

Precision simulations for Higgs physics in SHERPA

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MEPs@NLO: Multijet-merging at NLO

(arXiv: 1207.5030, 1207.5031 [hep-ph])

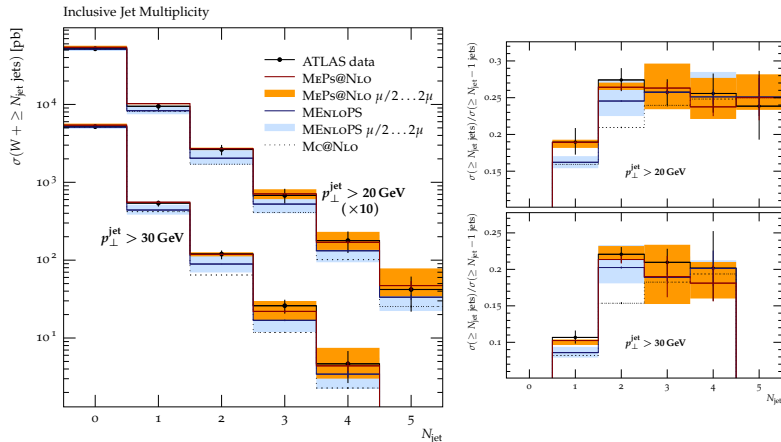
- basic idea like at LO: towers of MEs with increasing jet multi (but this time at NLO)
- combine them into one sample, remove overlap/double-counting

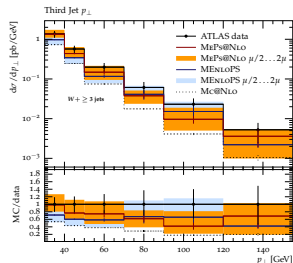
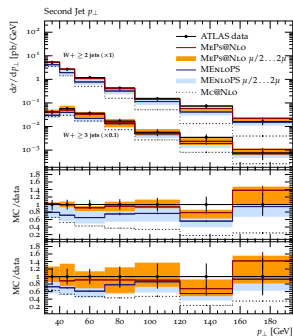
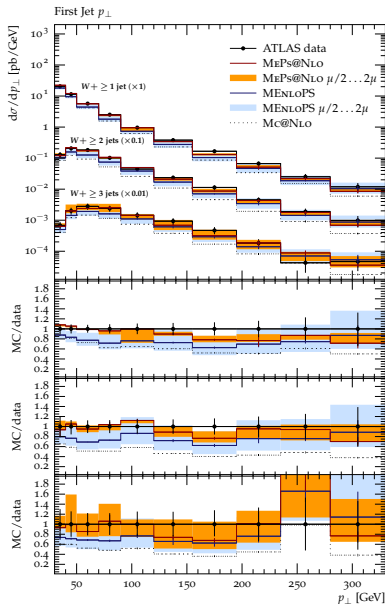
maintain NLO and LL accuracy of ME and PS

- this effectively translates into a merging of MC@NLO simulations and can be further supplemented with LO simulations for even higher final state multiplicities

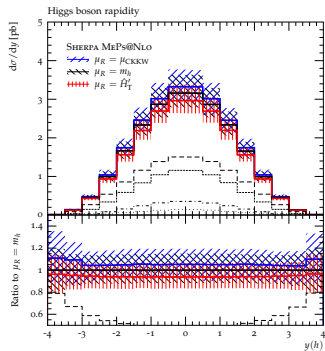
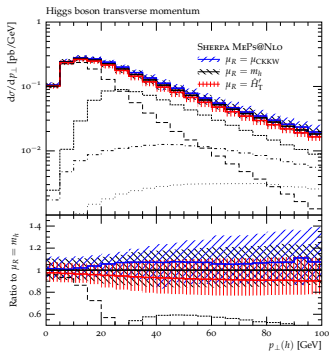
MEPs@NLO: validation in W +jets

(S. Hoeche, F. Krauss, M. Schoenherr & F. Siegert, JHEP 1304 (2013) 027)

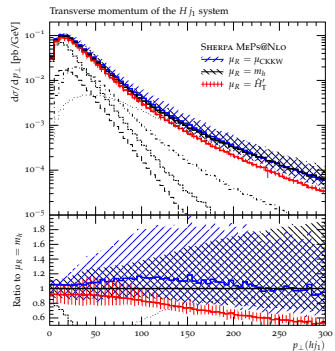
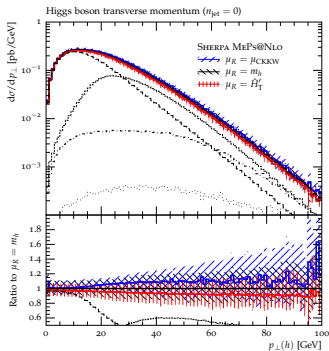




Inclusive observables for $gg \rightarrow H$

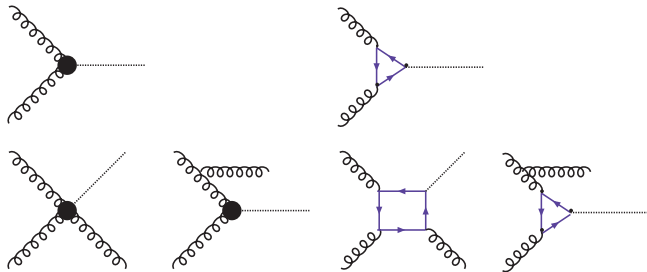


Exclusive observables for $gg \rightarrow H$



Quark mass effects

- include effects of quark masses

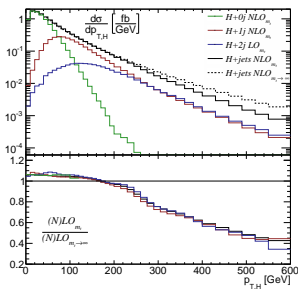


- reweight NLO HEFT with LO ratio:

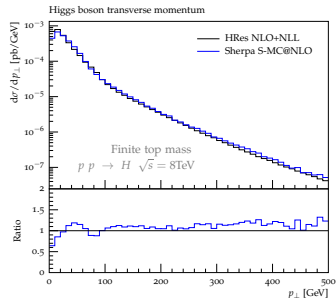
$$d\sigma_{\text{mass}}^{(\text{NLO})} \approx d\sigma_{\text{HEFT}}^{(\text{NLO})} \times \frac{d\sigma_{\text{mass}}^{(\text{LO})}}{d\sigma_{\text{HEFT}}^{(\text{LO})}}$$

Quark mass effects – results

- top mass effect in MEPS@NLO (on Higgs- p_{\perp})



- comparison with HRES (top-loop only)

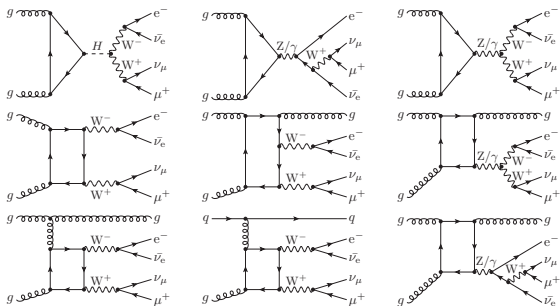


b -mass effects

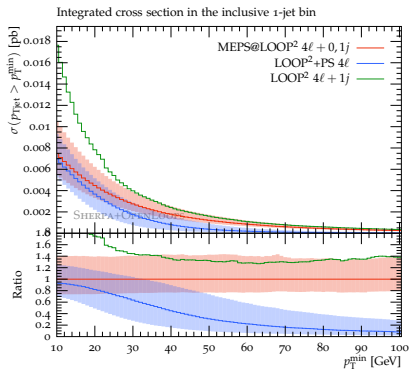
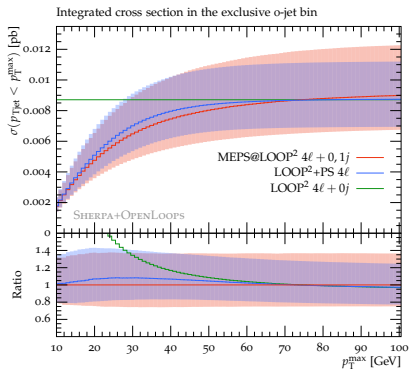
- b -mass effects more tricky
- relevant only for (negative) interference of top- and bottom-loops
(bottom² double Yukawa - suppressed)
- but: cannot start shower at m_H
radiation “sees” bottom at all scales above m_b
⇒ must use full theory there
- p_T spectrum naively “squeezed” – funny shapes
- LO multijet merging improves situation
- SHERPA's are finalising this as we speak

Higgs backgrounds: gluon-induced processes $W^+ W^- + \text{jets}$

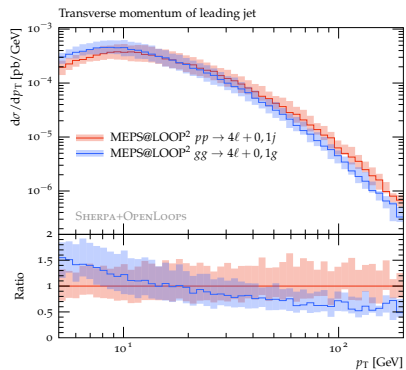
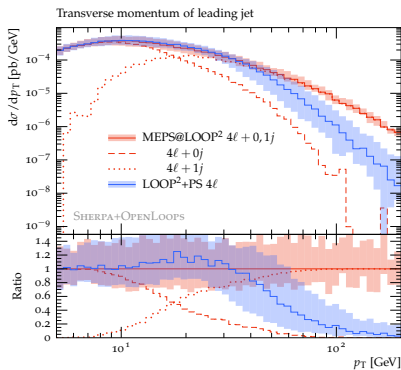
- include (LO-) merged loop² contributions of $gg \rightarrow VV$ (+1 jet)



- results without H : switch off H by $m_H \rightarrow \infty$
- impact of multijet merging vs. parton shower alone
- compare size with MEPS@NLO for $WW(+j)$



- one source of difference: quark-initiated $+1j$ configurations



Summary

- **MEPs@NLO** (multijet merging @ NLO)
for signals and backgrounds available in SHERPA
- validated in lots of processes: $gg \rightarrow H, VV, V+\text{jets}, t\bar{t}$
- **loop-induced proc's** in SHERPA:
 $gg \rightarrow VV$ with multijet merging
- improvement on
shape of QCD radiation,
but: **no NLO effects on rate**
- decomposed into **different terms**:
 box^2 (no H), $\text{box}-H$ -interference
(both at LO)
- being used in ATLAS analysis

