$pp \to H + n$ jets with SHERPA – update to 29/11/2012

S. Höche, F. Krauss, G. Luisoni, M. Schönherr, F. Siegert

Institute for Particle Physics Phenomenology

20/12/2012

Multijet merging at NLO – MEPS@NLO

- extension of CKKW-type multijet merging to NLO accuracy

  Lavesson, Lönnblad JHEP12(2008)070

  Höche, Krauss, MS, Siegert arXiv:1207.5030

  Gehrmann, Höche, Krauss, MS, Siegert arXiv:1207.5031

- implement resummation of parton shower through Sudakov weights, remove overlap of $\mathcal{O}(\alpha_s)$ terms with NLO calculation through modified vetoed truncated shower

$\Rightarrow$ construct inclusive sample where the first few jet multiplicities are calculated at NLO (supplemented by higher multiplicities at LO) while resumming the hierarchy of the emission scales of each individual jet up to a resummation scale (starting scale of the parton shower)

- scales need to be set according to parton shower histories to retain parton shower resummation properties

$$\alpha_s(\mu_{\text{def}}^2)^{n+k} = \alpha_s(\mu_0)^n \prod_{i=1}^{k} \alpha_s(t_i)$$

Multijet merging at NLO – MEPS@NLO

- extension of CKKW-type multijet merging to NLO accuracy

Lavesson, Lönnblad JHEP12(2008)070

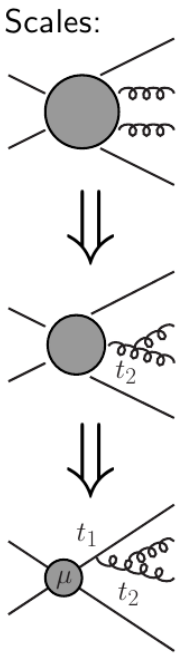
Höche, Krauss, MS, Siegert arXiv:1207.5030

Gehrmann, Höche, Krauss, MS, Siegert arXiv:1207.5031

- implement resummation of parton shower through Sudakov weights, remove overlap of $\mathcal{O}(\alpha_s)$ terms with NLO calculation through modified vetoed truncated shower

$\Rightarrow$ construct inclusive sample where the first few jet multiplicities are calculated at NLO (supplemented by higher multiplicities at LO) while resumming the hierarchy of the emission scales of each individual jet up to a resummation scale (starting scale of the parton shower)

  - scales need to be set according to parton shower histories to retain parton shower resummation properties

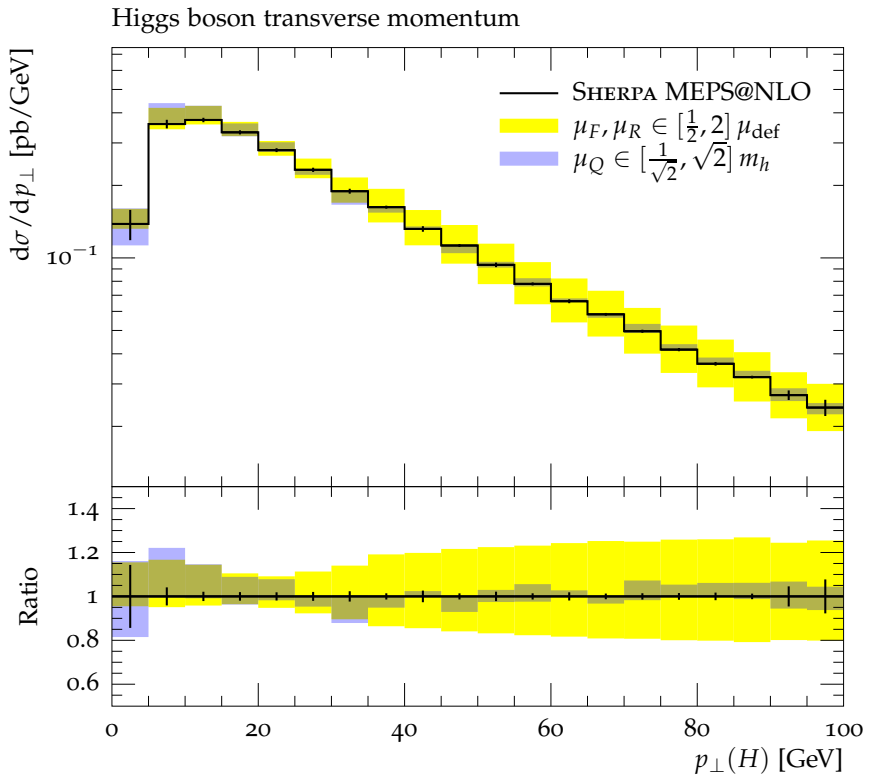


$$\alpha_s(\mu_{\text{def}}^2)^{n+k} = \alpha_s(\mu_0)^n \prod_{i=1}^{k} \alpha_s(t_i)$$

Plan for YR3

Setup: $pp \to H+$ jets (ggF)

- purely perturbative calculation (no hadronisation, MPI, etc.)
- 0,1,2 jets @ NLO, 3(4) jets @ LO
  here still only 0,1 @ NLO
  $Q_{\text{cut}} = 20$ GeV, $N_{\text{max}} = 3$
- customary perturbative scale variations
  $\mu_{R/F} \in [\frac{1}{2}, 2]\,\mu_{\text{def}}$
  $\mu_Q \in [\frac{1}{\sqrt{2}}, \sqrt{2}]\,m_h$
- variation of merging parameter $Q_{\text{cut}} \in \{20, 30, \mathbf{50}\}$ GeV and max. ME multi $N_{\text{max}} \in \{1, 2, 3\}$
- inclusive calculation
  $\to$ scales of each jet-multiplicity subsample not independent



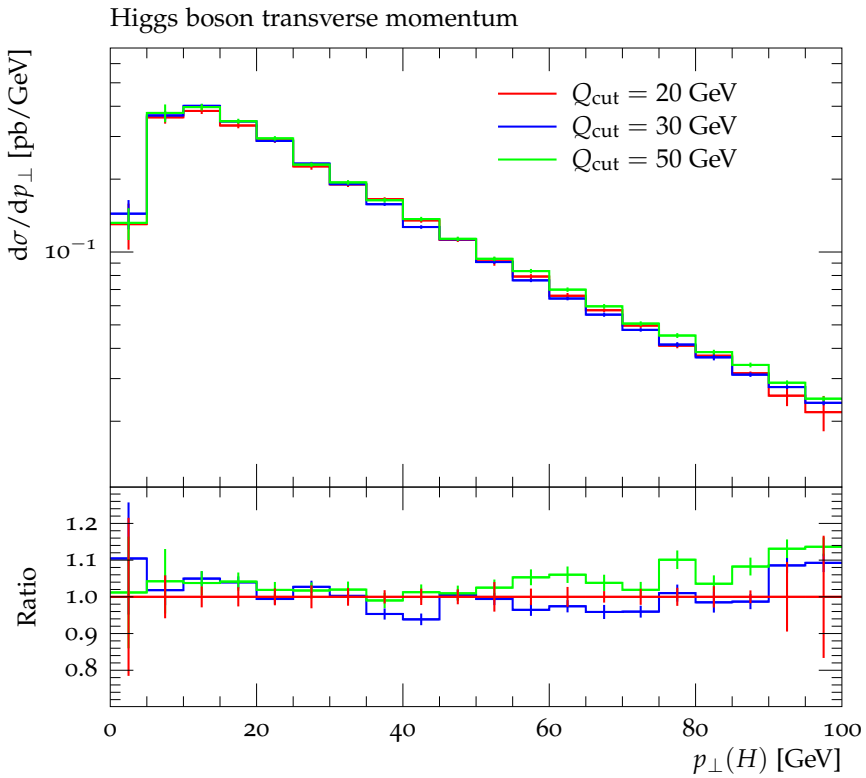
- inclusive cross section

  $\sigma = 15.2\ ^{+2.5}_{-1.5}\ ^{+1.0}_{-0.4}\ ^{+0.6}_{-0.0}\ ^{+0.2}_{-1.0}$ pb

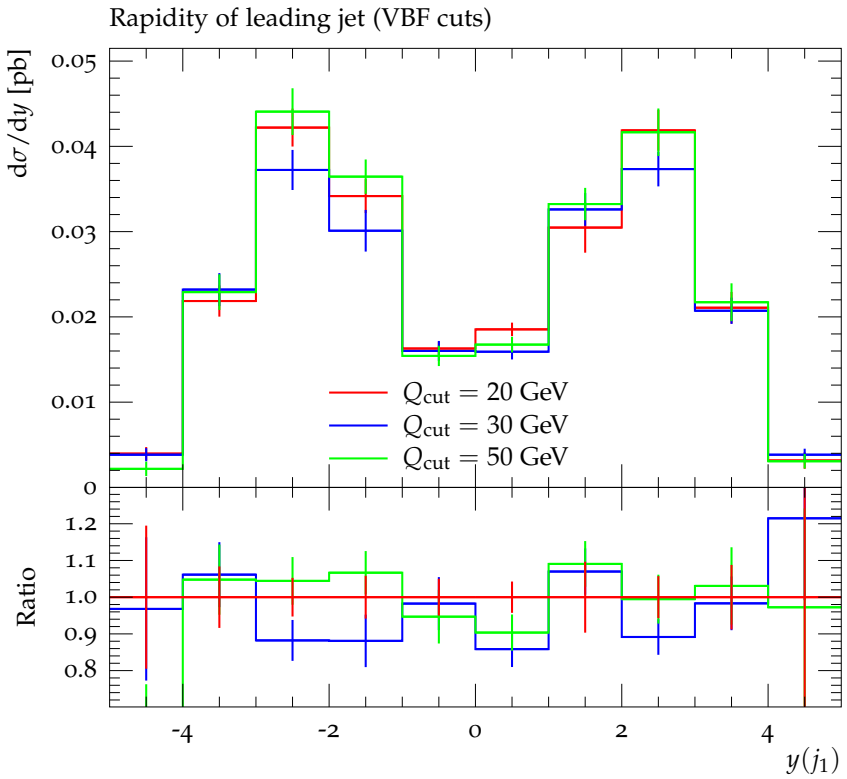
  $\mu_{R/F}$-, μ_Q-, Q_{cut}-, N_{max} var.
  N_{max} large due to inclusion of new initial states

Variation of Q_{cut}

inclusive observables



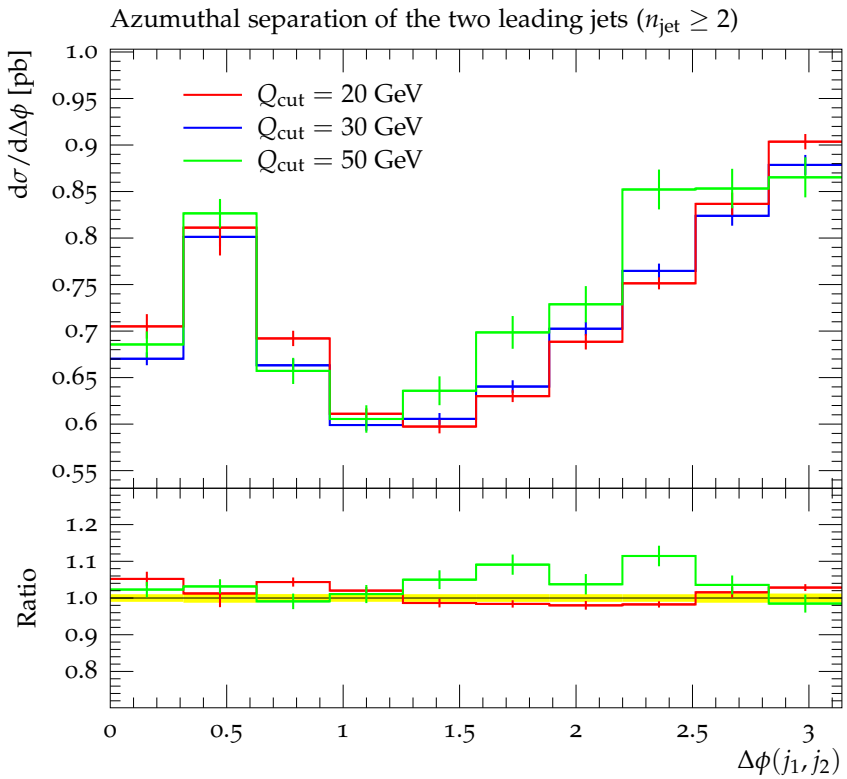
VBF-like topologies



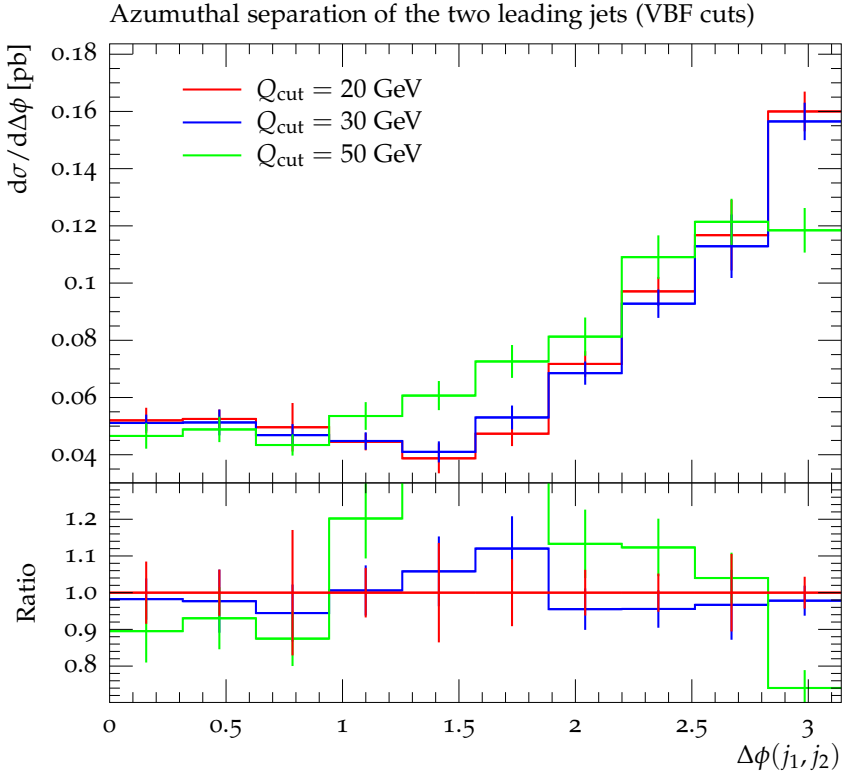
- very small residual Q_{cut} dependence, formally of $\mathcal{O}(\frac{1}{N_C^2}\,\alpha_s^2 L^3)$
  $\Rightarrow$ mismatch of terms in PS and NLO ME

Variation of Q_{cut}

two-jet selection



VBF selection

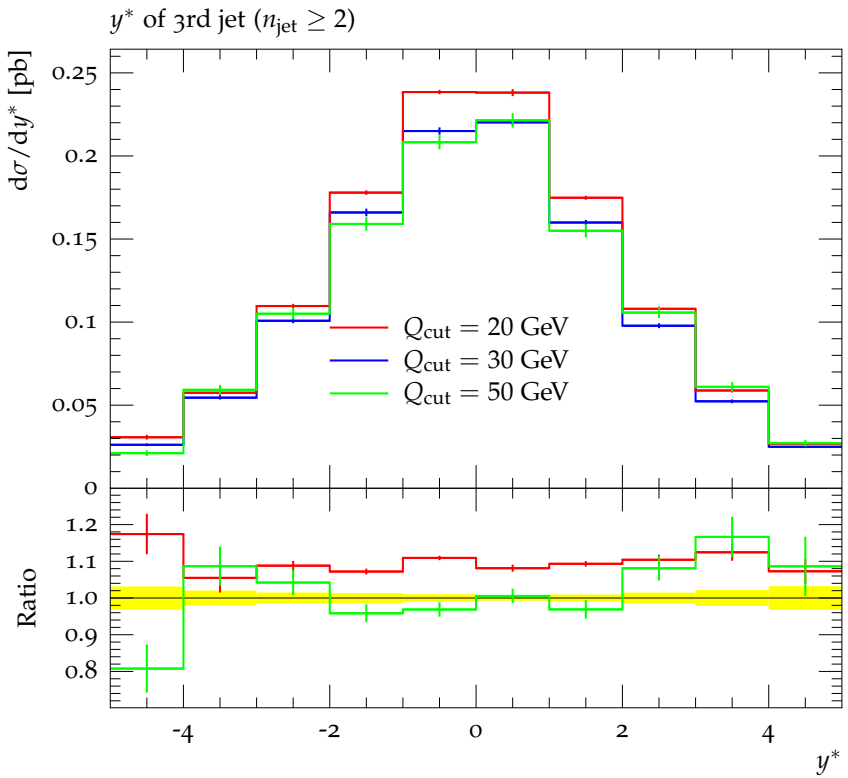


- with $Q_{cut} = 50$ GeV significant fraction of events produced at below Q_{cut}
  $\rightarrow$ 1st jet produced at LO by $pp \rightarrow H$ MC@NLO
  $\rightarrow$ 2nd jet produced by PS on top of $pp \rightarrow H$ MC@NLO

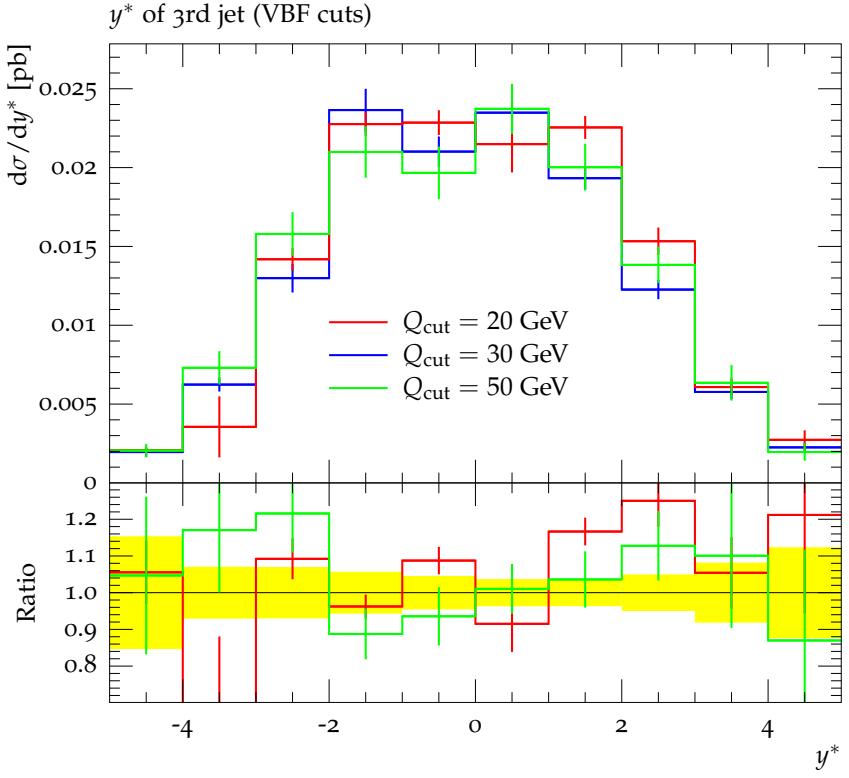
$\Rightarrow$ PS produces uncorrelated emissions in soft-collinear approximation

Variation of Q_{cut}

two-jet selection



VBF selection



- with $Q_{\text{cut}} = 50$ GeV significant fraction of events produced at below Q_{cut}
  $\rightarrow$ 1st jet produced at LO by $pp \rightarrow H$ MC@NLO
  $\rightarrow$ 2nd jet produced by PS on top of $pp \rightarrow H$ MC@NLO
  $\rightarrow$ 3rd jet produced by PS on top of $pp \rightarrow H$ MC@NLO

$\Rightarrow$ PS produces uncorrelated emissions in soft-collinear approximation

Conclusions

Preliminary results

- large uncertainties due to Q_{cut} only when substantial number of events in selection have hard well-separated jets but fall below Q_{cut}
  $\rightarrow$ this test the ability of the PS to describe hard well-separated jets
  $\rightarrow$ if it were able to so, multijet merging would not be relevant
- VBF-topologies are currently only described at LO $\Rightarrow$ move to NLO
- NLO description of multileg final states (in ME region) and resummation of scale hierarchies at the same time
  $\Rightarrow$ needed for multiscale processes

Plans for YR3

- 0,1,2 @ NLO, 3,(4) @ LO ($pp \rightarrow H + 2$jets virtual from GoSam)
- full theoretical uncertainty estimate (perturbative & non-perturbative)

Thank you for your attention!