Machine learning-assisted measurement of multi-differential lepton-jet correlations in deep-inelastic scattering with the H1 detector

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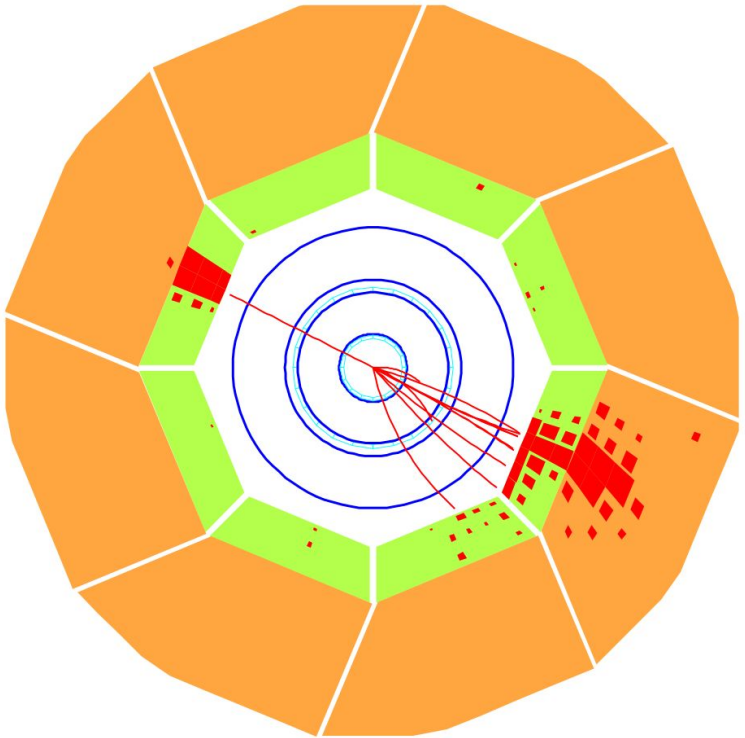
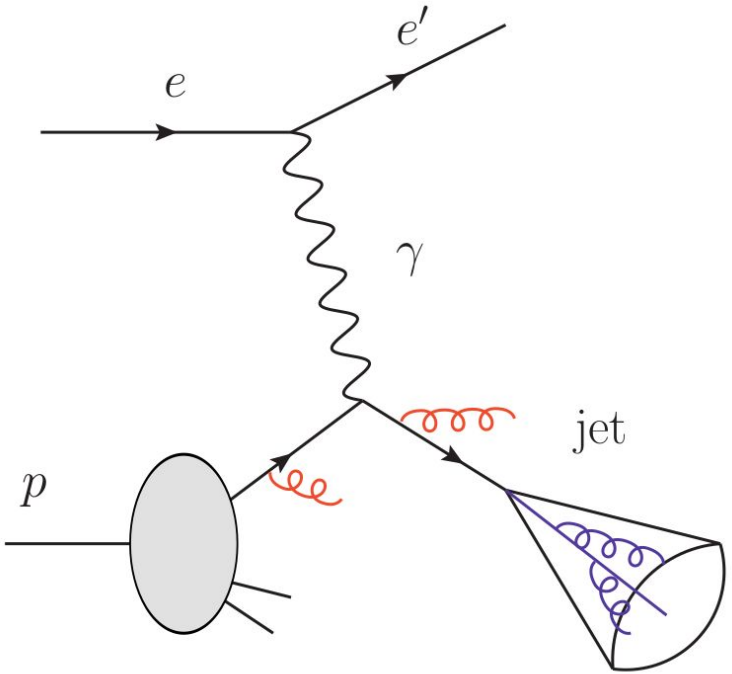
UC RIVERSIDE

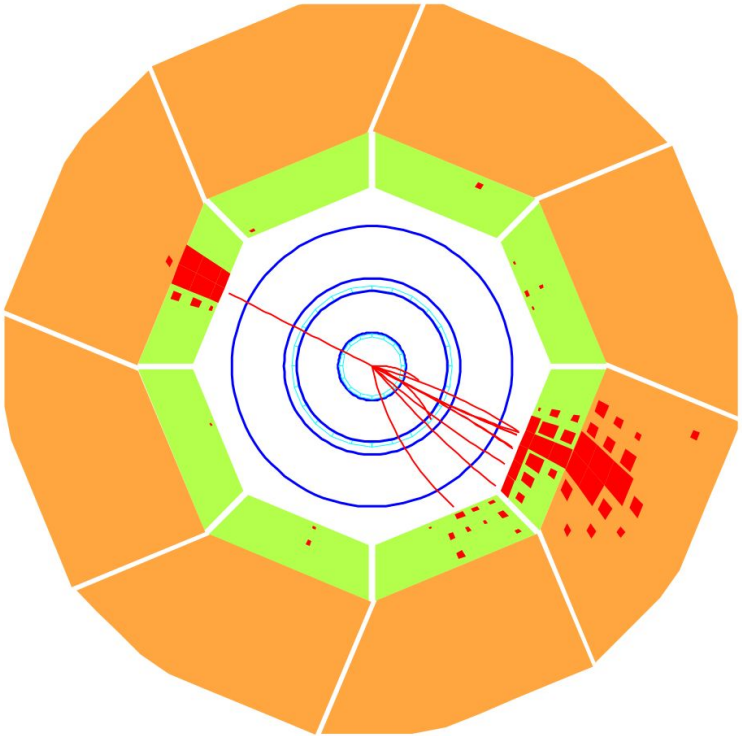


A new channel to probe for quark TMDs and evolution

Liu et al. PRL. 122, 192003 (2019)
Gutierrez et al. PRL. 121, 162001 (2018)

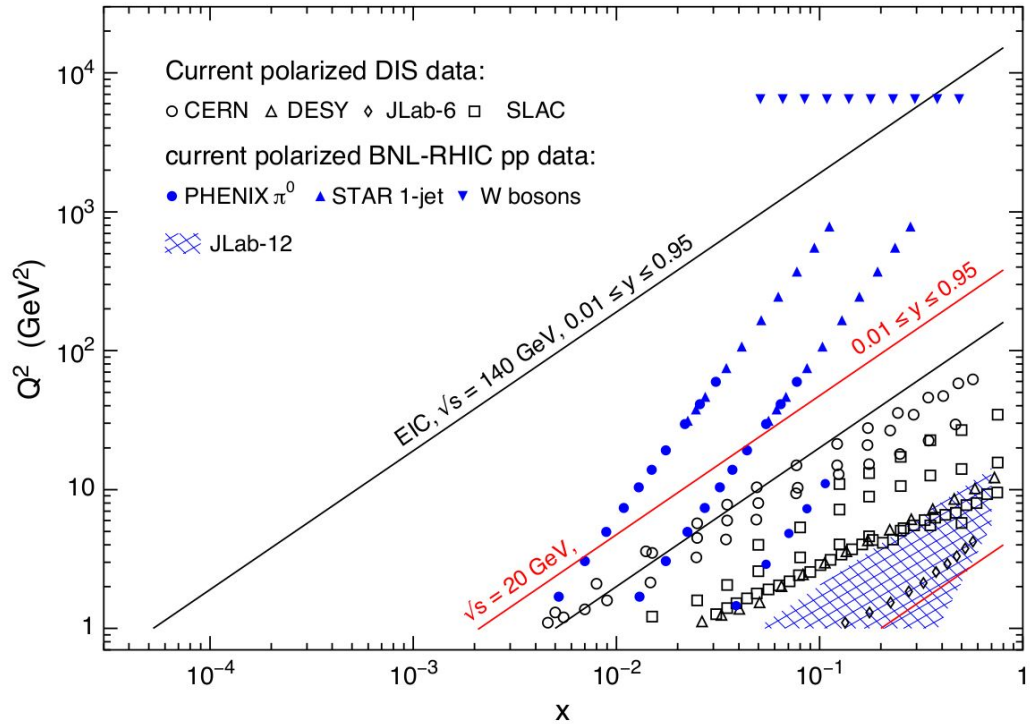
$$q_T = |\vec{k}_{l\perp} + \vec{p}^{\,j}_{\perp}|$$



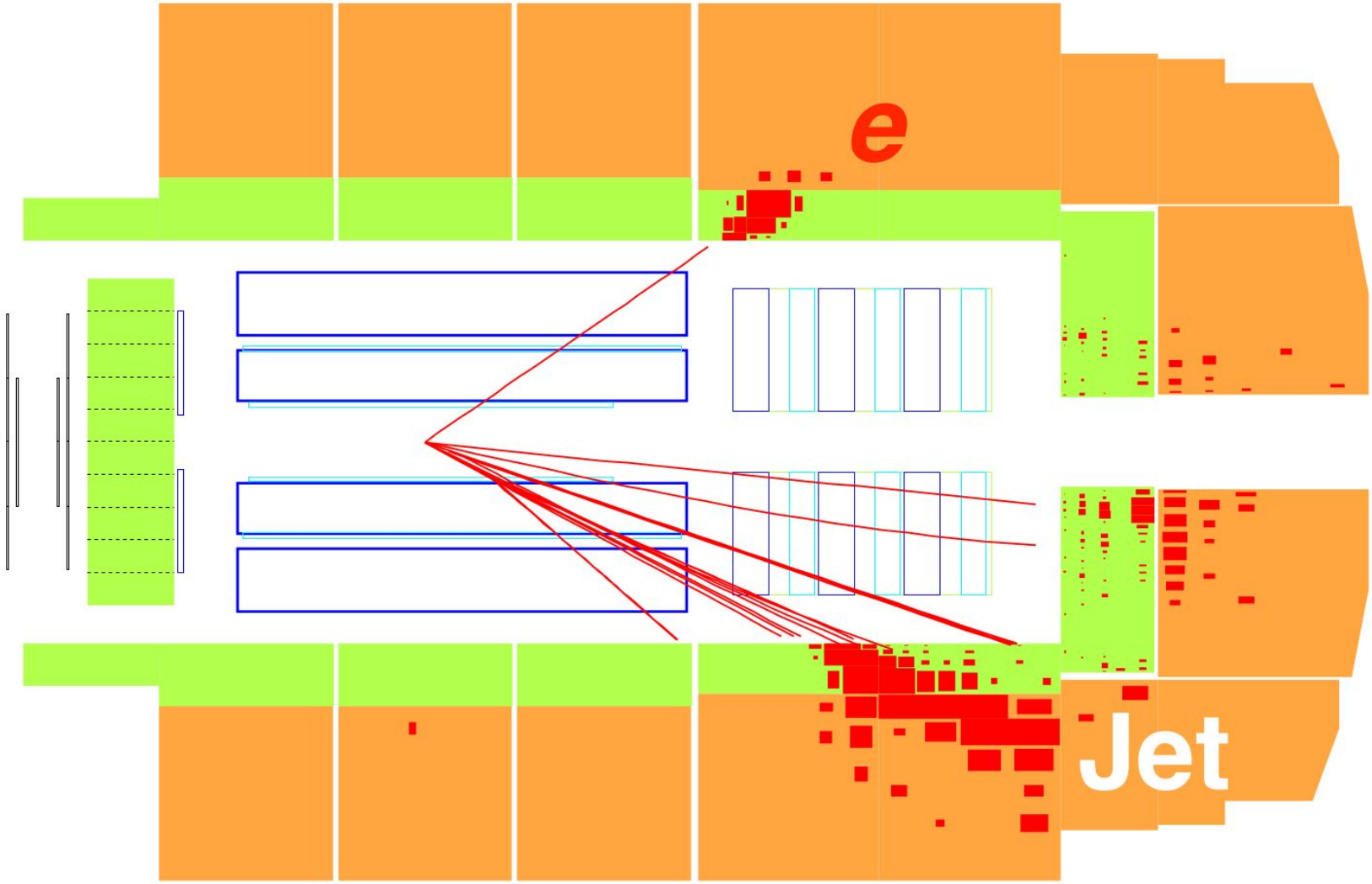


Constraining TMD evolution

H1 can bridge low Q2 DIS from fixed-target exp. and high Q2 Drell-Yan at colliders.
Fixing open issues of TMD factorization & universality

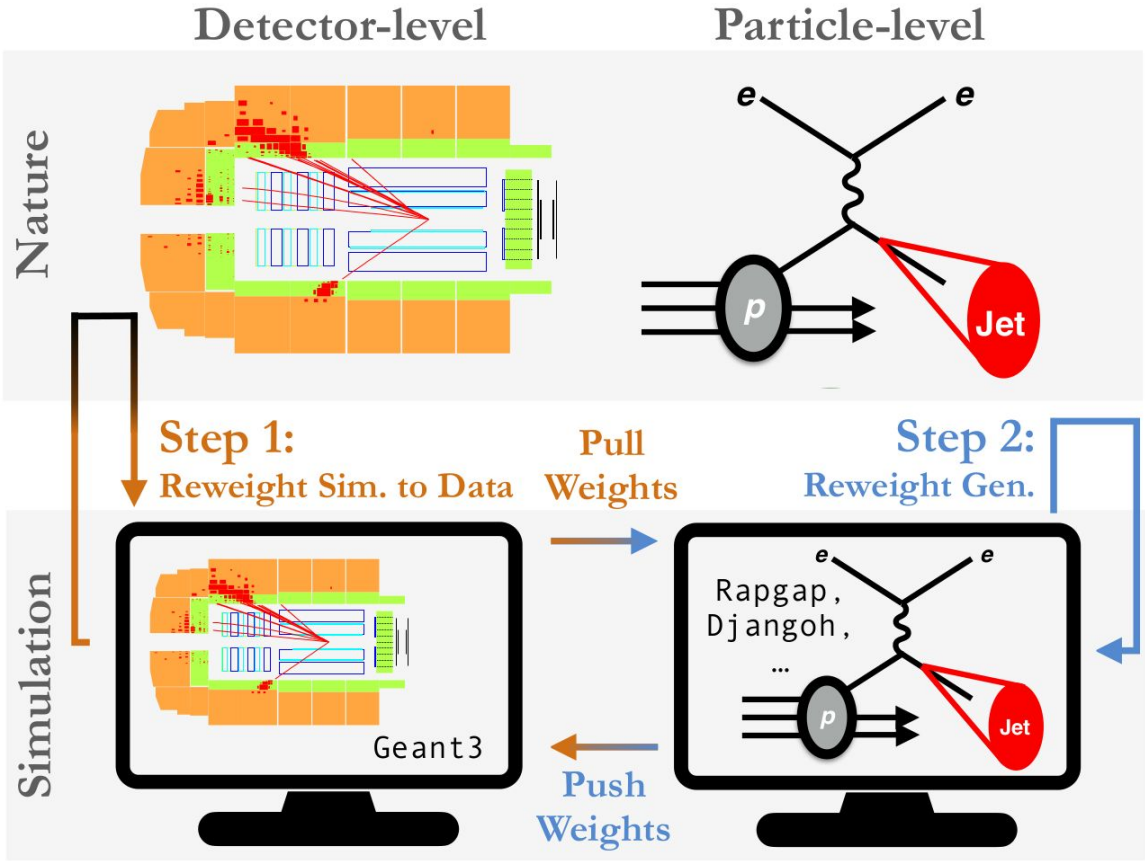


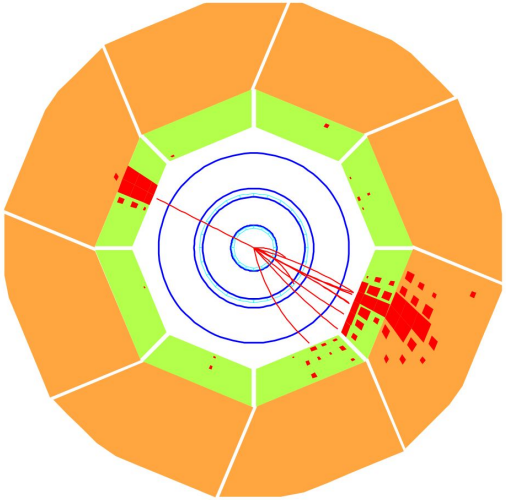
Unpolarized TMD DIS measurements
Important baseline for EIC


e
Jet

Unfolding with Omnifold (via machine-learning).

Andreassen et al. PRL **124**, 182001 (2020)





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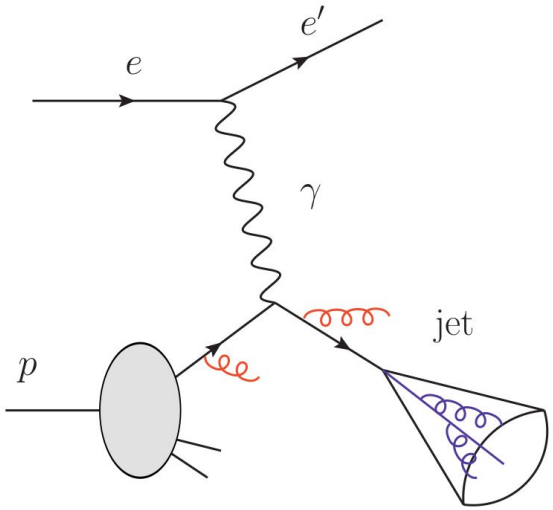
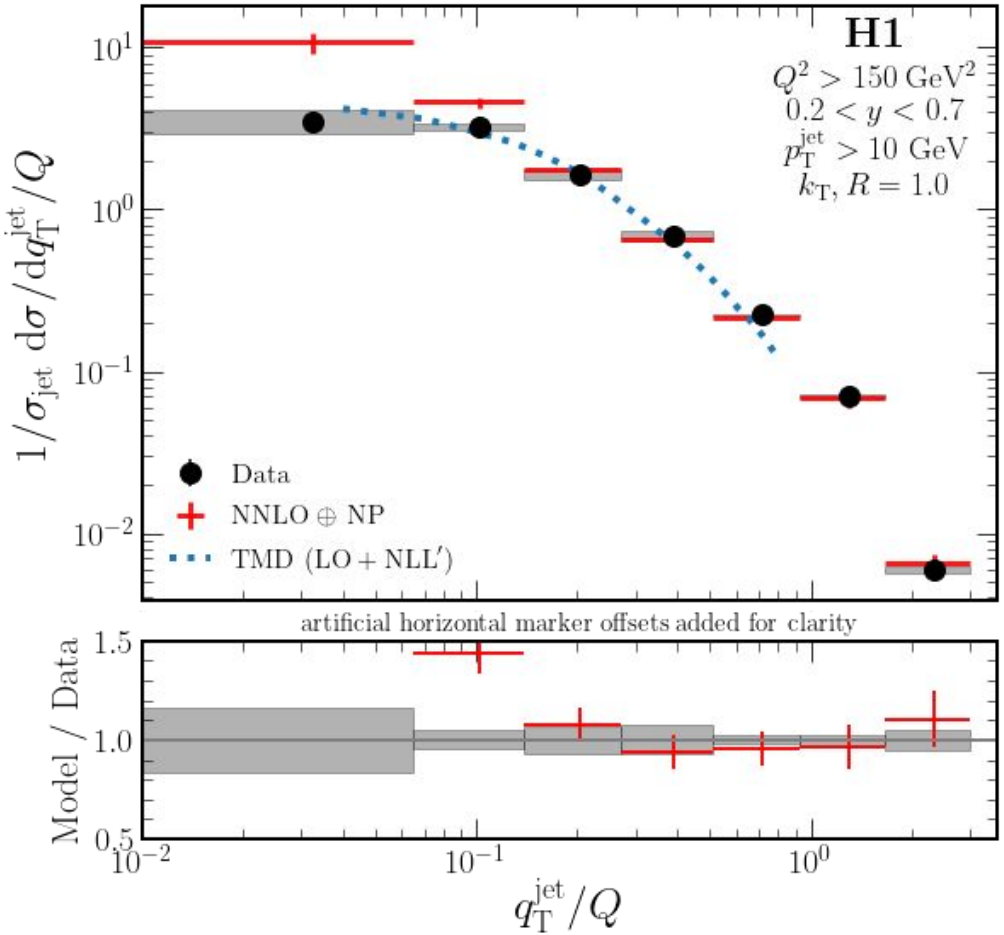
Measurement of Lepton-Jet Correlation in Deep-Inelastic Scattering with the H1 Detector Using Machine Learning for Unfolding

V. Andreev *et al.* (H1 Collaboration)

Phys. Rev. Lett. **128**, 132002 – Published 31 March 2022

Article References No Citing Articles Supplemental Material PDF HTML Export Citation





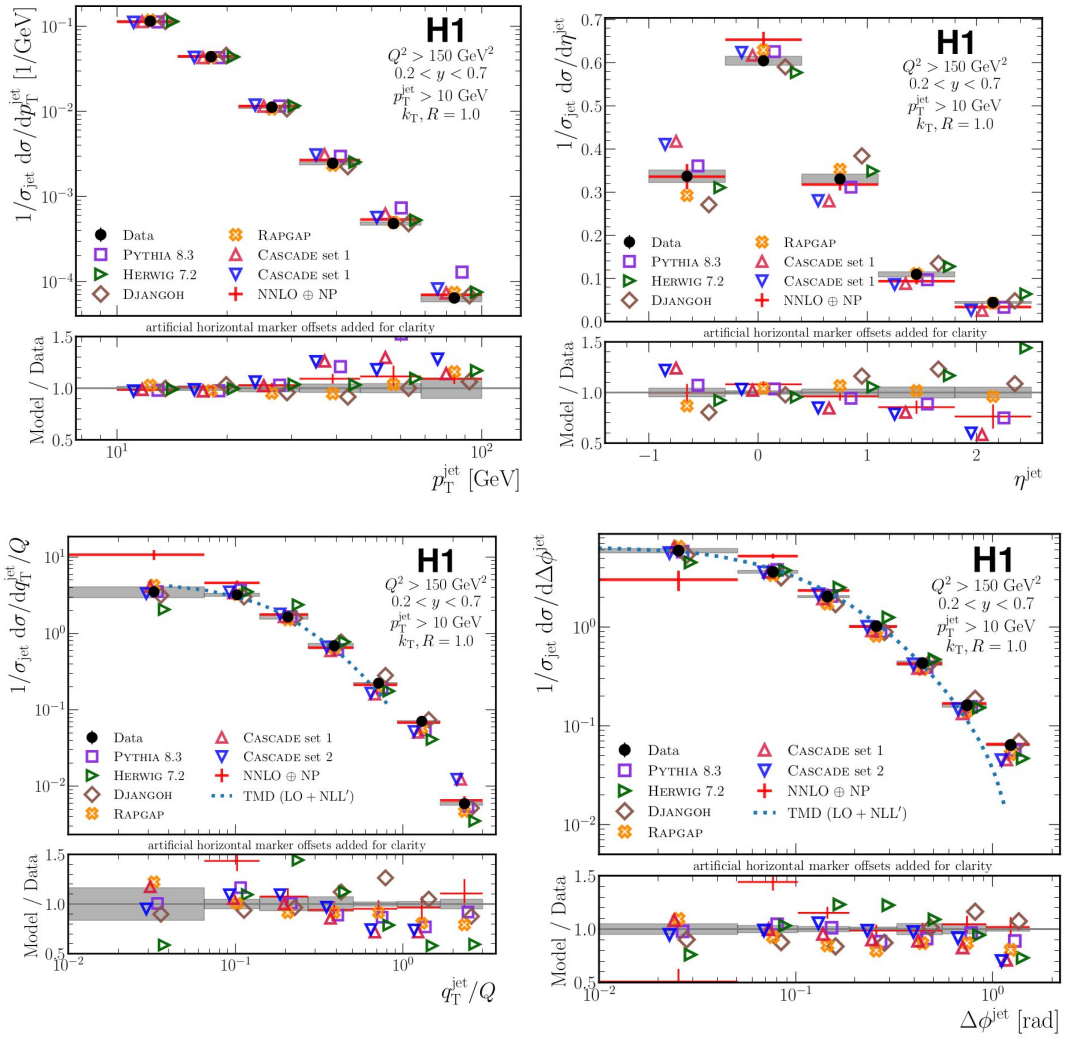
Textbook example of "matching" between collinear and TMD frameworks

First time seen in DIS!

(not seen in fixed-target DIS)

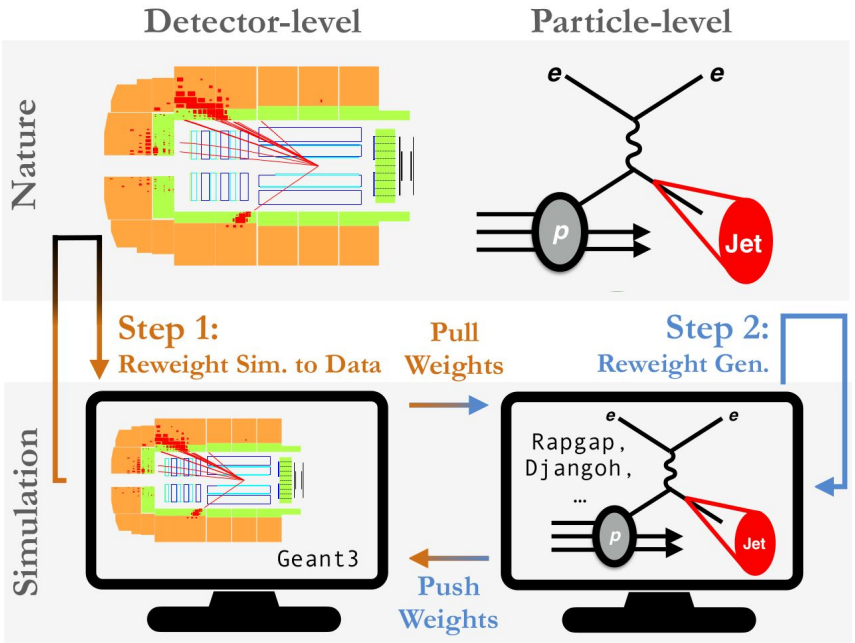
Omnifold allowed us to do a simultaneous, unbinned “unfolding”

First-ever measurement that uses machine-learning to correct for detector effects.



"This measurement also represents a ***milestone in the use of ML techniques for experimental physics,*** *as it provides the first example of ML-assisted unfolding,.... This opens up the possibility for high dimensional explorations of nucleon structure with H1 data and beyond"*

H1 Collaboration, Phys. Rev. Lett. **128**, 132002



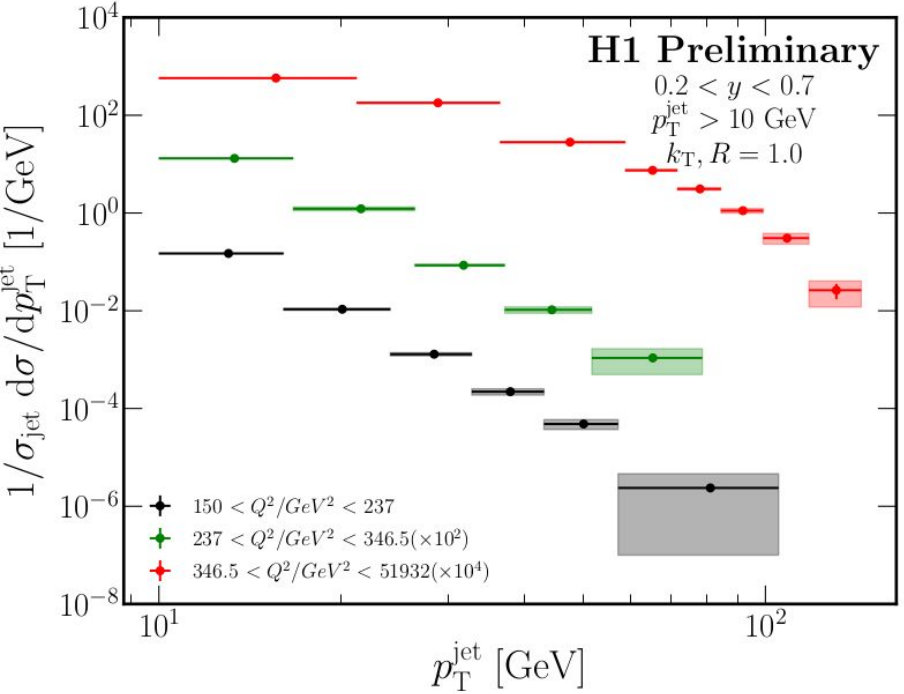
Machine learning-assisted measurement of multi-differential lepton-jet correlations in deep-inelastic scattering with the H1 detector

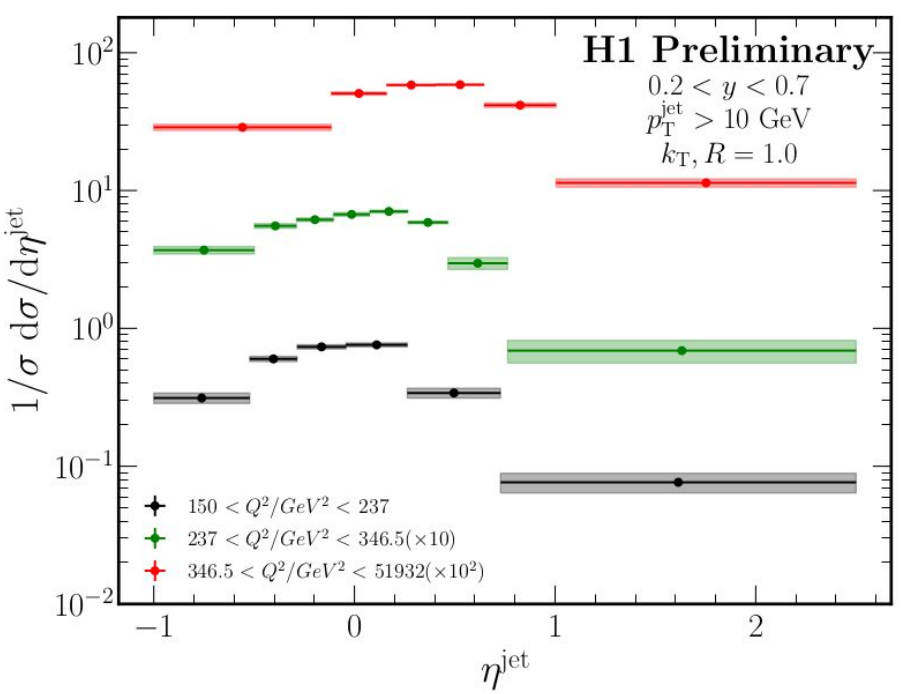
H1 Collaboration

https://www-h1.desy.de/h1/www/publications/htmlsplit/H1prelim-22-031.long.html

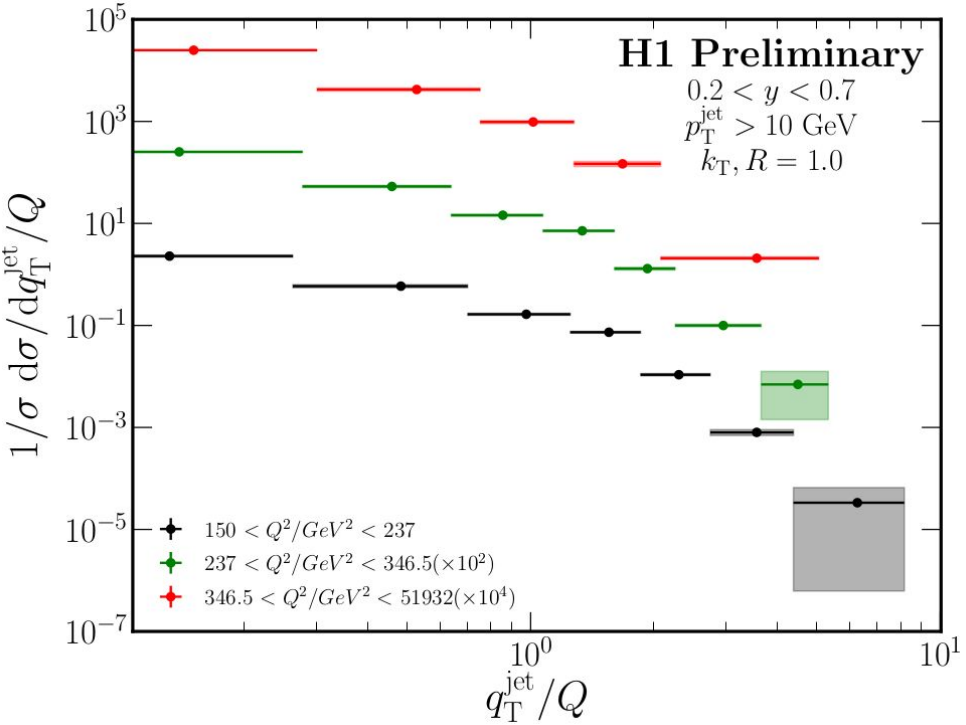
Preliminary result release on June 22.
Plan is to have it on arXiv soon

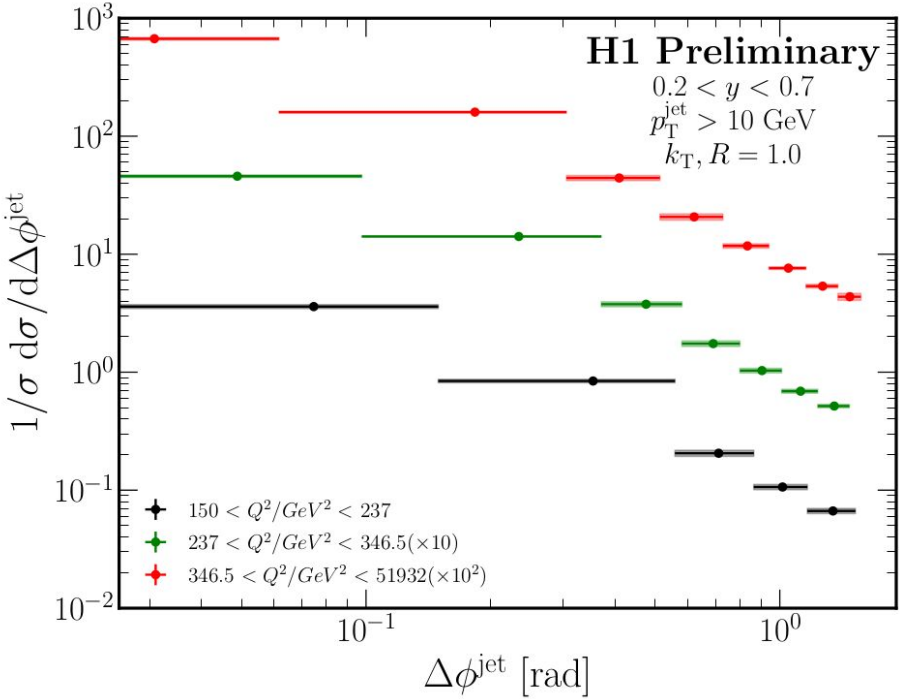
Transverse momentum and pseudorapidity in bins of Q2



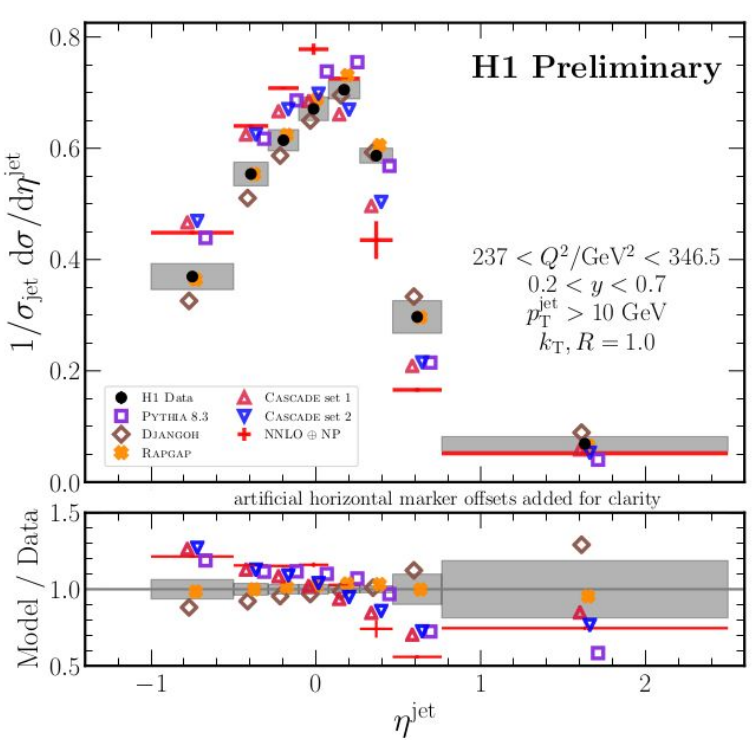


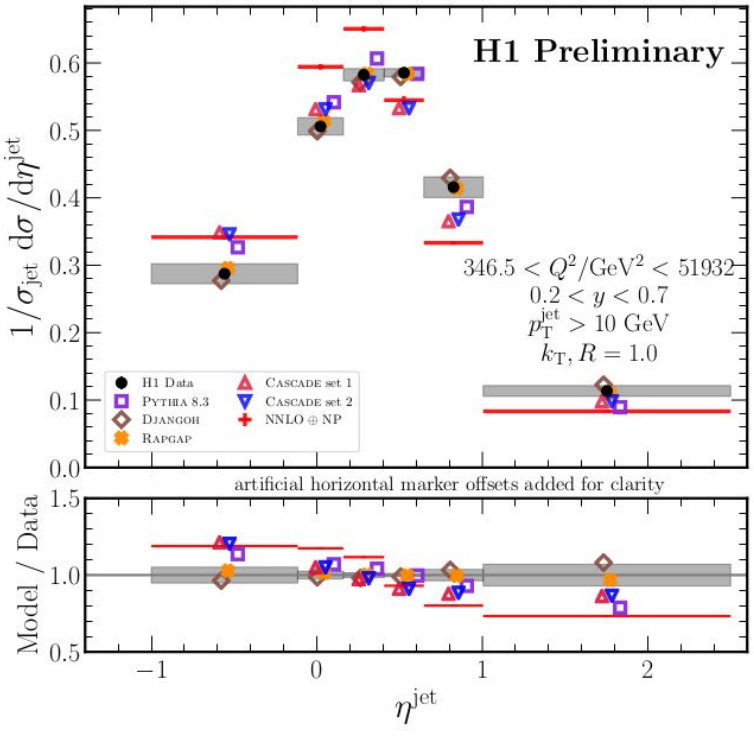
Momentum imbalance and azimuthal correlation in bins of Q2





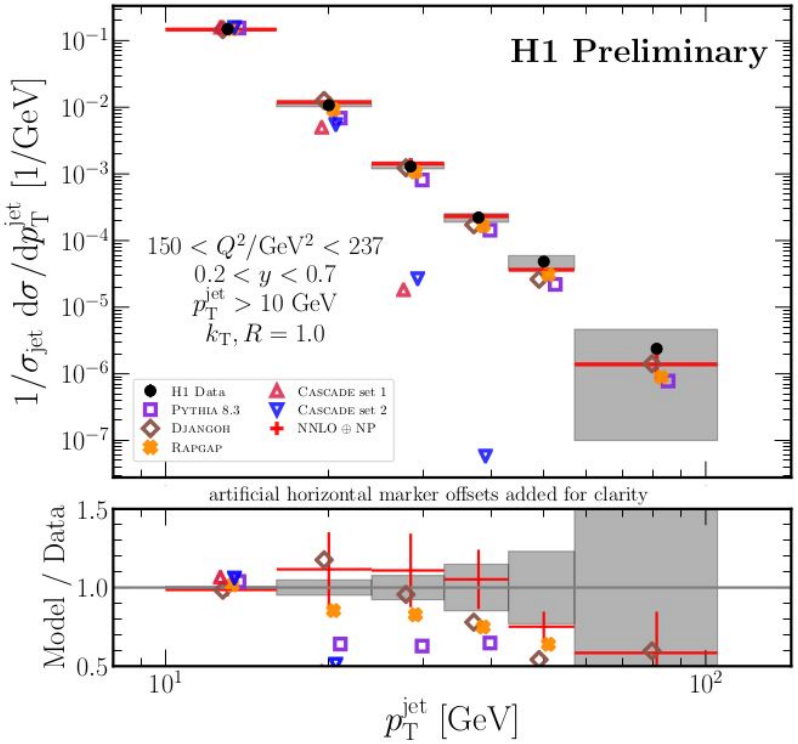
Jet pseudorapidity in Q2 slices

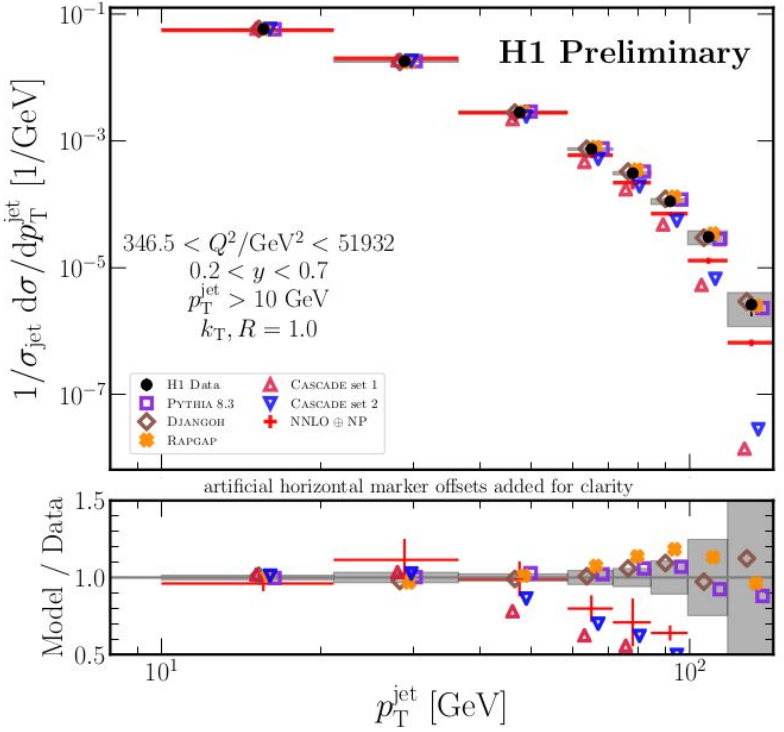




Emphasizes shortcomings of pQCD calculation and some MC generators

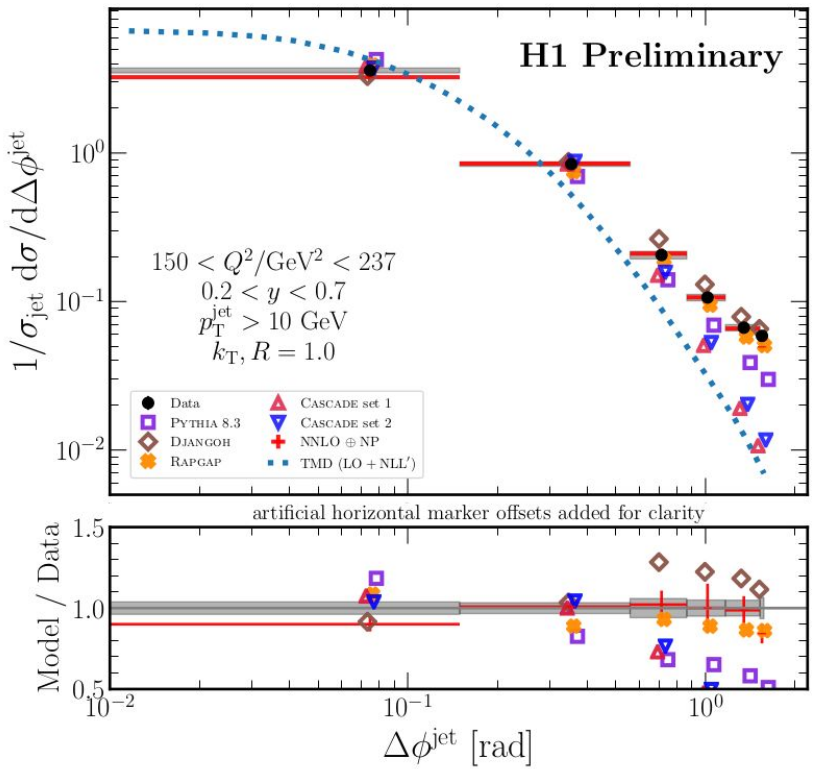
Jet transverse-momentum in Q2 slices

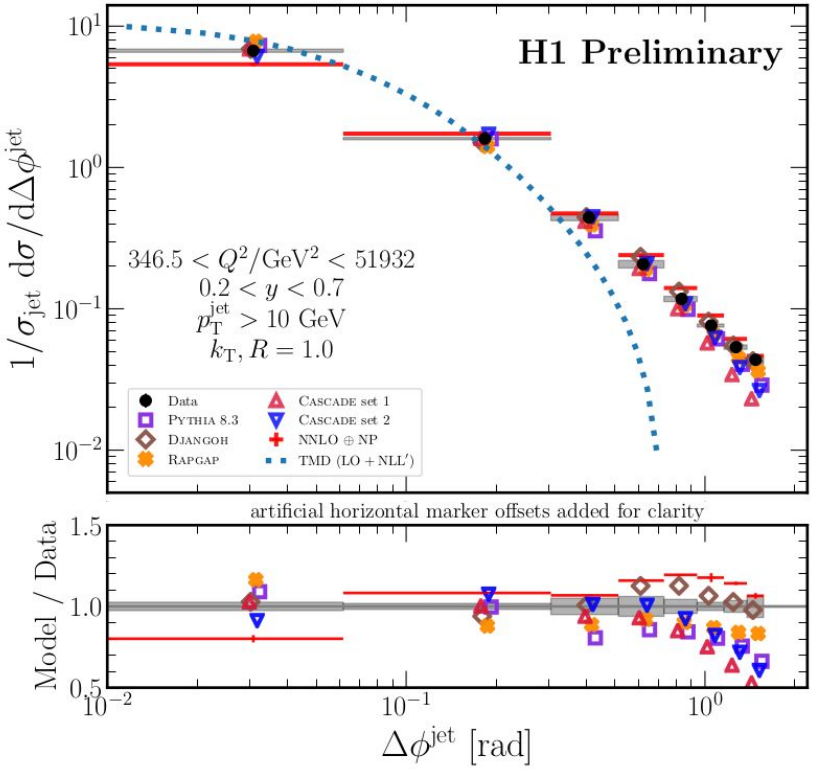




Emphasizes shortcomings of pQCD calculation and some MC generators

Azimuthal correlation in Q2 slices



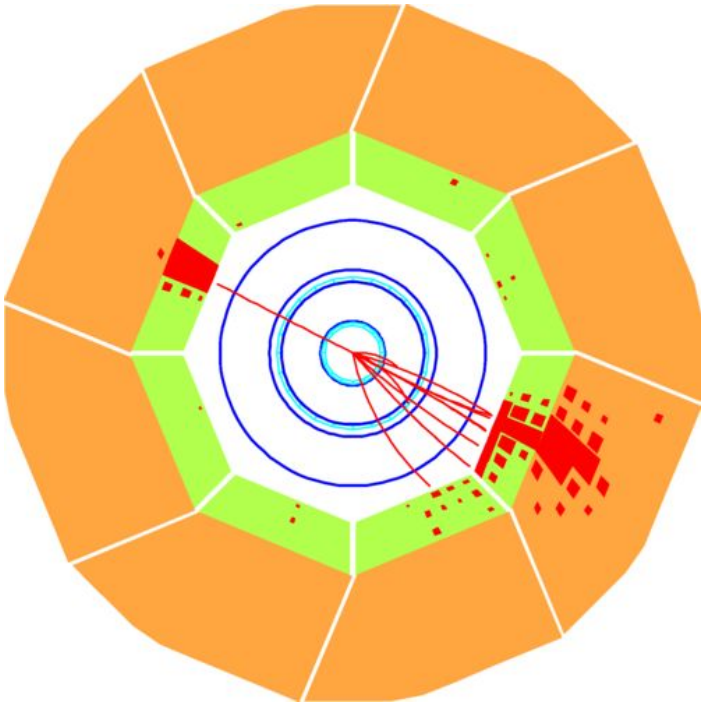


Constraints on TMD evolution with Q2?

Summary

- H1 collaboration reports measurements of lepton jet momentum and azimuthal imbalance in DIS, which provide **a new way to constrain TMD PDFs and their evolution**

- Multi Differential measurement can probe Q2 evolution of TMD calculations, and reveals shortcomings of pQCD calculations at NNLO and some MC generators



Backup

Motivation

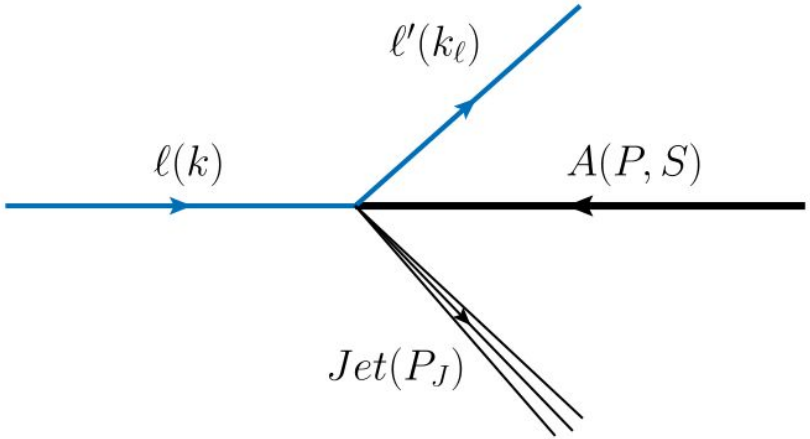
Lepton-jet imbalance $q_T = |\vec{k}_{l\perp} + \vec{p}^{\,j}_{\perp}|$

In Born-level configuration

Probes quark TMD PDFs

Liu et al. PRL. 122, 192003 (2019)

Gutierrez et al. PRL. 121, 162001 (2019)



$$\frac{d^5\sigma(\ell p \to \ell' J)}{dy_\ell d^2k_{\ell\perp} d^2q_\perp} = \sigma_0 \int d^2k_\perp d^2\lambda_\perp x f_q(x, k_\perp, \zeta_c, \mu_F)$$
$$\times H_{\mathrm{TMD}}(Q, \mu_F) S_J(\lambda_\perp, \mu_F)$$
$$\times \delta^{(2)}(q_\perp - k_\perp - \lambda_\perp).$$