A critical appraisal of NLO-matching methods

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Creator:inkscape 0.46

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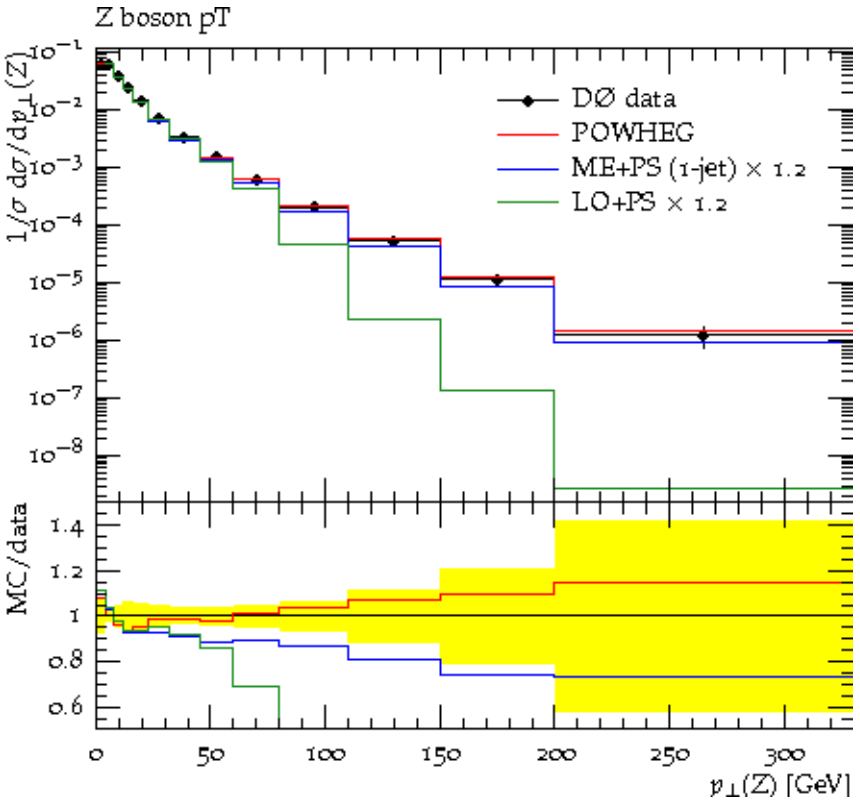
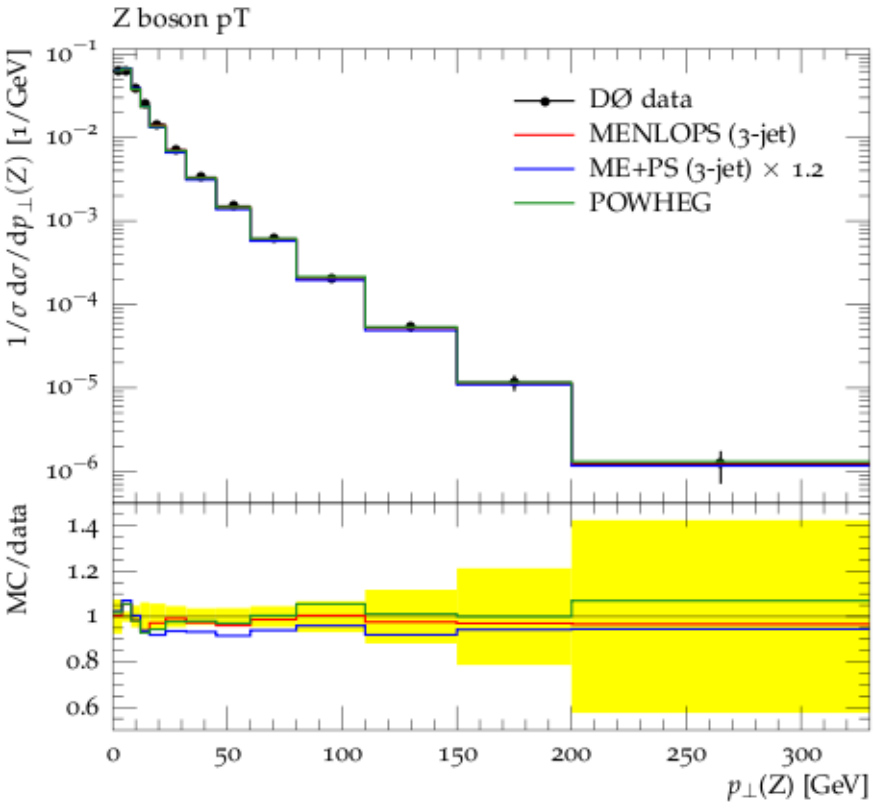
Some example results

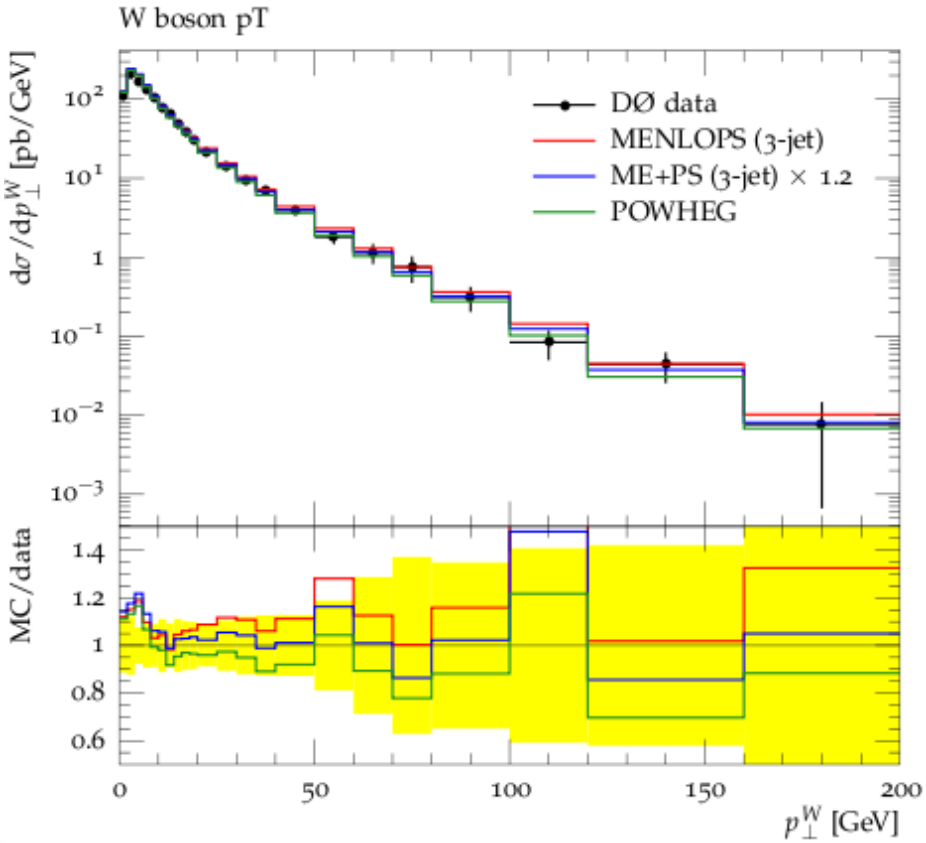
- p_T^Z at Tevatron

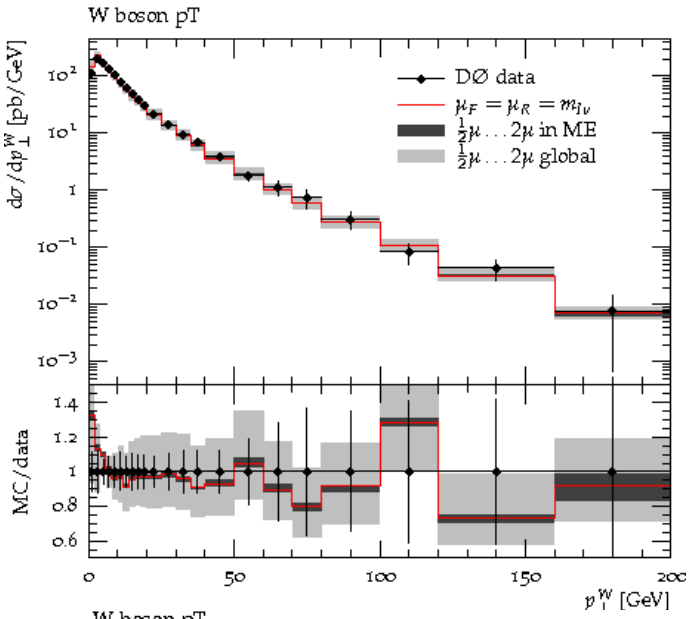


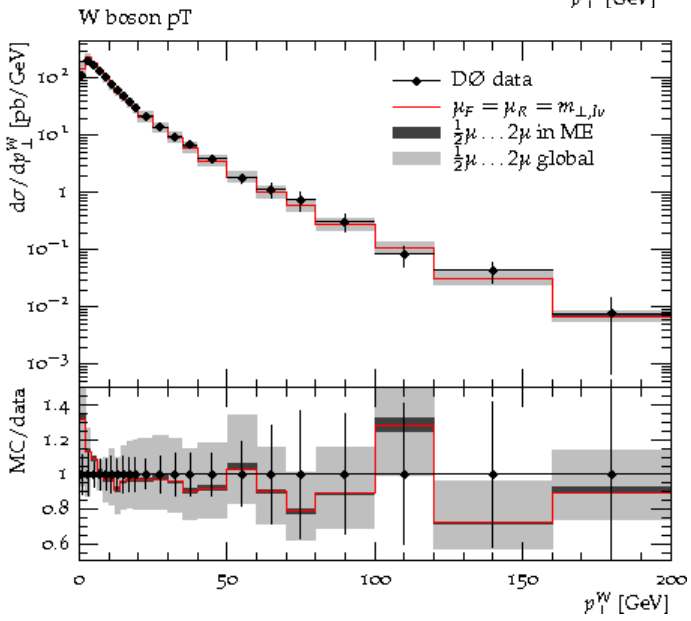


Some example results

- p_T^W at Tevatron: scales

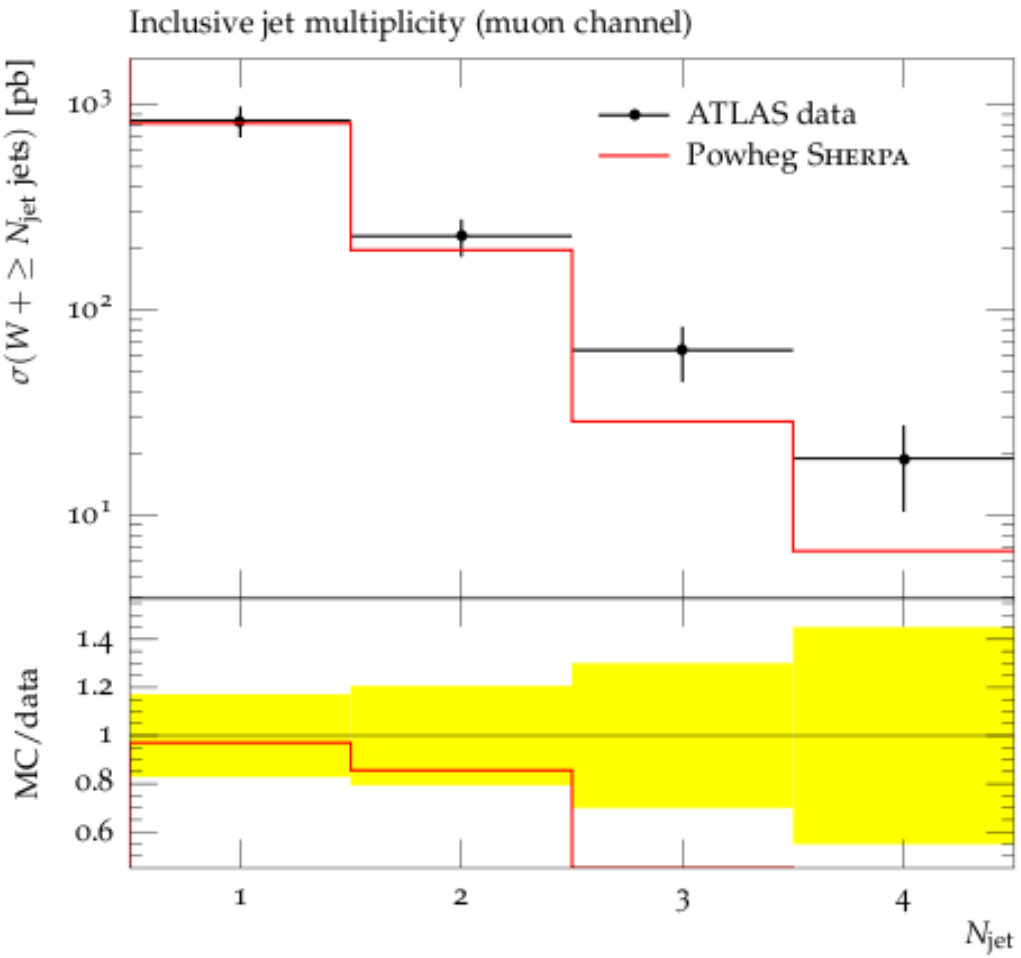


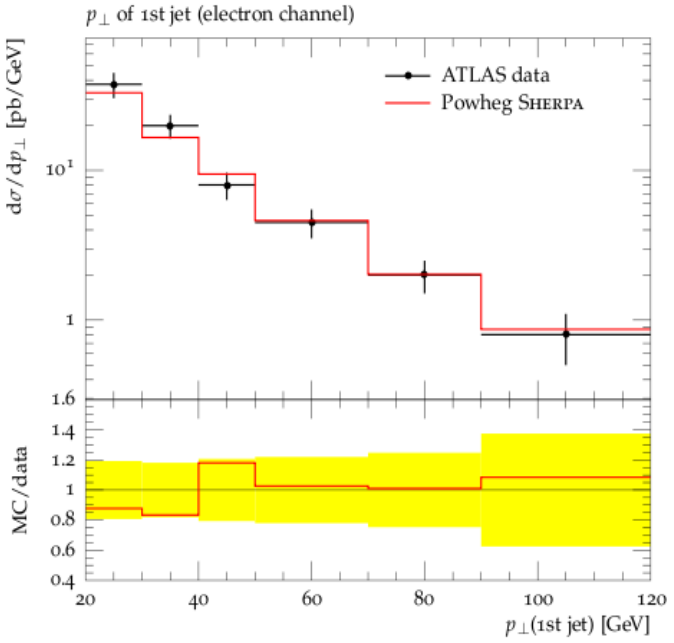


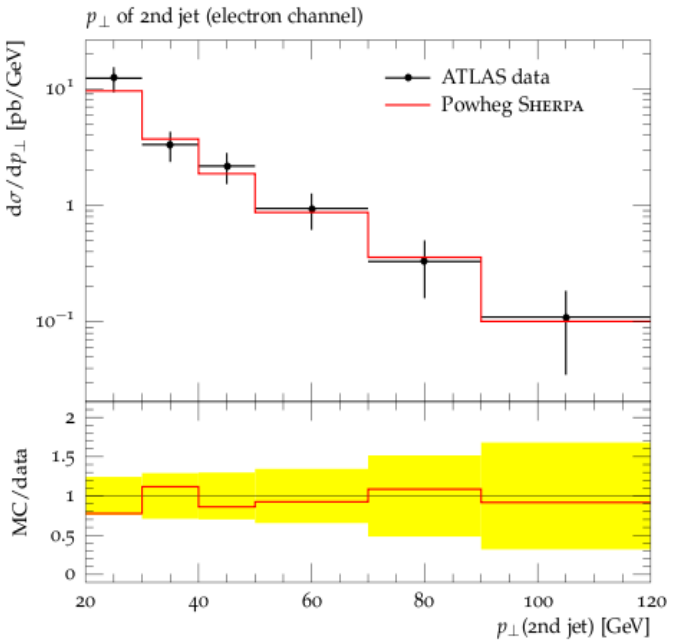


Some example results

- W+j @ LHC







Issues never really discussed:

1. Link between R and B:

   Powheg thrives on ratio R/B, must obtain R by emitting from B
   → this link is not unique, different B may lead to same R and vice versa; manifest problems in CS, maybe alleviated in FKS subtraction → no discussion in literature for complicated processes

2. Using the shower to construct subtraction:

   MC@NLO (indirectly) uses the parton shower for subtraction – which does not catch divergences in subleading colours
   → need to introduce fudge factors or similar
   → alternative: shower with sub-leading colours included

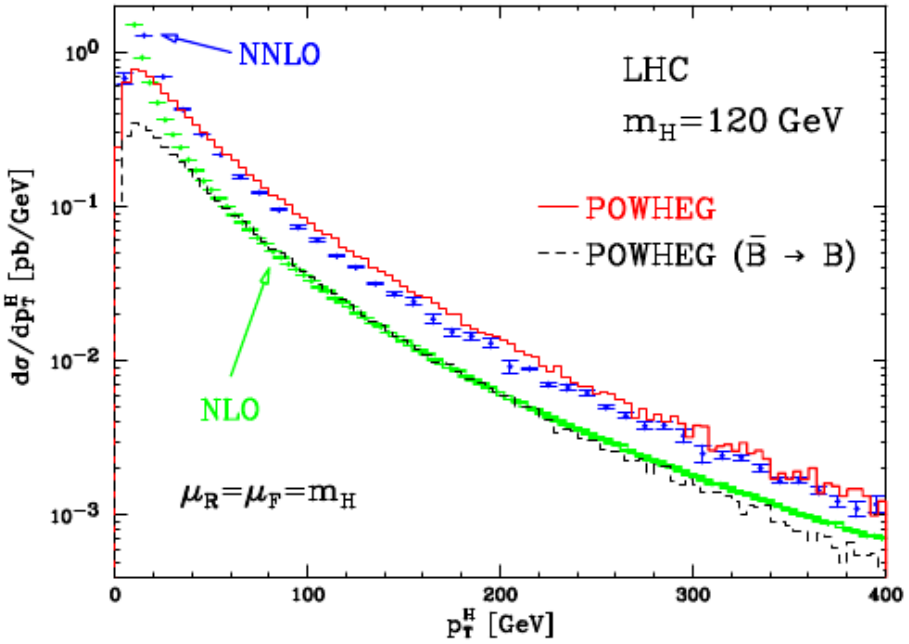
3. Exponentiation:

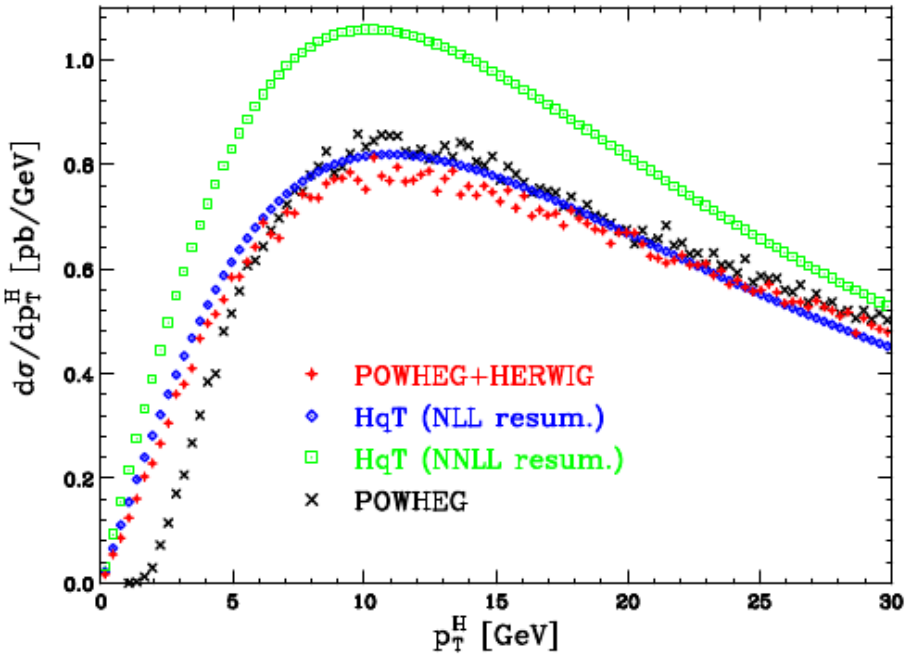
   In Powheg R/B gets exponentiated over full phase space
   → are these the correct logarithms?

Will concentrate on this in the following

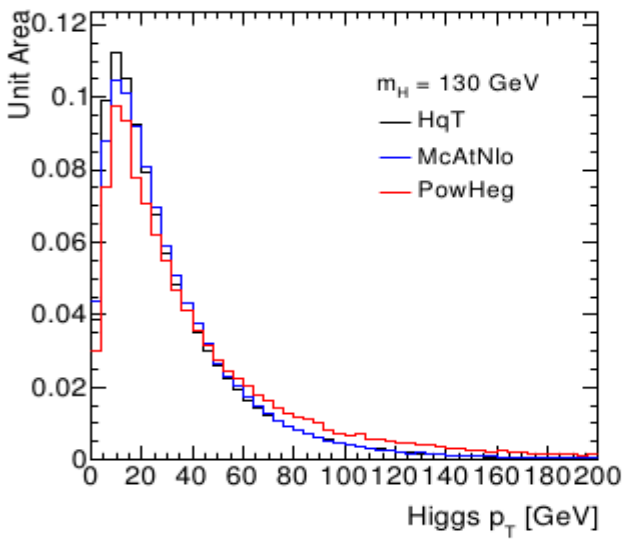
Differences between approaches

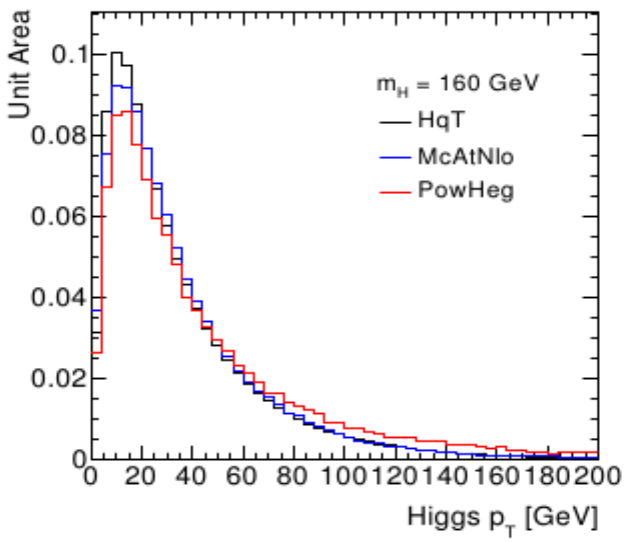
- Compare Higgs pt-spectrum with fixed order and resummation results.
- Study done by Powheg authors below
- Study done by Atlas group next slide

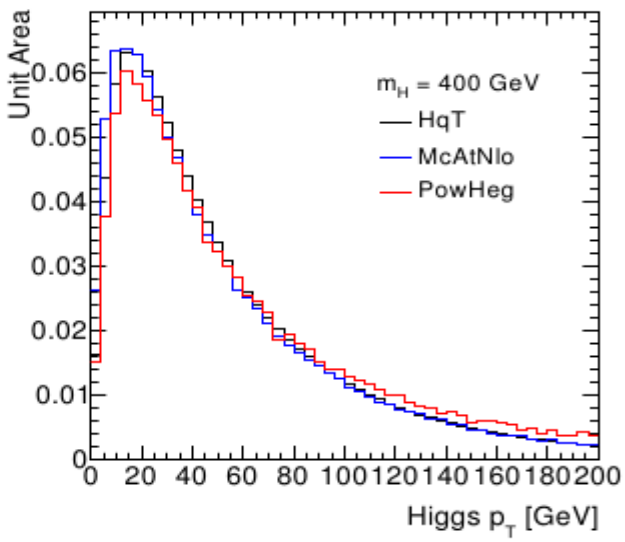


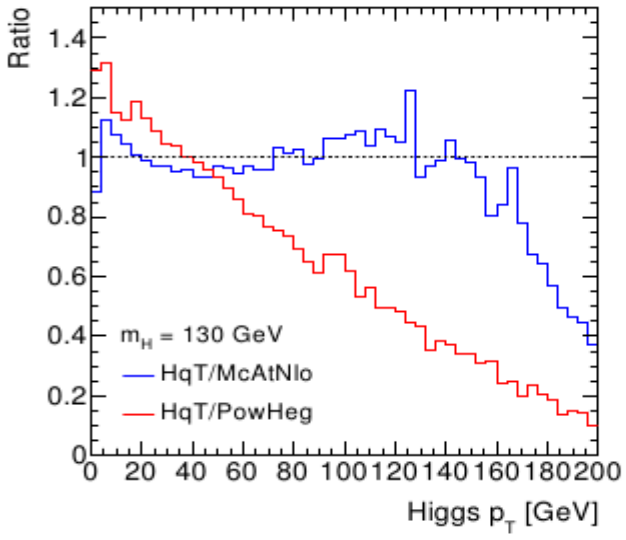


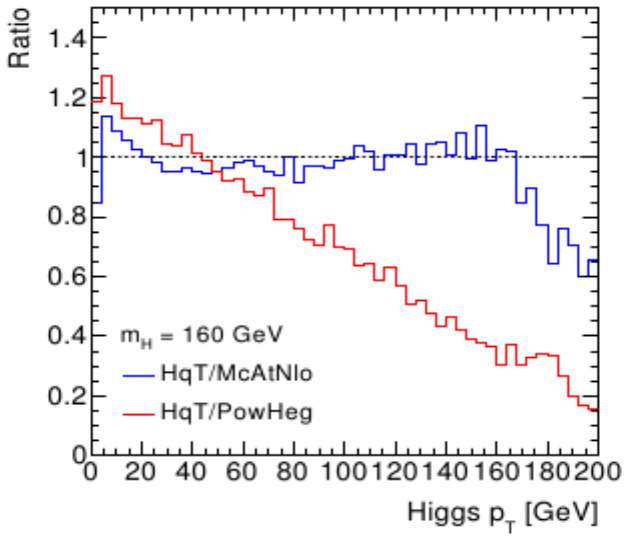
Differences between approaches

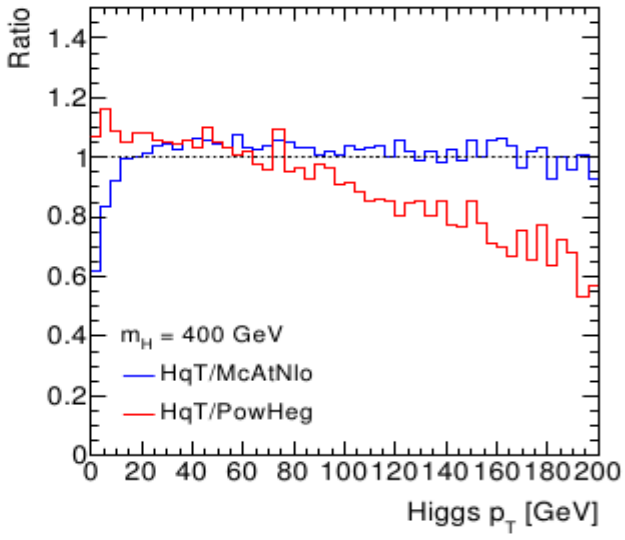












Differences between approaches

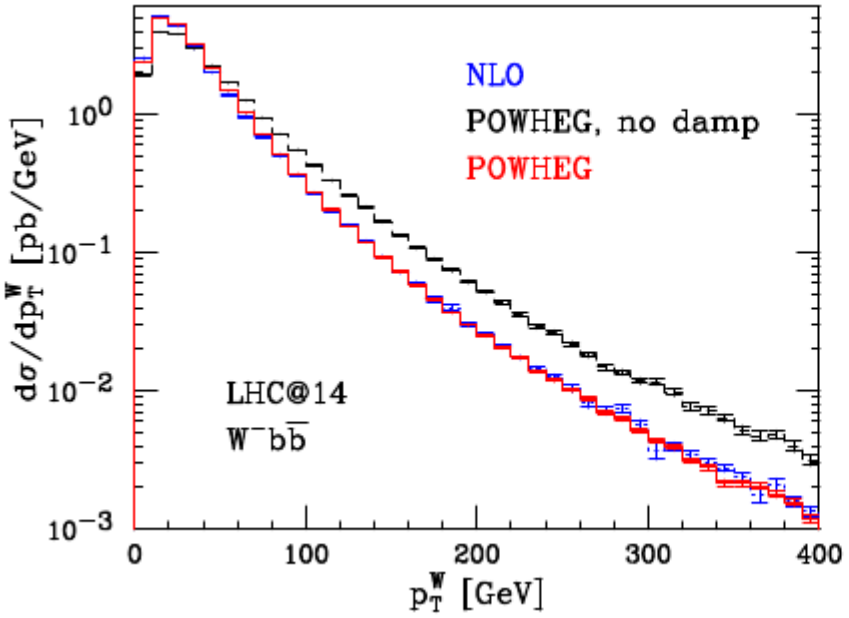
- There seems to be a harder pt spectrum in Powheg than in MC@NLO, recently in Wbb it was more than one order of magnitude above NLO result (next slide)
- Authors connect this to (unknown) NNLO corrections → too good to be true?
- But: In most processes by now they add a tunable adjustment function, softening the high-pt tails and putting them into the $R^{(\text{non-sing})}$ bit

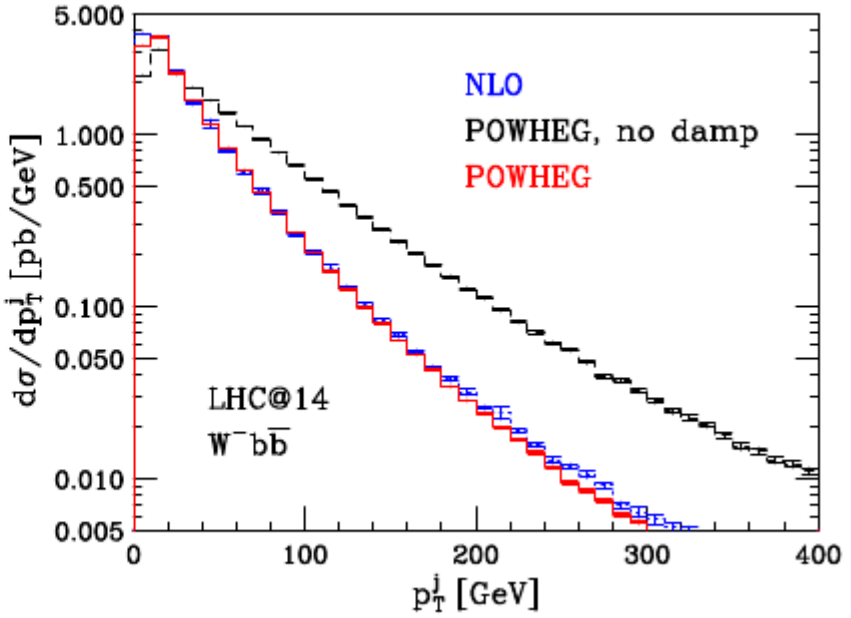
  (no exponentiation of R/B over full phase space)
- Check gg → H as test-case.

  (Different from DY production by more than a colour factor.)

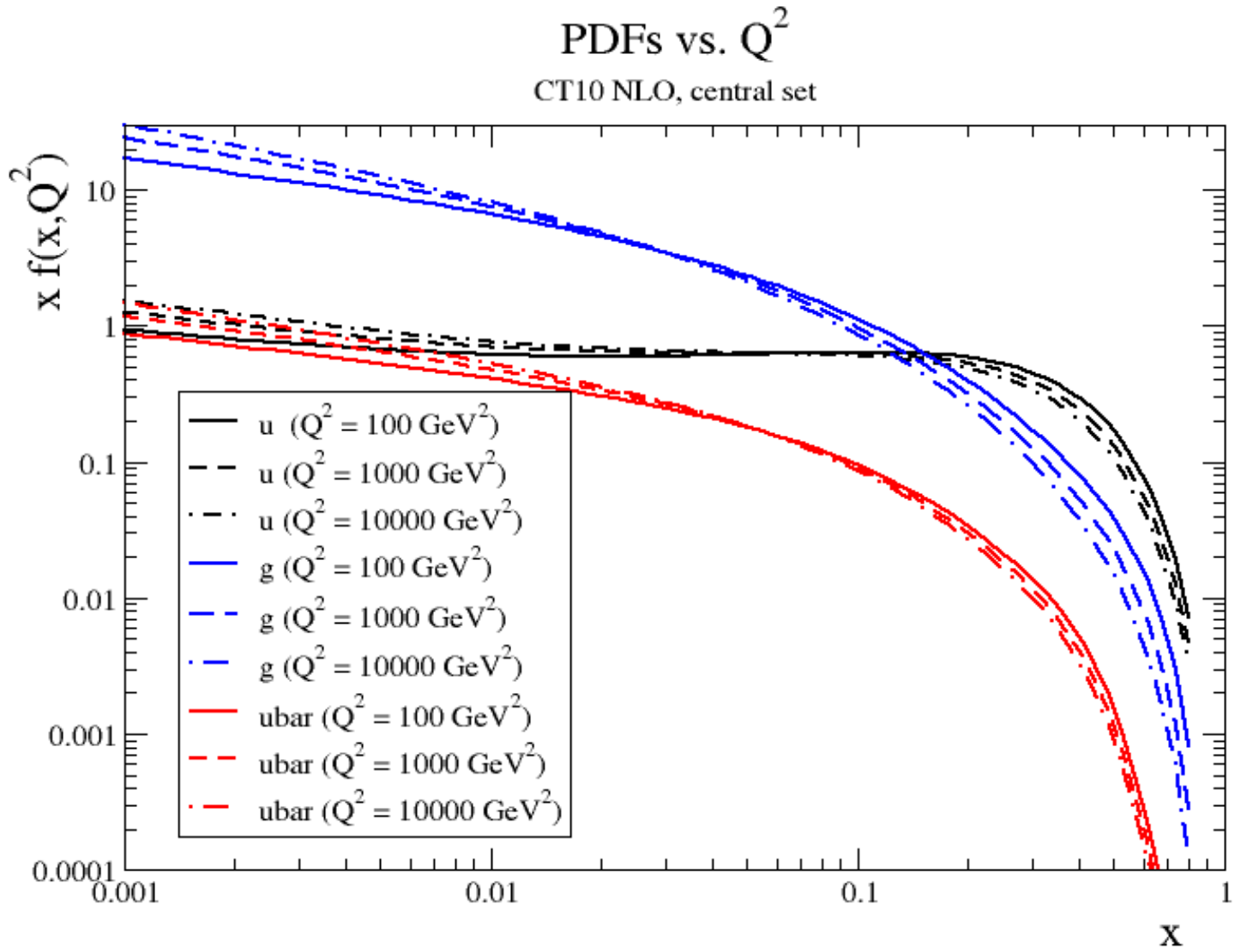
Differences between approaches

- Wbb production in Powheg (at LHC, 14 TeV)



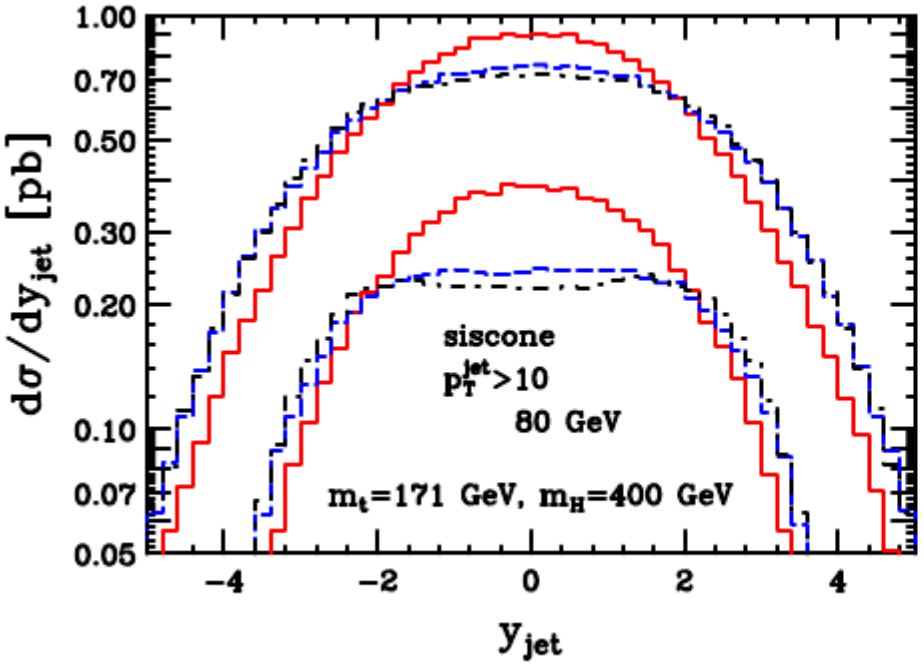


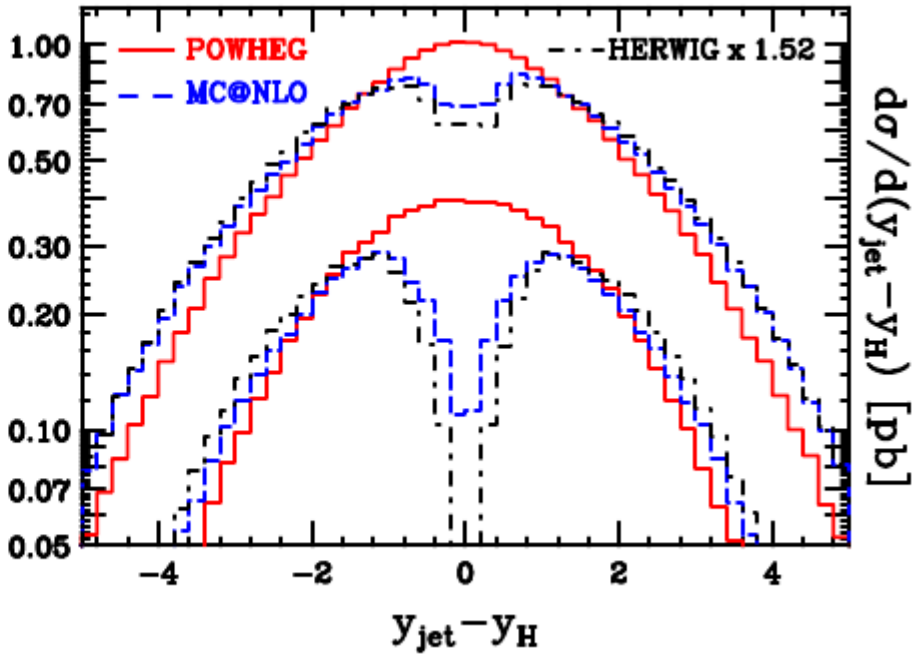
Why gg → H is different from DY

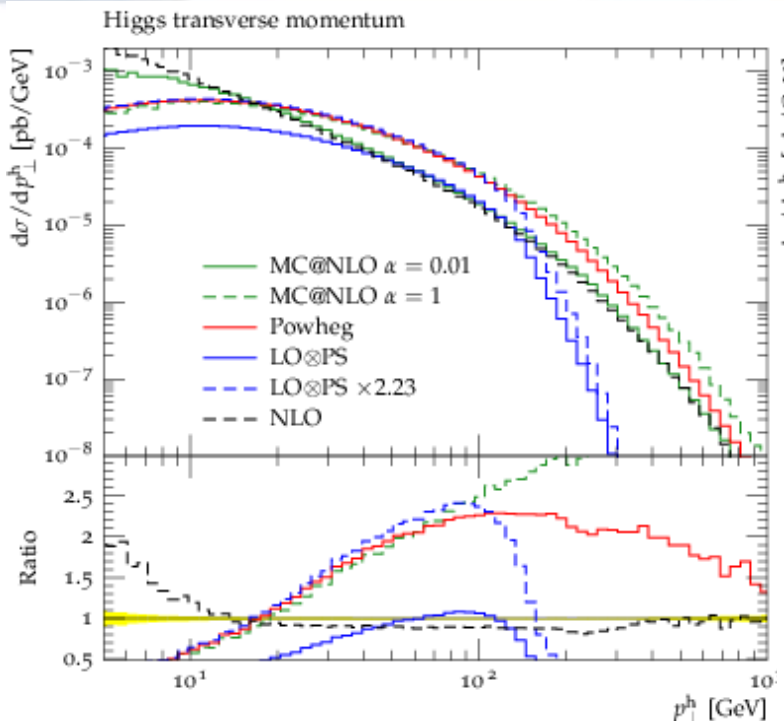


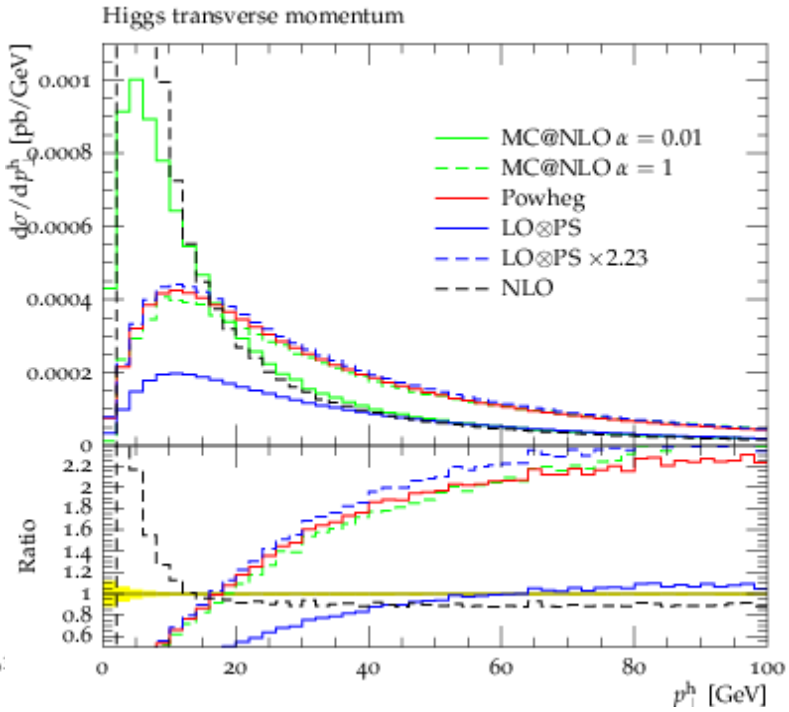
Differences between approaches

- Apart from the different pt-spectrum, there is also another interesting feature in how the phase space is filled in the two different approaches.
- They are, again, attributed to different higher order contributions.
- I have some doubts concerning this interpretation (next slides)






Higgs transverse momentum
MC@NLO α = 0.01
MC@NLO α = 1
Powheg
LO⊗PS
LO⊗PS ×2.23
NLO
Ratio
$p_\perp^h$ [GeV]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MC@NLO α = 0.01
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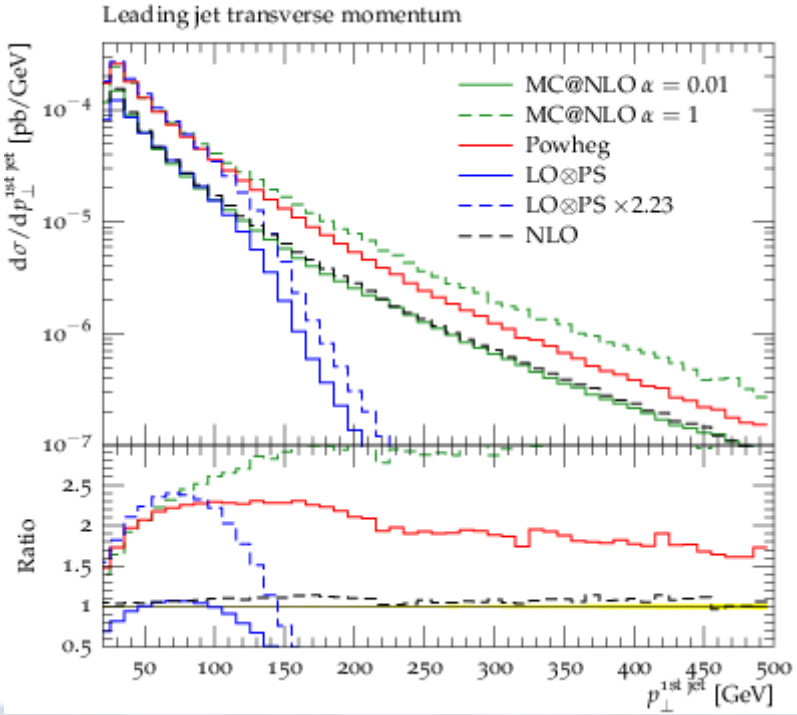
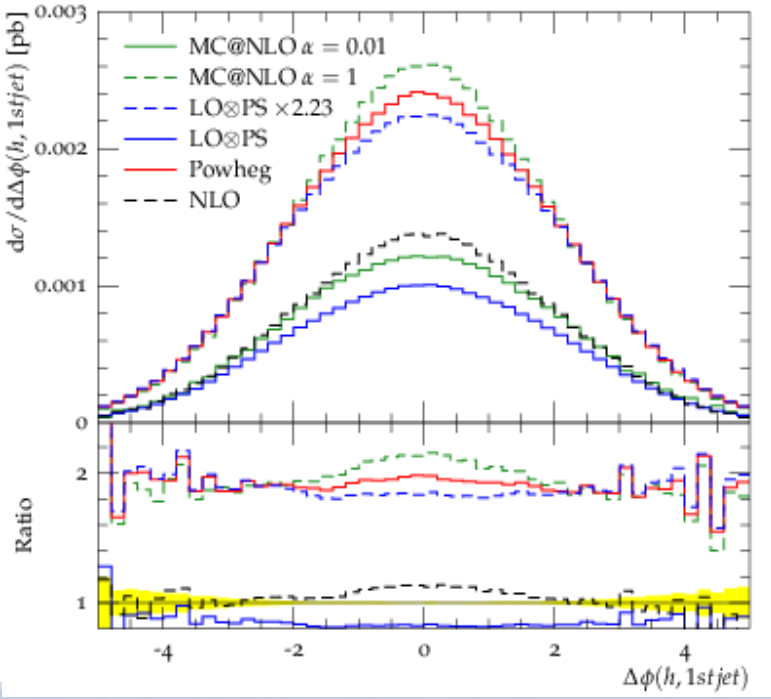
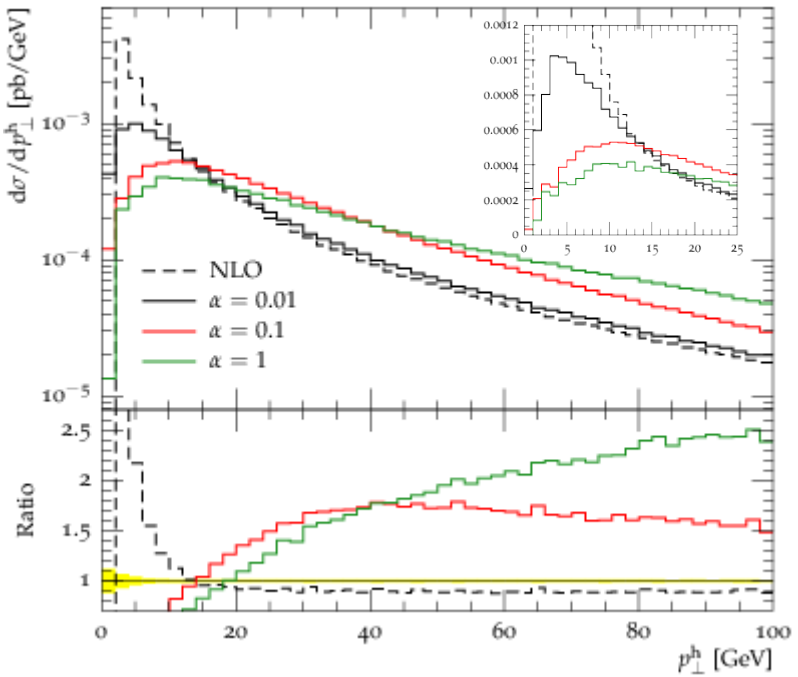
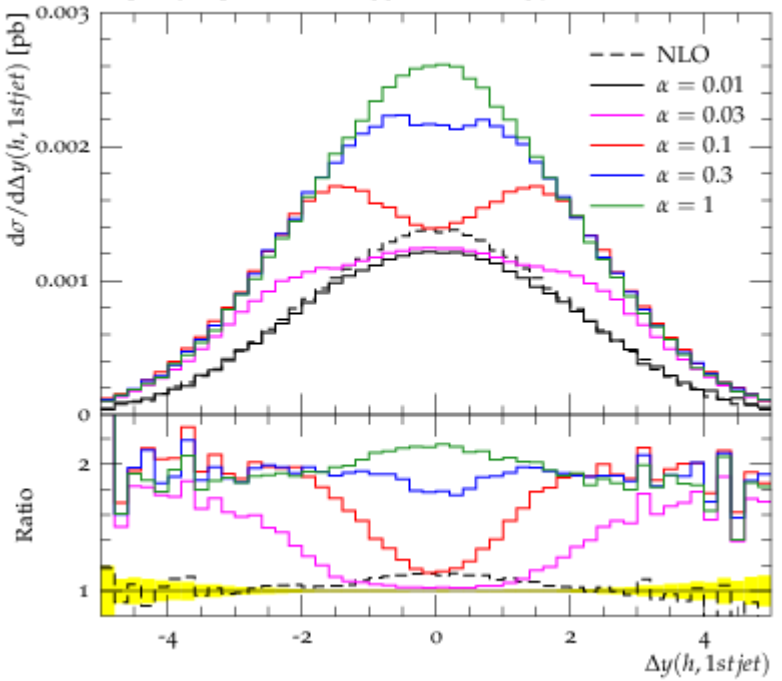

Leading jet transverse momentum
MC@NLO α = 0.01
MC@NLO α = 1
Powheg
LO⊗PS
LO⊗PS ×2.23
NLO
Ratio
$p_\perp^{1st\ jet}$ [GeV]


MC@NLO α = 0.01
MC@NLO α = 1
LO⊗PS ×2.23
LO⊗PS
Powheg
NLO
Ratio
Δφ(h, 1st jet)

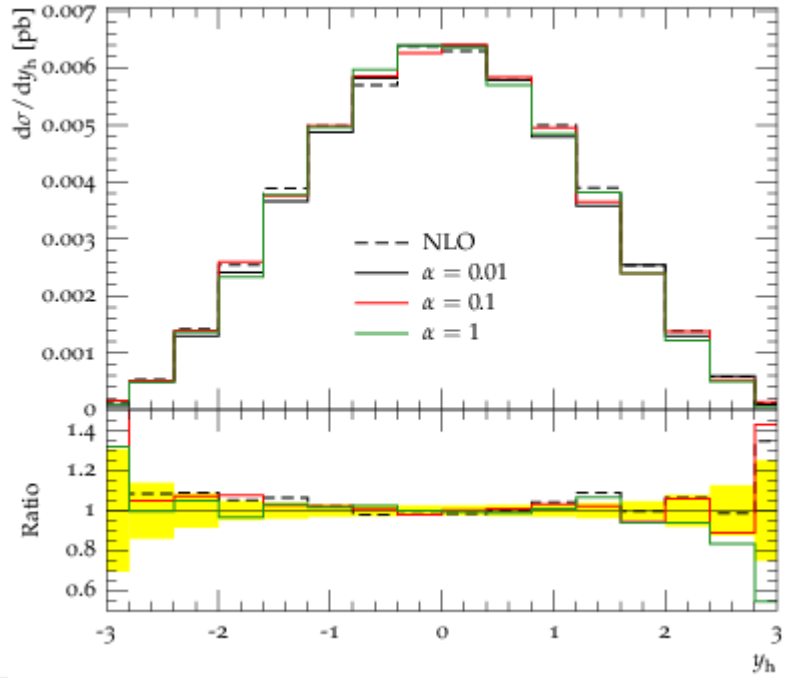
Higgs transverse momentum



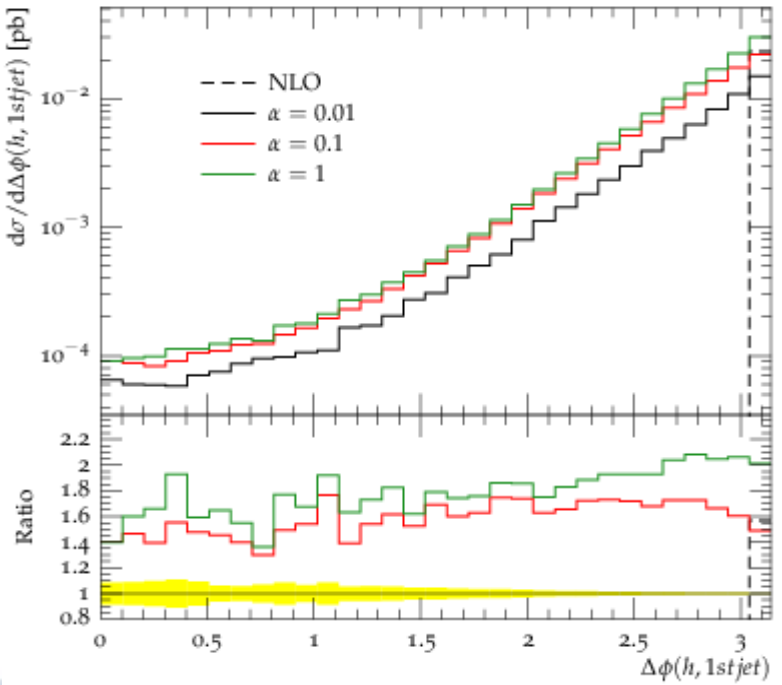
Rapidity separation of Higgs and leading jet



Higgs boson rapidity



Azimuthal separation of Higgs and leading jet



Conclusions

- Imho, NLO matching still not fully sorted out, despite different claims. MC@NLO and Powheg have been around for 10 and 5 years, respectively. But up to now, mainly processes with simple colours have been implemented.

  Exceptions: tt in MC@NLO, V+j & jj in Powheg

- Some aspects in these methods not fully understood yet (phase-space coverage, link of MEs for B and R, sub-leading colours, etc.)
- This leads to huge uncertainties, well above NLO uncertainties, clearly not acceptable if NLO accuracy is to be stated
- Before these aspects are solved we will not see any correct and meaningful “CKKW@NLO”-type simulation – different claims are probably overly optimistic