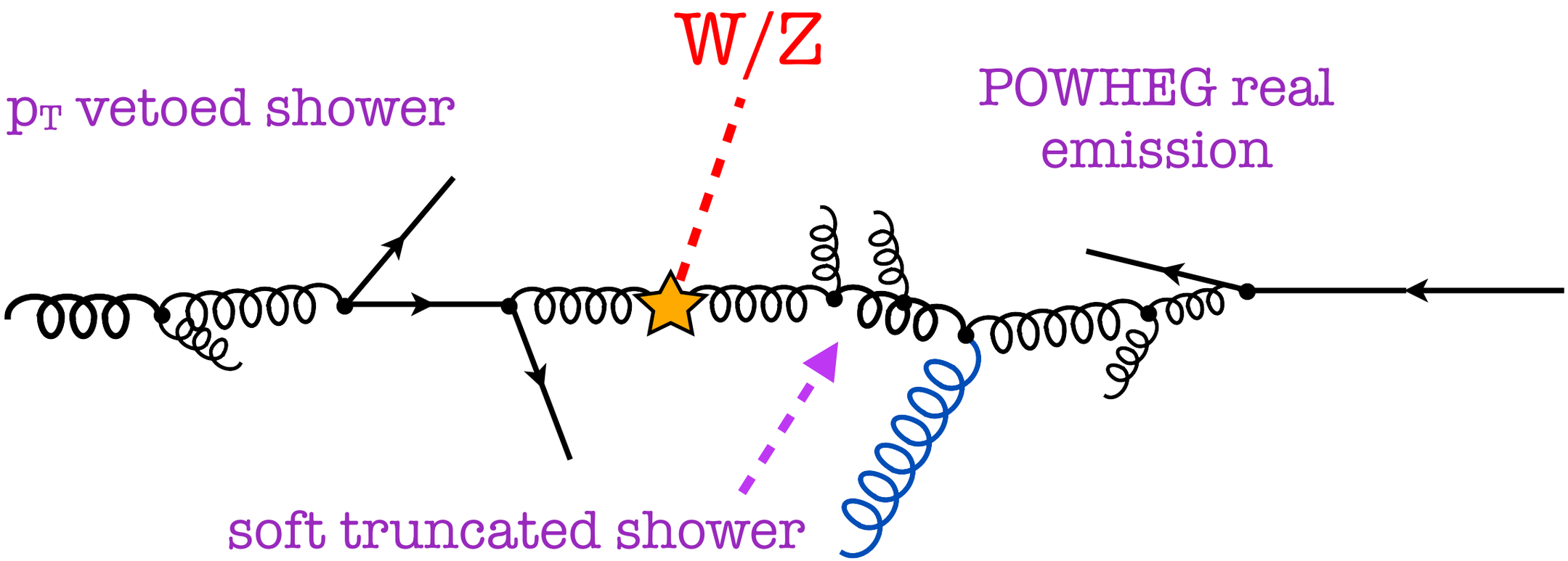




- $Z \rightarrow ee$ p_T
- Powheg-Box + Pythia 8 & Herwig++, hadron level + U.E.
- Powheg w. CTEQ6m, Py8 as before, HW++ has MRSTLOMC

Truncated shower effects?

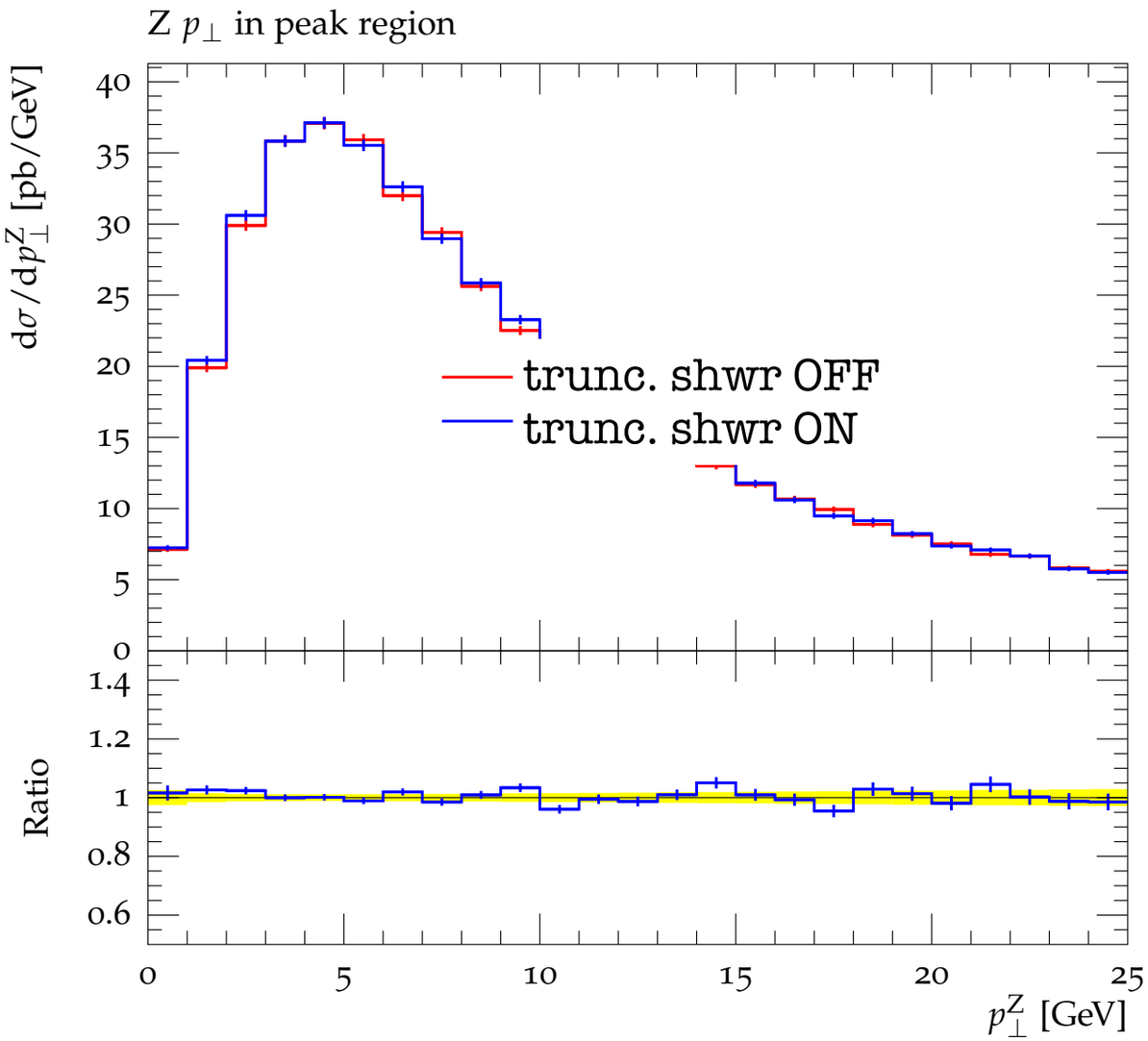
- When POWHEG gives a real emission according to the NLO calculation it's supposed to be the hardest.
- So in general you just veto emissions from the shower with $p_T > p_{T,POWHEG}$

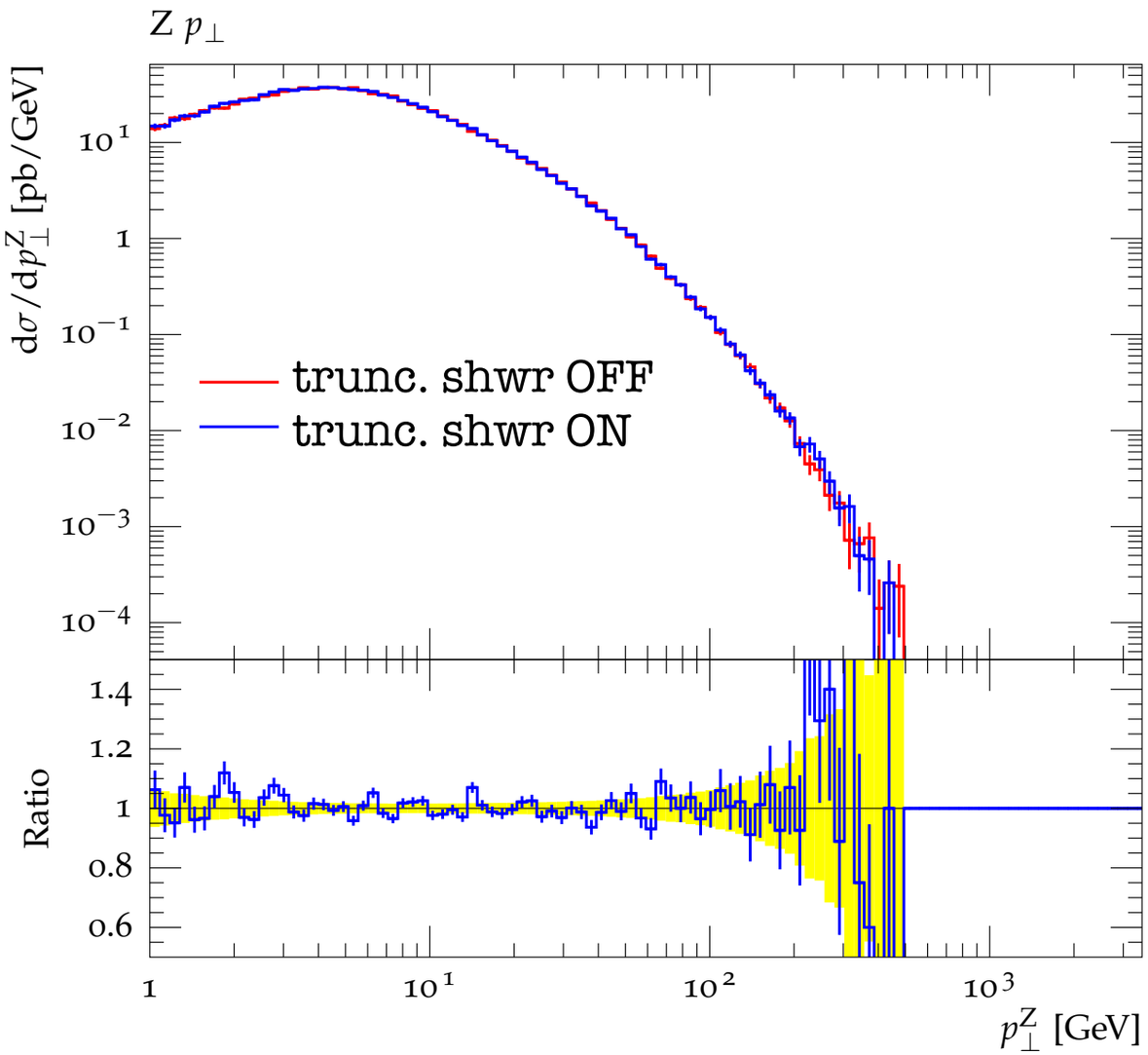


- But if the shower is A.O. then the shower should also try to include 'earlier' soft wide angle emissions

[Idea: Nason 2004, Implementation: KH, Richardson, Tully 2008]

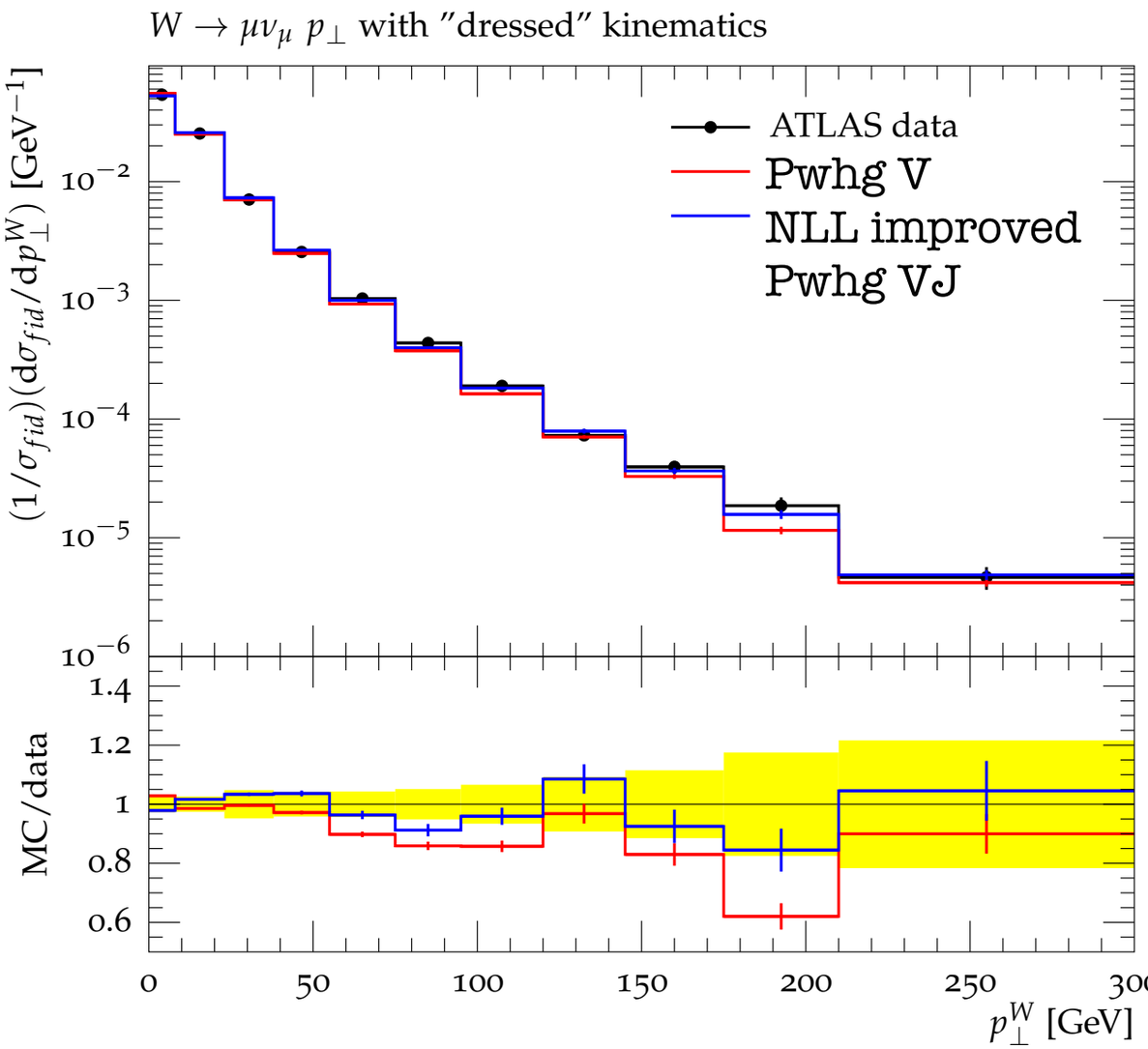
HW++ native Powheg w. & w.o. the truncated shower

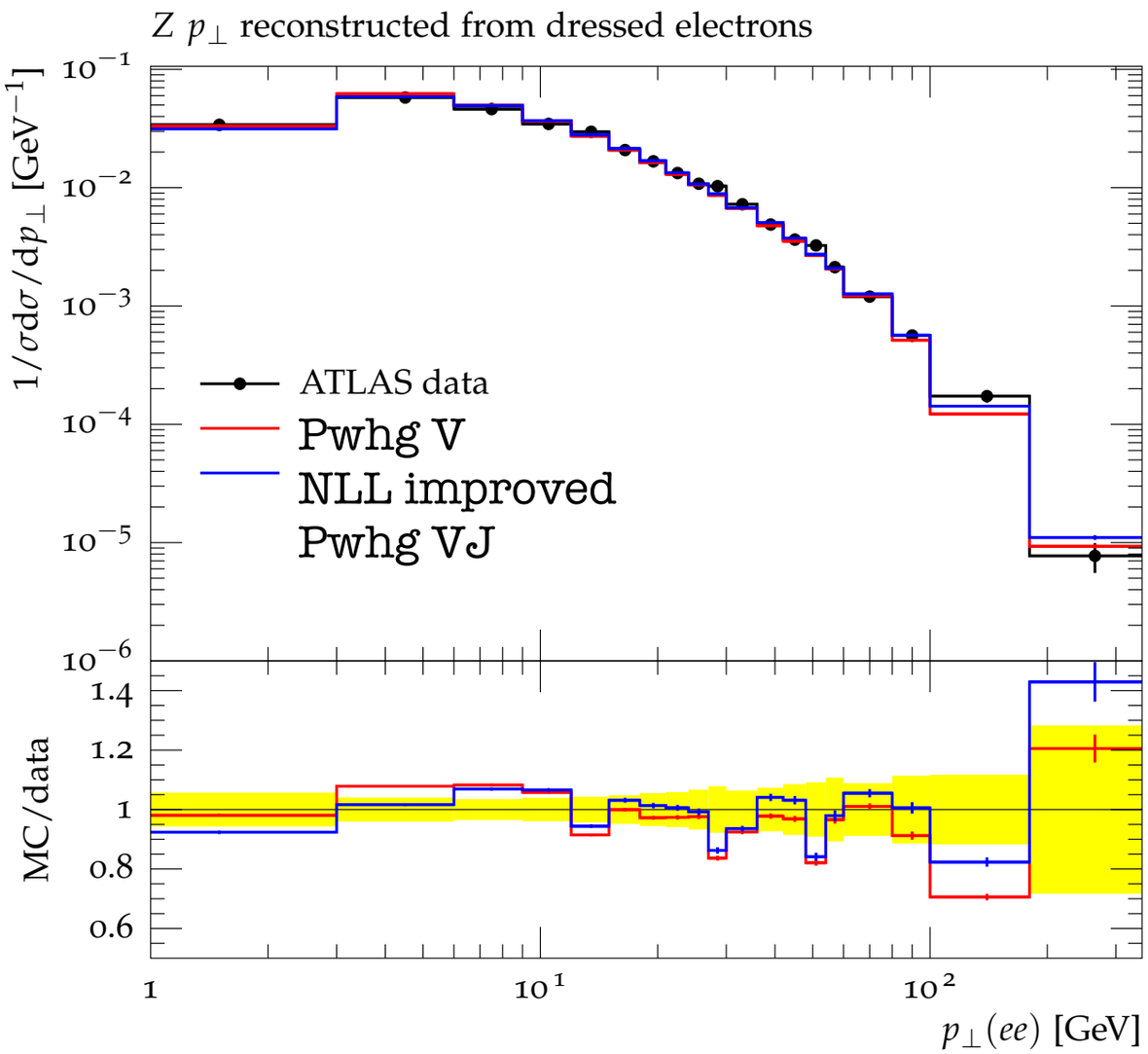




- Native HW++ Powheg simulation used here; parton level
- HW++ truncated shower off [red] vs on [blue]
- Truncated shower effects negligible in V p_T spectra

Comparison to higher order NLL+NLO





- Red is Powheg V + Herwig++ [V = W / Z]
- Blue is merged Powheg V + Powheg VJ + Herwig++
- NLO effect is small - roughly approximated in Powheg V

* N.B. CTEQ6m used also in HW++ shower in these two plots!

Summary 1/2

- Agreement with 2011 W & Z p_T data looked OK
  - Differences in this v.quick study w.r.t ATLAS analysis:
  - Used CTEQ6m in Powheg at variance with ATLAS paper
  - To ease comparison to data used C++ shower MC …
  - Generated my W^+ & W^- LH files separately - combined using independent program

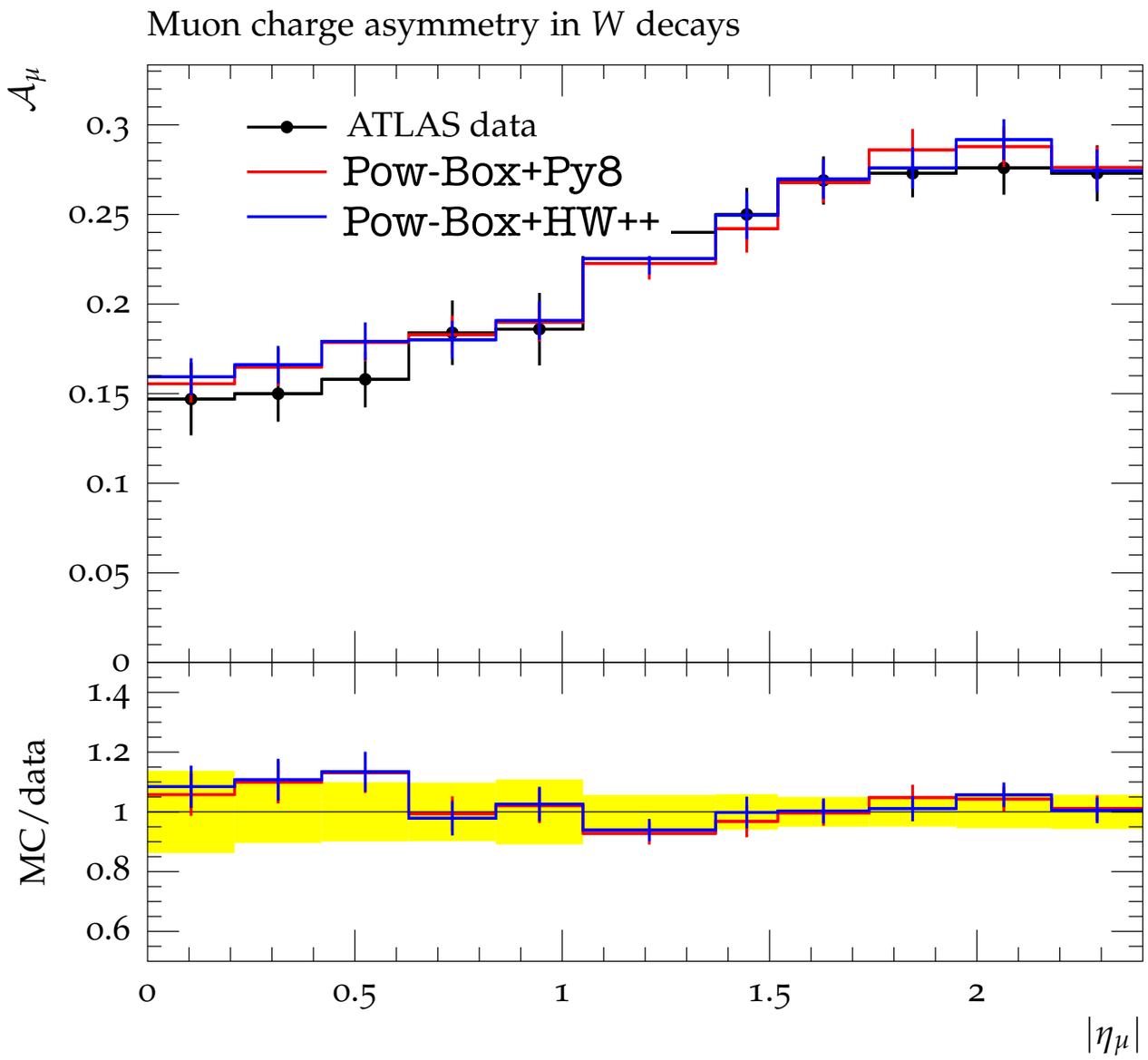
- Non-perturbative corrections [hadronizat^n & MPI] are negligible, in line with naive expectations

- Correction due to multiple [parton shower] emissions beyond single [hard] Powheg emission is not small: 20% increase at high p_T

Summary 2/2

- W / Z p_T robust against changes in Py8 shower
- Powheg-Box + Py8 and Powheg-Box + HW++ looked in pretty good agreement
- Checks with fully fledged internal HW++ Powheg simulation show truncated shower effects are negligible for this observable [+ many more besides]
- Powheg-V simulations agree well w. NLO+NLL p_T from development version of enhanced Powheg-VJ

Muon charge asymmetry



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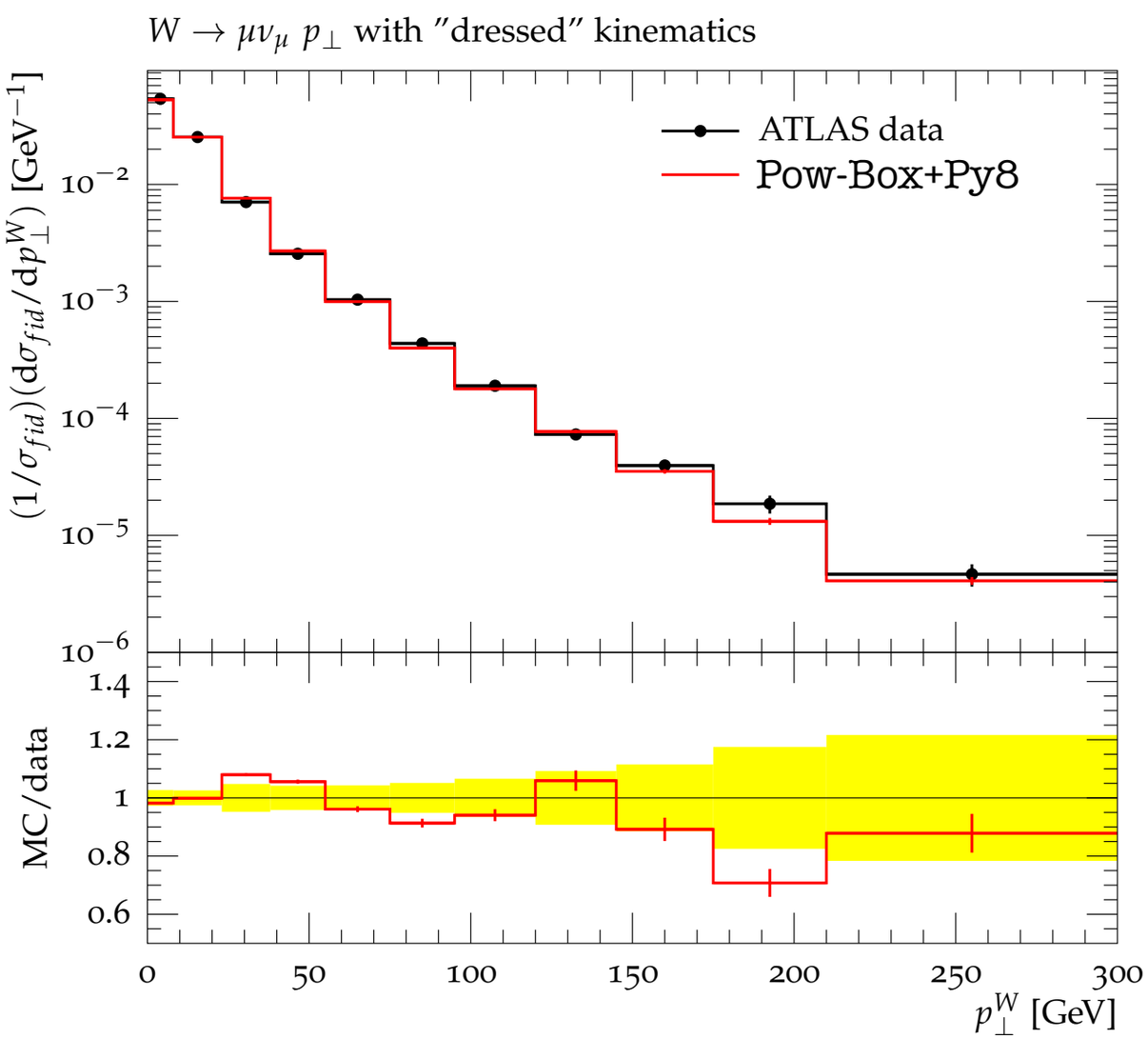
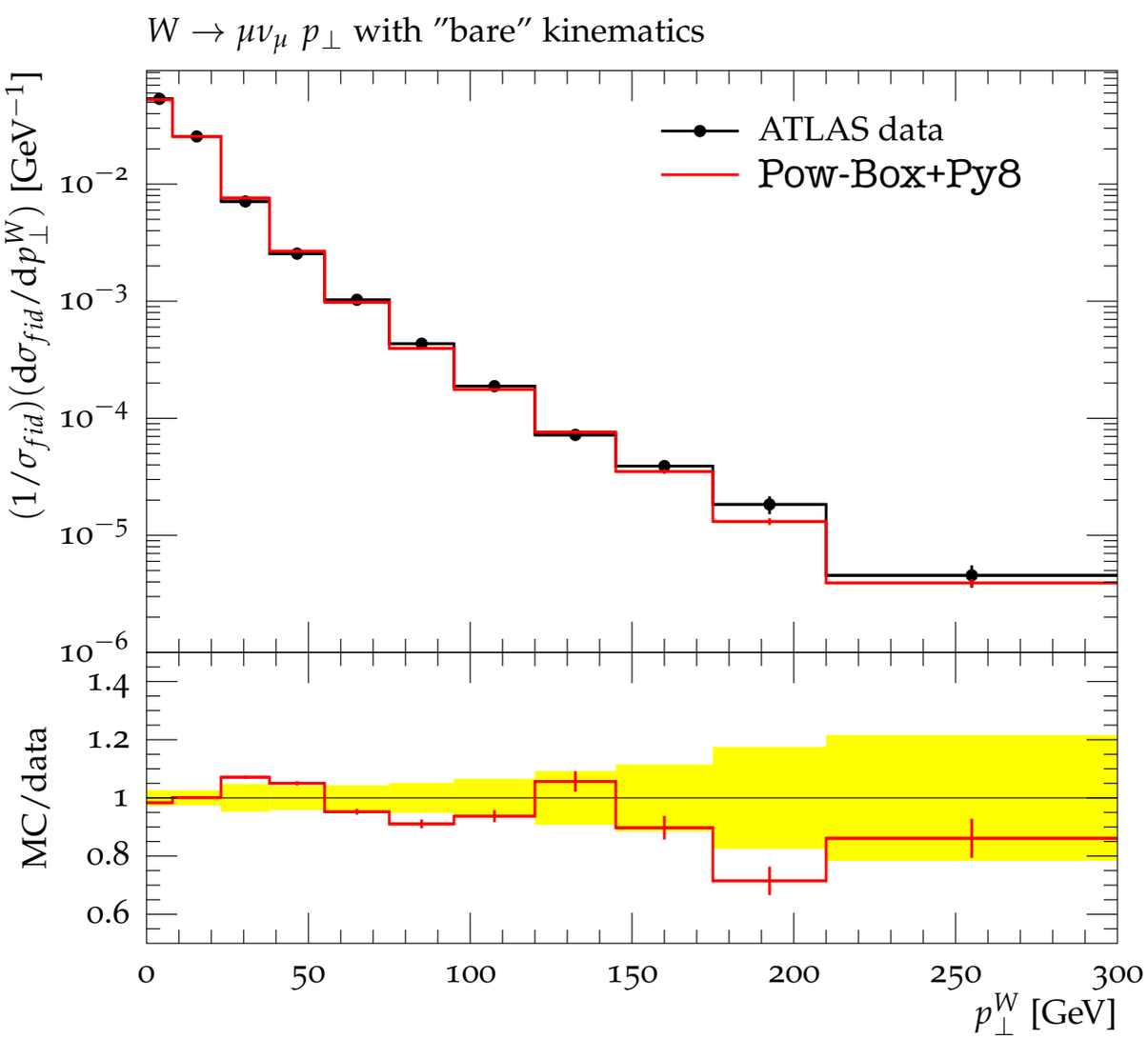
Powheg-Box W / Z programs + Pythia 8

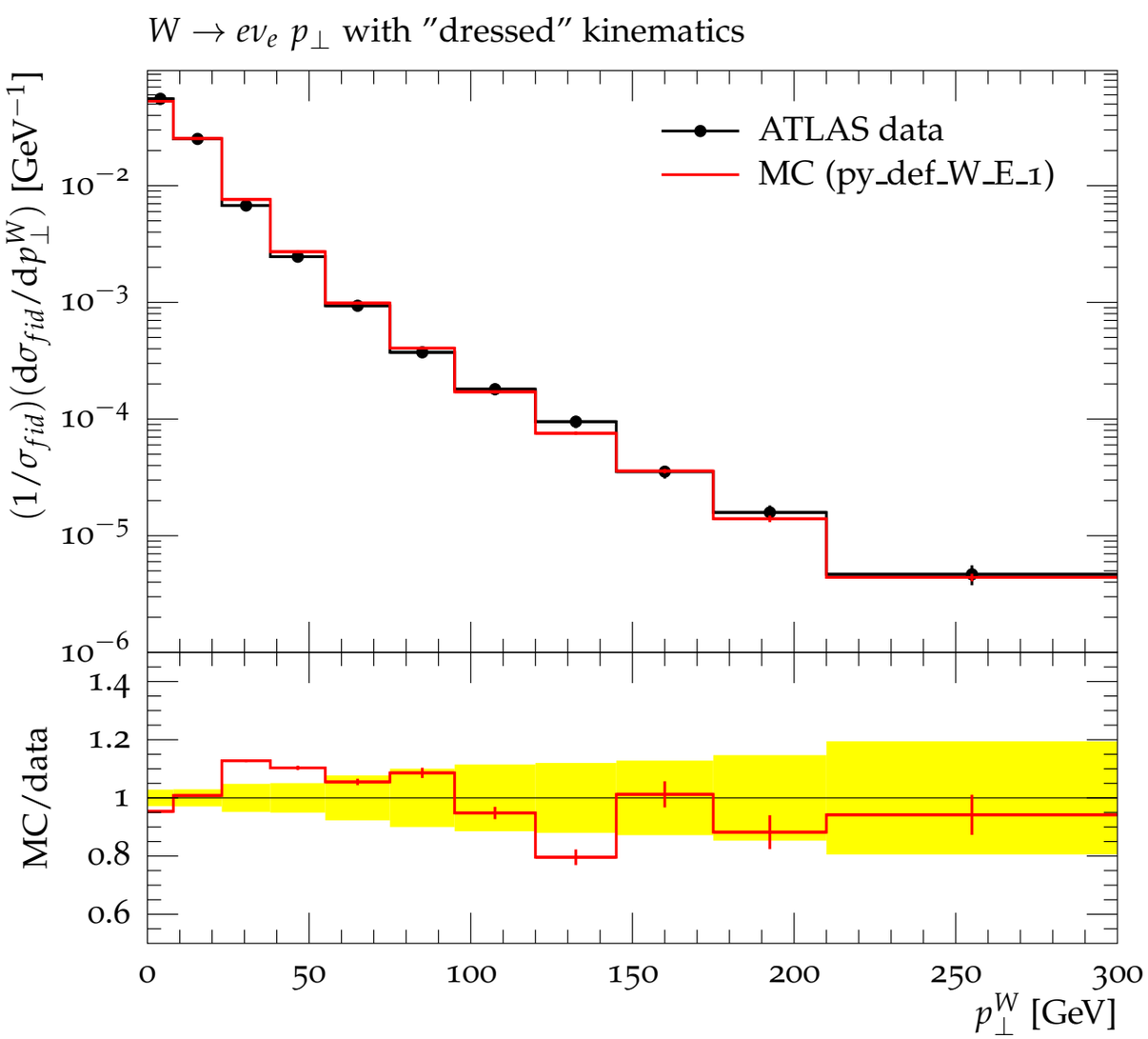


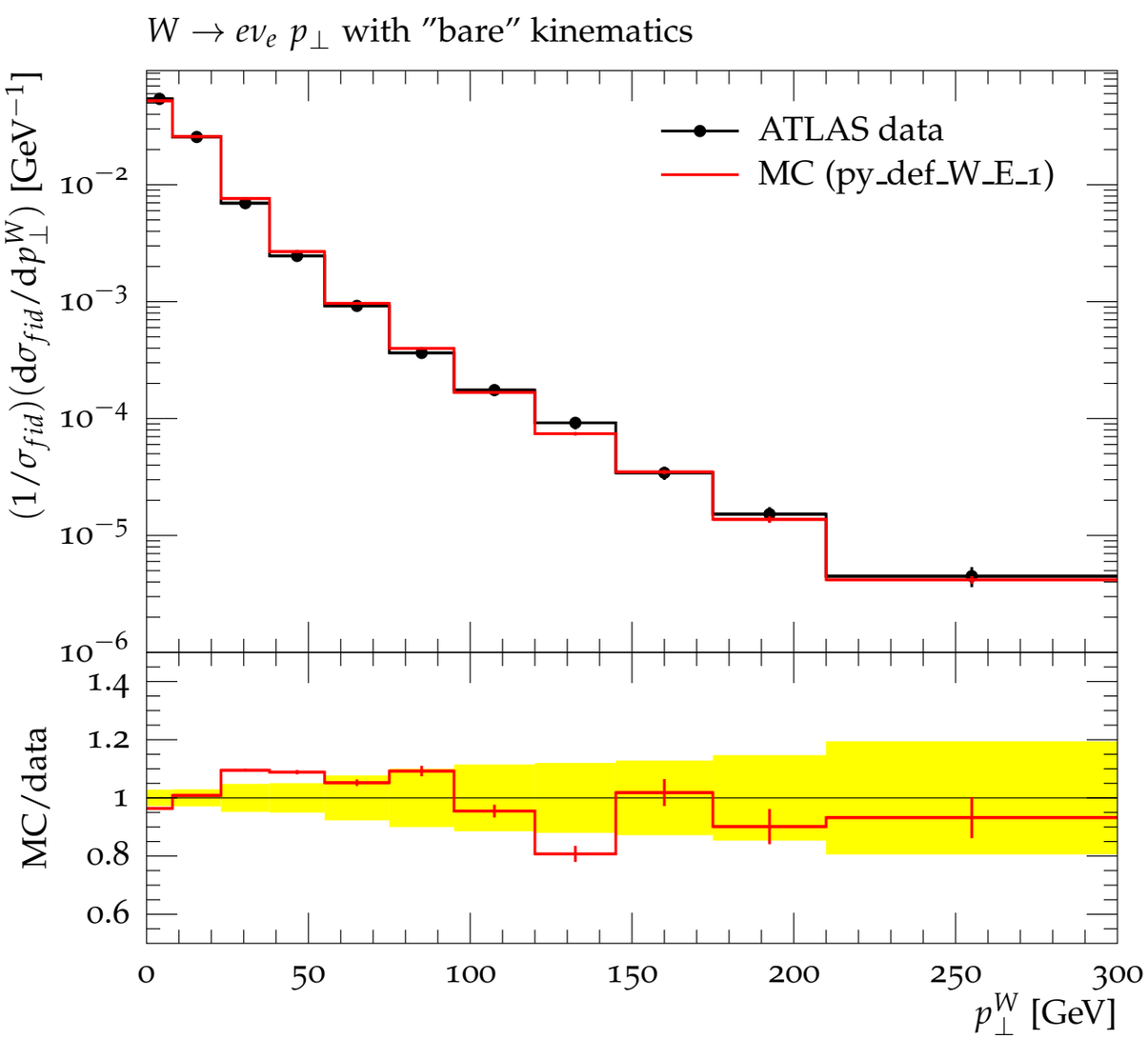


- W→μν p_T
- "Dressed" vs. "Bare" kinematics - hard to distinguish.

[Rivet analyses by E.Yatsenko & J.Katzy]

Powheg-Box W / Z programs + Pythia 8





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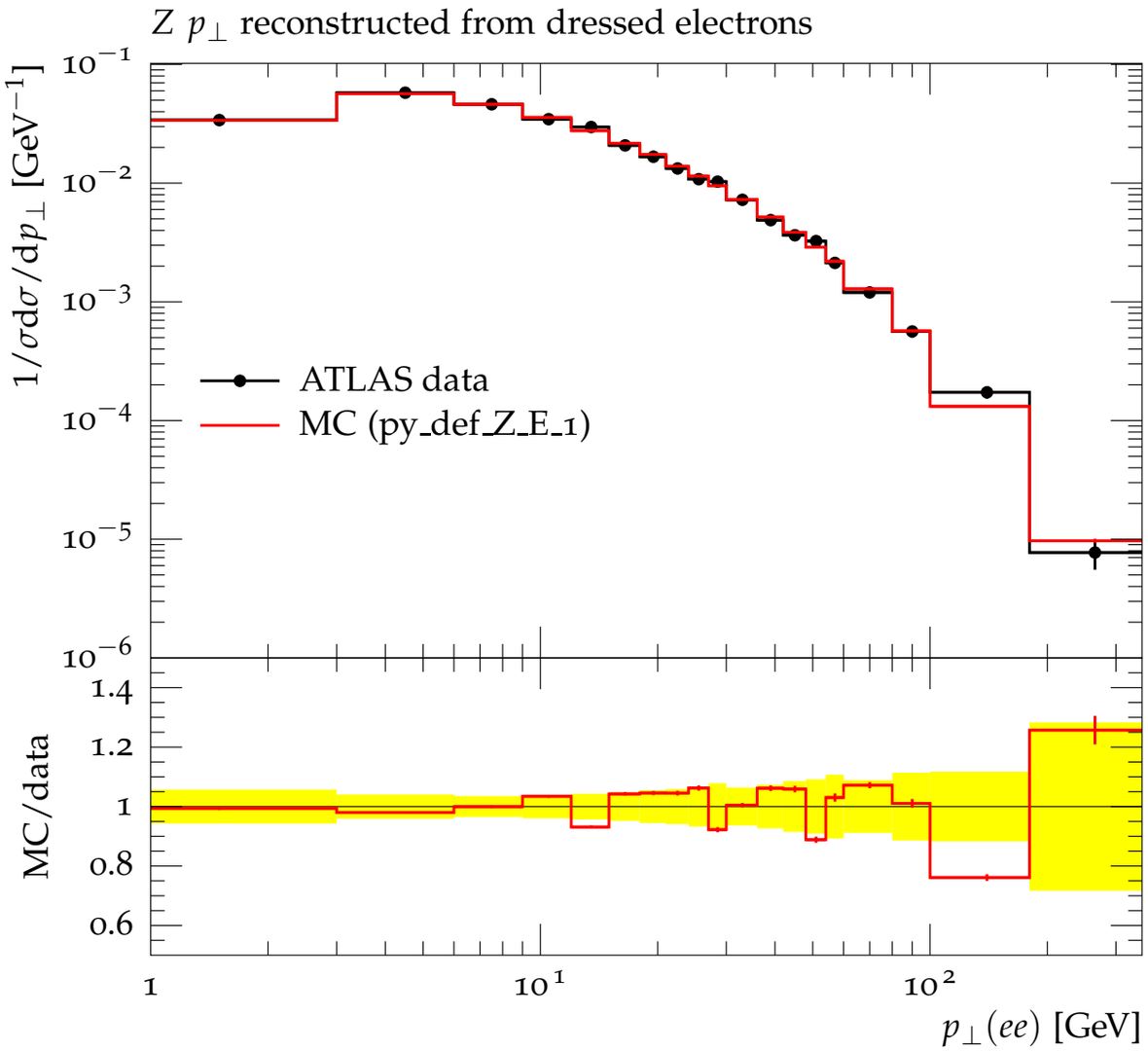
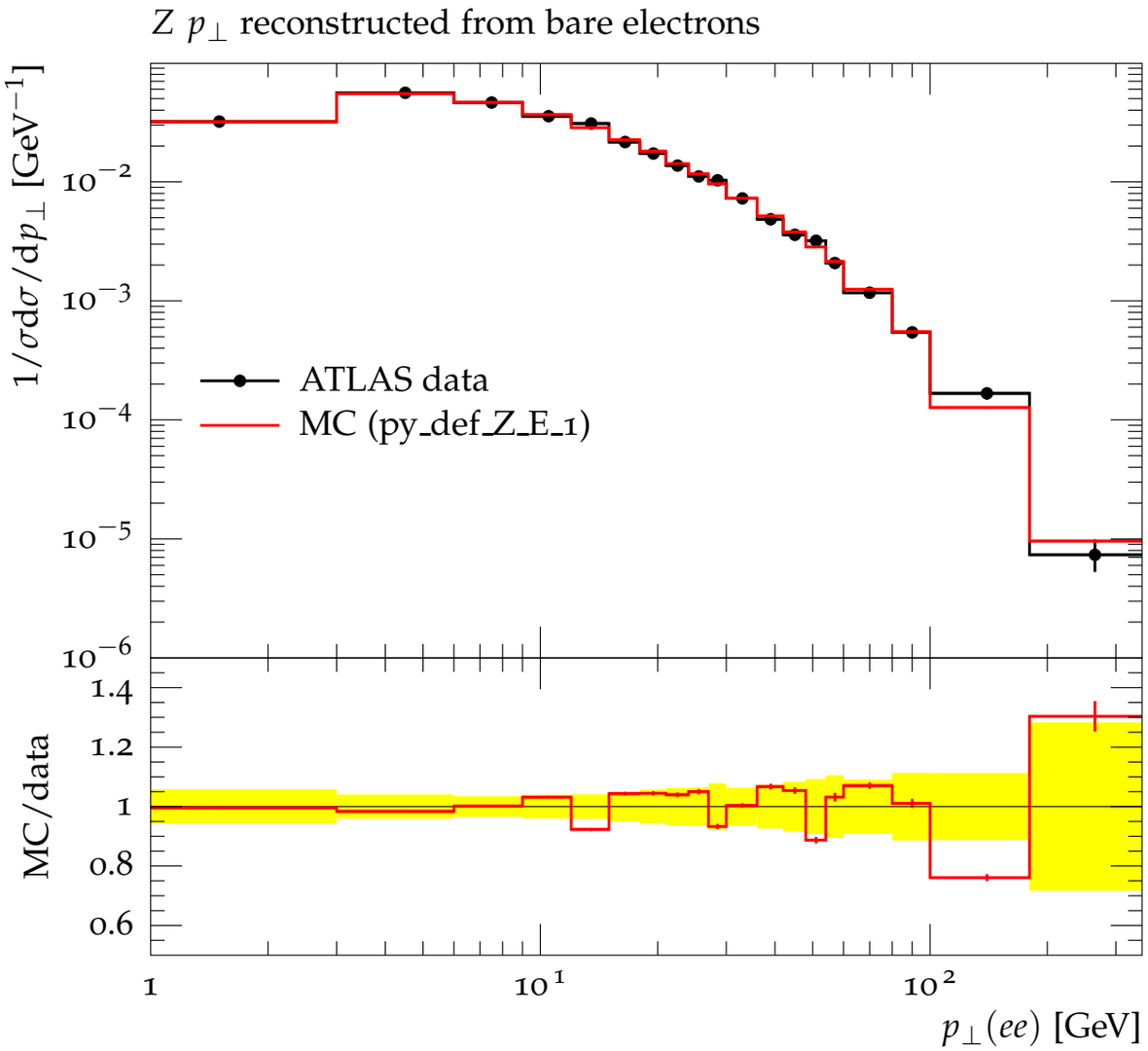
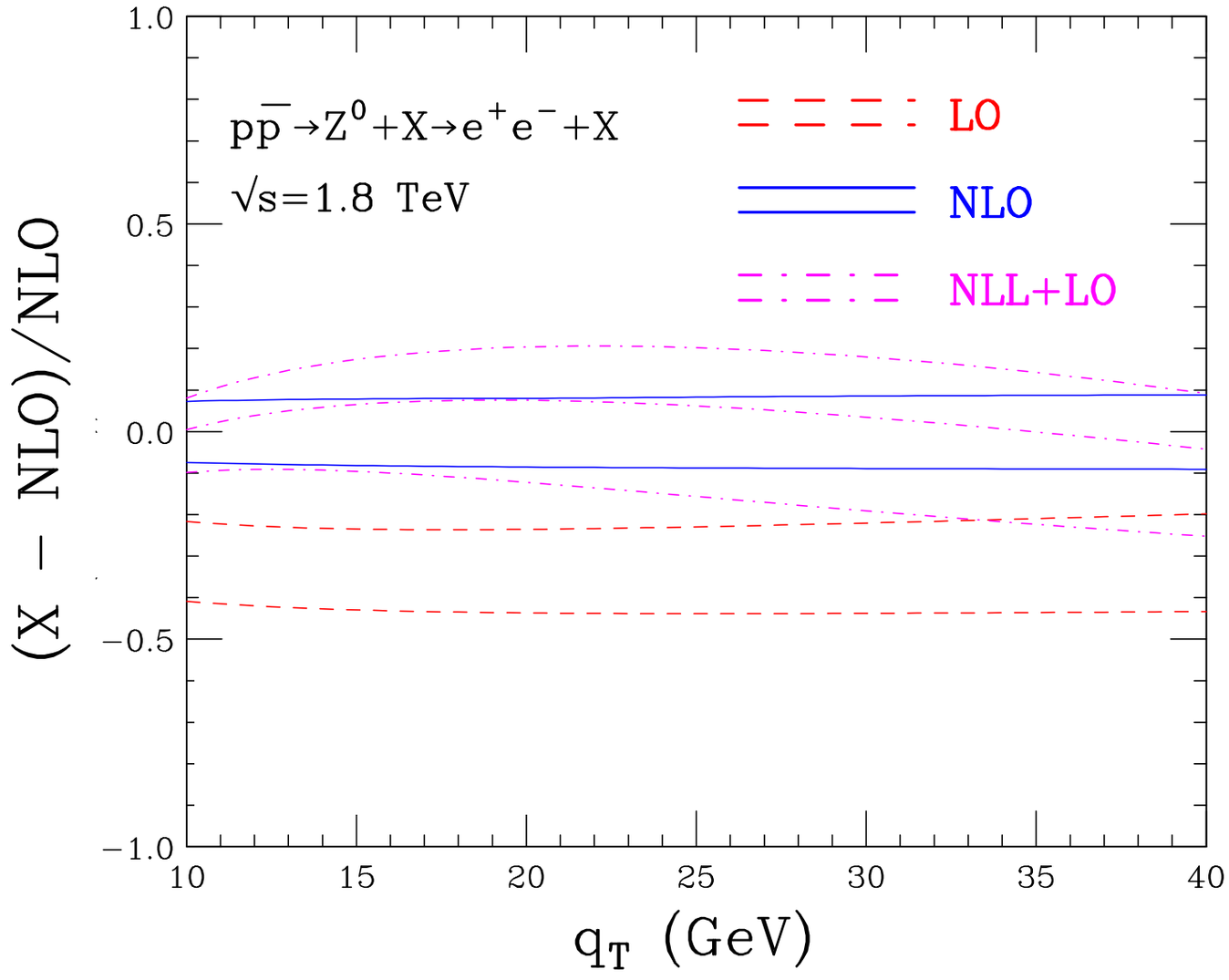




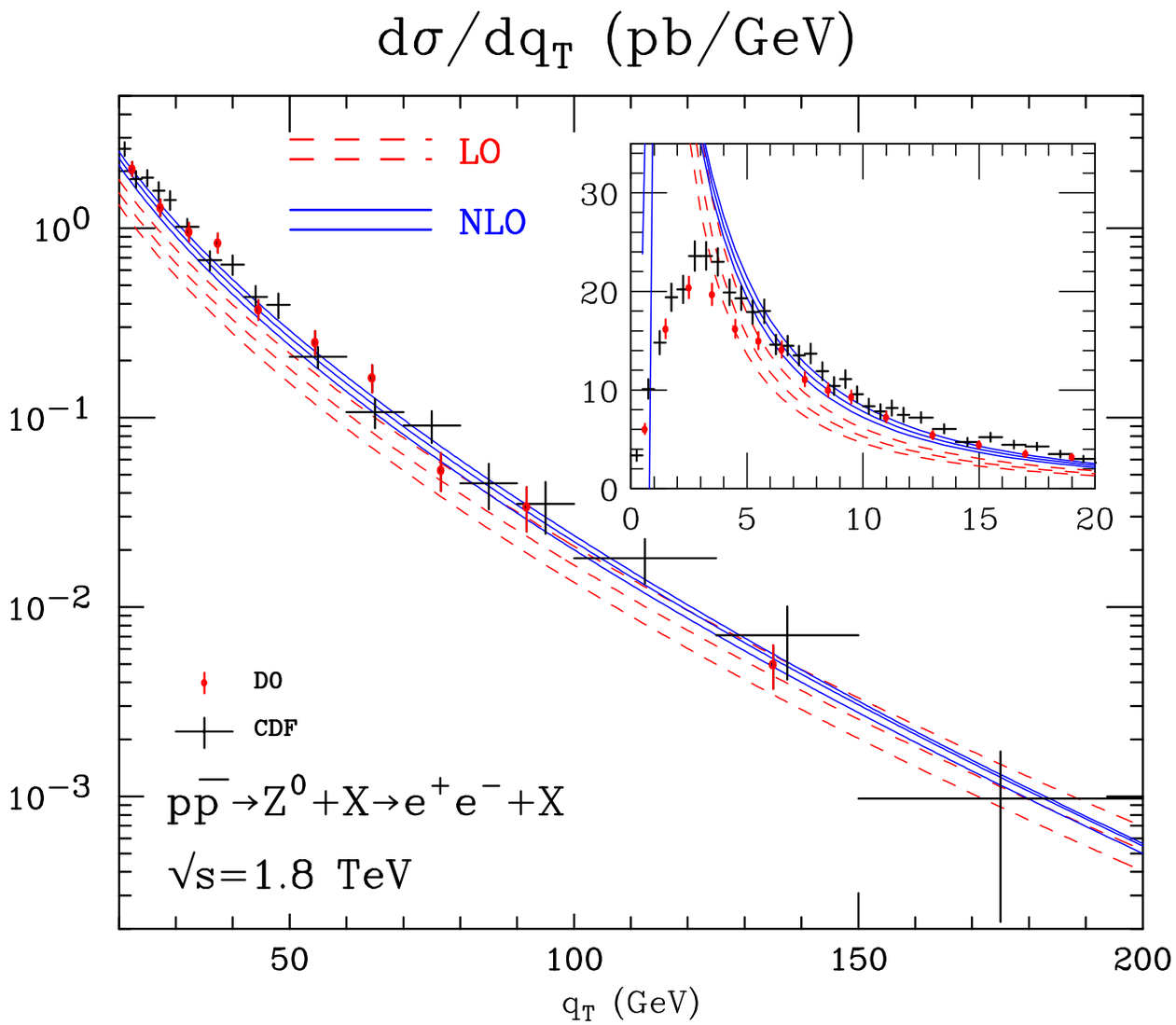
- Z→ee p_T
- “Dressed” vs. “Bare” kinematics

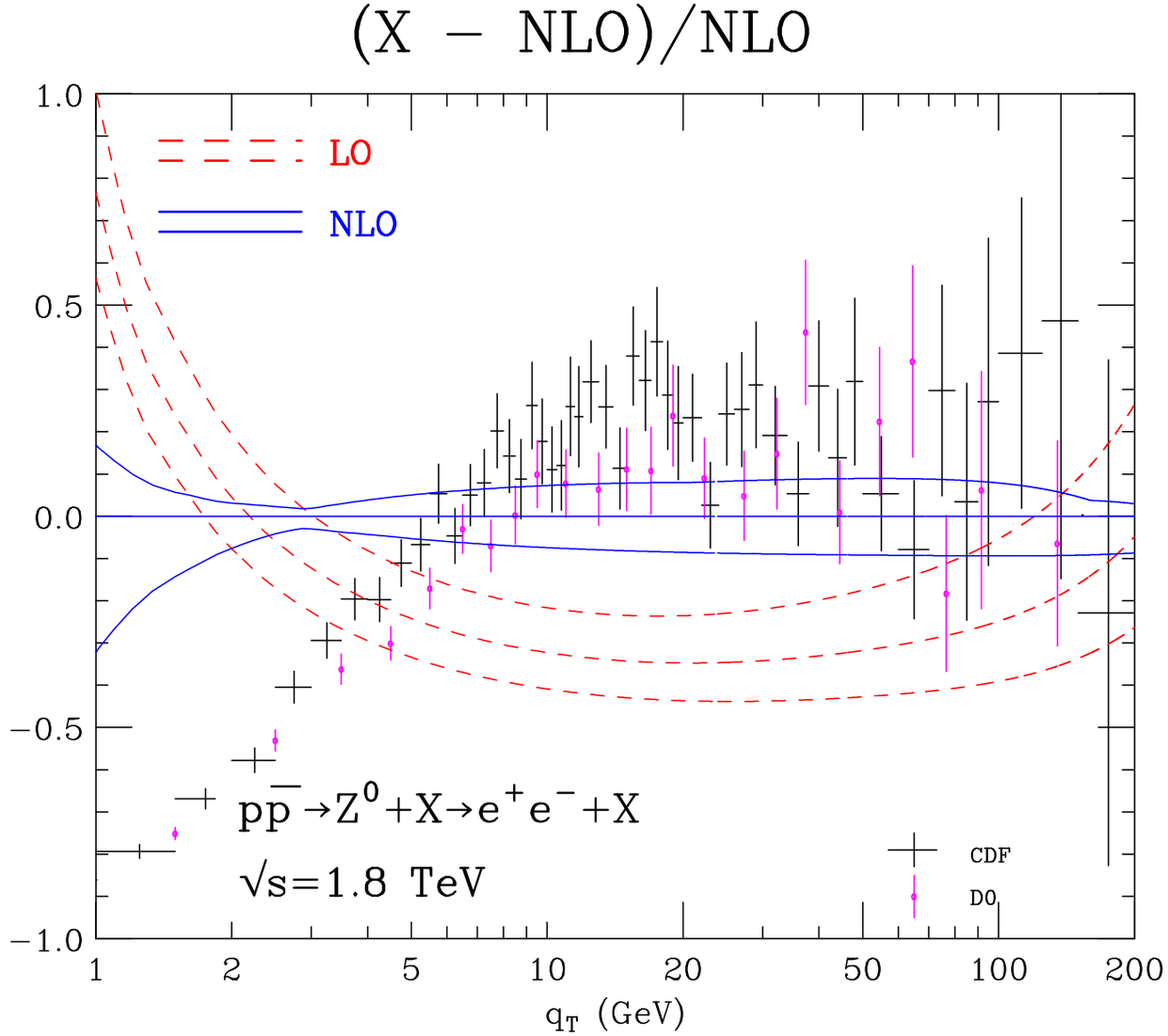
Bozzi, Catani, de Florian, Ferrera, Grazzini [NPB 2009]



- NLO μ_R & μ_F unc. at $p_T = 40$ GeV is 20% and increasing ⬅
- NLL μ_R & μ_F unc. at $p_T = 40$ GeV is 20% and decreasing ⬅
- More recent 2011 NNLL+NLO computation confirms
- Accuracy not degraded by NLO → NLL+LO for $p_T < 40$ GeV

Bozzi, Catani, de Florian, Ferrera, Grazzini [NPB 2009]





- $p_T < 70$ GeV: LO & NLO μ_R & μ_F error bands don't overlap
  … and NLO band is shrinking
- Err. redefined to be 'more reliable' for $p_T < 70$ GeV :

  $\Delta(\mu_R, \mu_F) = \mathrm{NLO}_{\text{central value}} - \mathrm{LO}_{\text{closest value}}$
- Err. again 'unreliable' for $p_T < 20$ GeV - starts shrinking