Back-to-back azimuthal jet correlation in pp and ep

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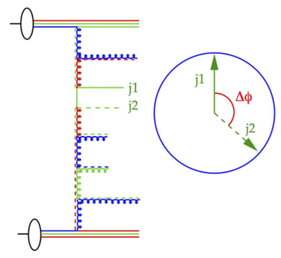
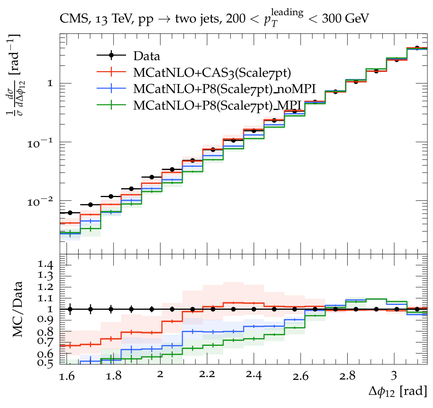
Introduction

With the theoretical advancement in pQCD for jet productions in pp as well as ep collisions, jets have become an increasingly attractive observable as a tool to probe the intricate structure of the nucleon and dynamics of hadronization process. Azimuthal correlations in dijet, Z+jet, lepton+jet production at large and moderate transverse momenta are computed by matching Parton - Branching (PB) TMD parton distributions [1] and showers with NLO calculations via MCatNLO.

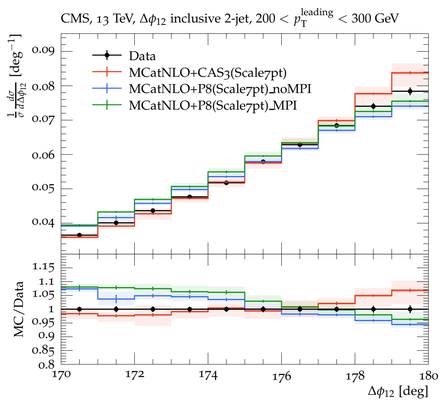


Azimuthal correlations in dijet events [pp]

Comparison dijet data [2,3] with MC tools



MCatNLO+CAS3

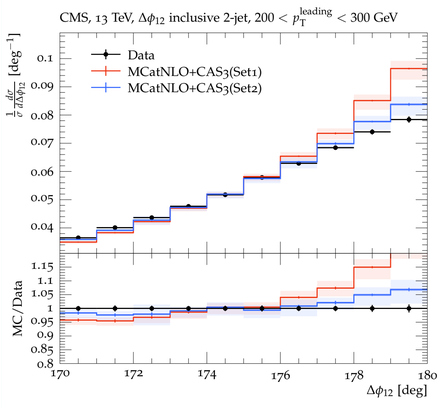


MCatNLO+P8

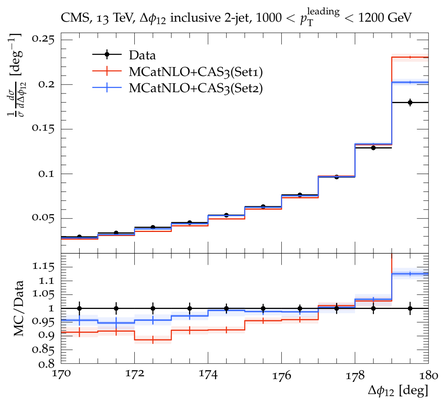
Strong difference in shape (between CAS3 [4] & P8) [5]
Check results with & without MPI
Small $\Delta\phi$ region: need multi-jet merging
PB uncertainties: TMD + scale uncertainties
Pythia uncertainties: $\mu_{R,F}$ in ME + μ_R variation in PS

PB gives a good description of the back-to-back region.

Sensitivity to the TMD distribution



$200 < p_T^{leading} < 300$ GeV

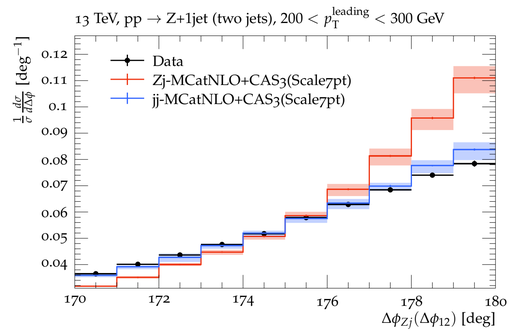


$1000 < p_T^{leading} < 1200$ GeV

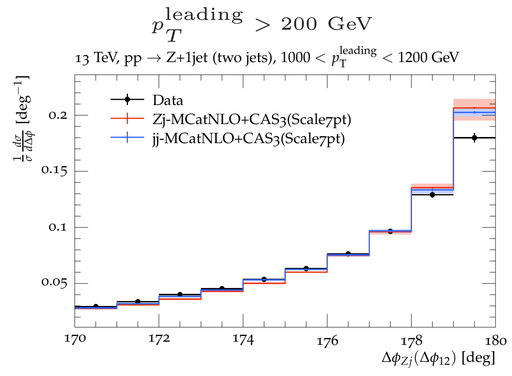
TMD important in the back-to-back region.
Sensitivity to the scale in α_s observed.

in Z+jet events [pp]

Comparison Z+jet & dijet



$p_T^{leading} > 200$ GeV



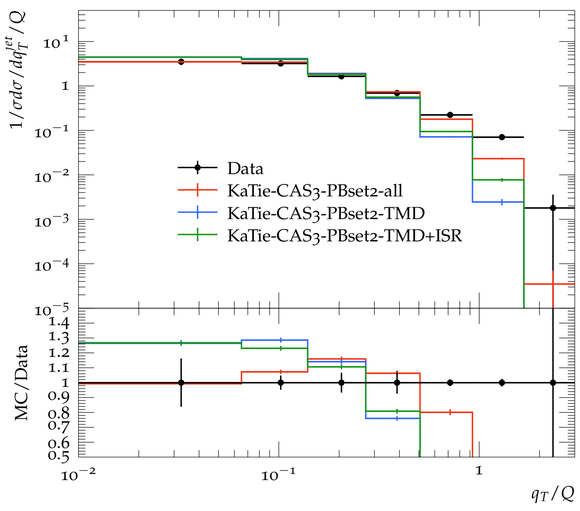
$p_T^{leading} > 1000$ GeV

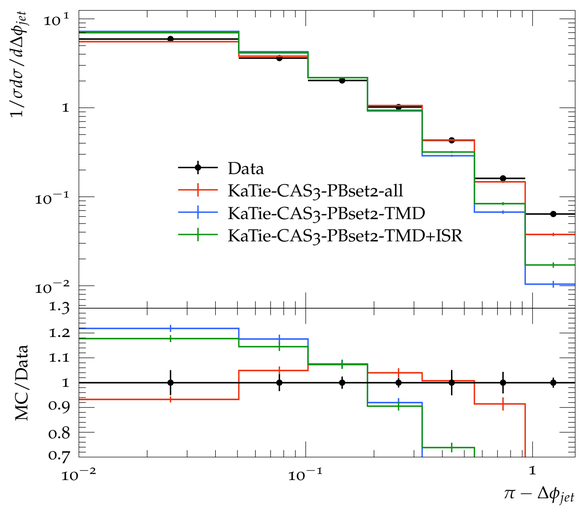
low $p_T^{leading}$: Z+jet-production gives a steeper distribution
high $p_T^{leading}$: the distributions become similar in shape [6].

These two different patterns can be used to search for potential $f$actorization - breaking effects in the back-to-back region (depends on the different color, spin structure of the final states and their interferences with the initial states).

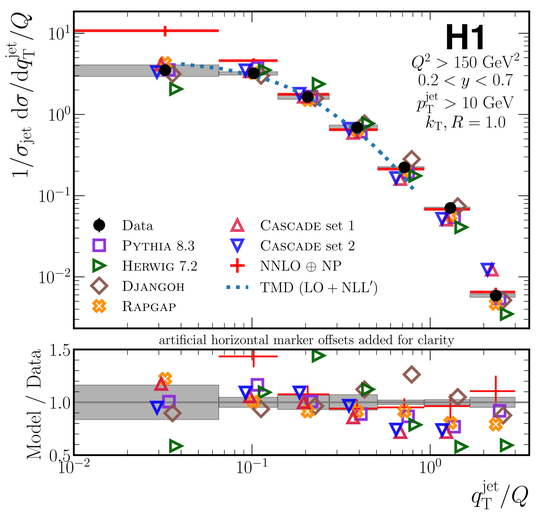
lepton-jet momentum imbalance & azimuthal correlation in deep-inelastic scattering [ep]

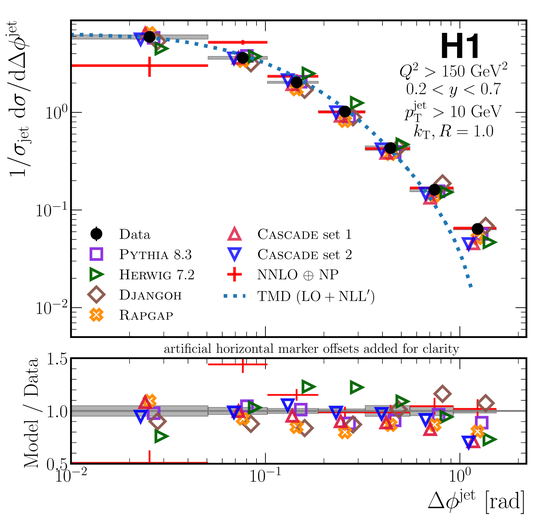
lepton-jet correlation: Novel way of probing transverse motion of quarks in proton, i.e. quark TMD PDF.
lepton-jet p_T imbalance: $q_T^{jet} = |\vec{k_\perp}^{\,l} + \vec{p_\perp}^{\,jet}|$
The TMD-based calculations are provided by the MC generator Cascade, using matrix elements from KaTie and parton branching TMD PDFs.





KaTie-CAS3-PBset2-all, KaTie-CAS3-PBset2-TMD+ISR, KaTie-CAS3-PBset2-TMD





Different MC event generators [7]

Best description of both low q_T and back-to-back Δ_ϕ region of measured data is available via PB-sets.
sensitivity to α_s and PDFs observed.

Conclusions

In all these three different studies:
PB-TMD distributions applied to NLO calculations via MCatNLO/KaTie together with the PB-TMD parton shower.
A very good description of cross section in $\Delta(\phi)_{1,2} \sim \pi$ observed.
The importance of consistently handling the soft-gluon coupling in angular ordered parton evolution confirmed.
The importance of details of the parton shower checked.

References

[1] A. Bermudez Martinez, *et al.* Phys. Rev. D **99** (2019) no.7, 074008 [arXiv:1804.11152 [hep-ph]].

[2] A. M. Sirunyan *et al.* [CMS], Eur. Phys. J. C **78** (2018) no.7, 566 [arXiv:1712.05471 [hep-ex]].

[3] A. M. Sirunyan *et al.* [CMS], Eur. Phys. J. C **79** (2019) no.9, 773 [arXiv:1902.04374 [hep-ex]].

[4] S. Baranov, *et al.* Eur. Phys. J. C **81** (2021) no.5, 425 [arXiv:2101.10221 [hep-ph]].

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[6] H. Yang,*et al.* [arXiv:2204.01528 [hep-ph]].

[7] V. Andreev *et al.* [H1], Phys. Rev. Lett. **128** (2022) no.13, 132002 [arXiv:2108.12376 [hep-ex]].