HP2024
NAGASAKI

Present and future constraints on nPDFs using dijet production in pPb collisions at 8.16 TeV with the CMS detector

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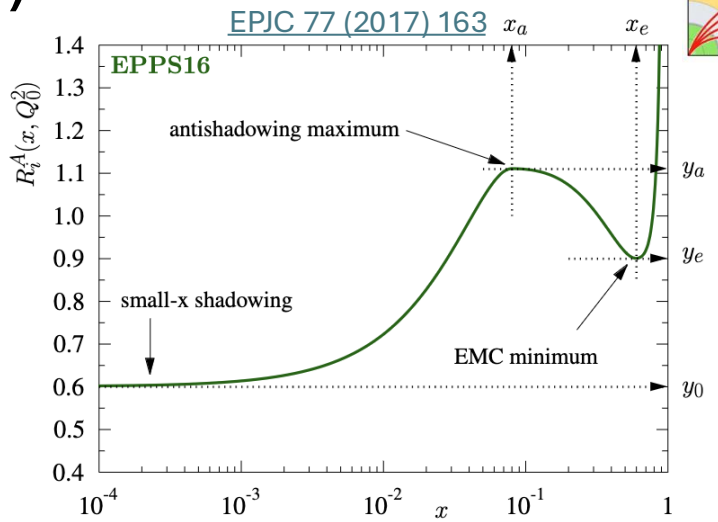
Nuclear parton distribution functions (nPDFs)

Describe how quarks and gluons are shared among the nucleons within a nucleus and how this distribution changes due to nuclear effects

Nuclear effects:

- ***Shadowing*** - at low momentum fractions, x, the parton density in a nucleus is reduced compared to that in a free proton
- ***Antishadowing*** - at intermediate momentum fractions, the parton density in a nucleus is enhanced
- ***EMC effect*** - A modification in the structure function ratios observed in deep inelastic scattering experiments



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Analysis	nCTEQ15HQ (50)	EPPS21 (51)	nNNPDF3.0 (52)	TUJU21 (80)	KSASG20 (81)
Theoretical input:					
Perturbative order	NLO	NLO	NLO	NNLO	NNLO
Proton PDF	∼CTEQ6.1	CT18A	∼NNPDF4.0	∼HERAPDF2.0	CT18
Proton PDF correlations		✓	✓		
Deuteron corrections	(✓)[a,b]	✓[c]	✓	✓	✓
Collider data:					
Z bosons	✓	✓	✓	✓	
$W^{\pm}$ bosons	✓	✓	✓	✓	
Light hadrons	✓	✓[d]			
– Cut on p_T	3 GeV	3 GeV			
Jets		✓	✓		
Prompt photons			✓		
Prompt D^0	✓	✓	✓[e]		
– Cut on p_T	3 GeV	3 GeV	0 GeV		
Quarkonia (J/ψ, ψ', Υ)	✓				

This talk

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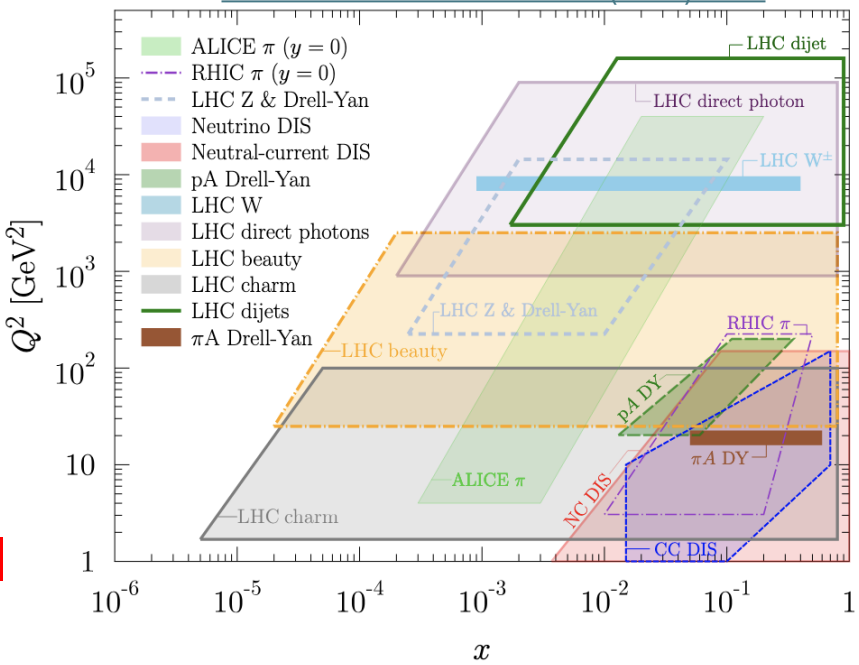
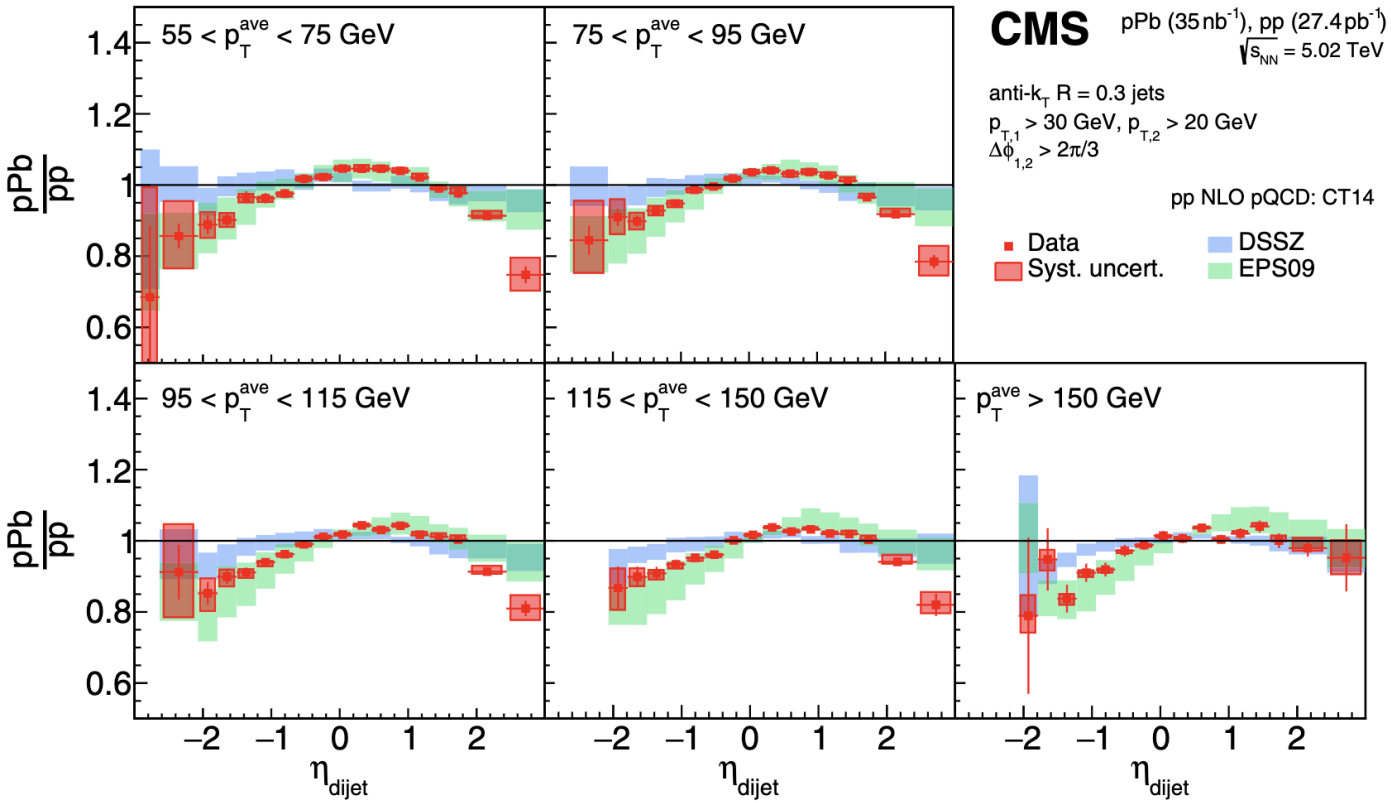


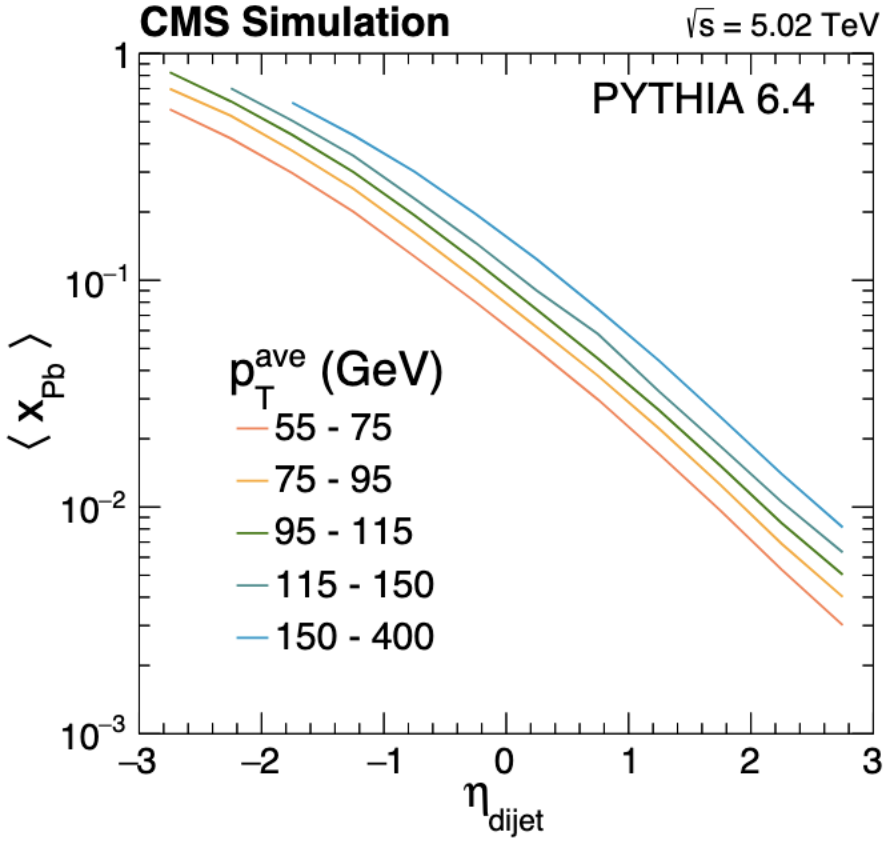
Dijet measurements

Previous CMS dijet pseudorapidity measurements in pPb and pp at 5.02 TeV provided improvements for nPDF (EPPS16 with CT14)

PRL121 (2018) 062002



$$x_{\mathrm{Pb}} \approx \frac{2p_{\mathrm{T}}^{dijet}}{\sqrt{s_{\mathrm{NN}}}} e^{-\eta_{\mathrm{CM}}^{\mathrm{dijet}}} \cosh \Delta\eta_{\mathrm{CM}}^{\mathrm{dijet}}$$



Seel also photonuclear jet production in ultra-peripheral Pb+Pb collisions at 5.02 TeV from ATLAS (arXiv:2409.11060)

Impact of CMS pPb 5.02 TeV dijet measurement on nPDFs

CMS dijet data differential in the average p_T and rapidity (η^{dijet}) of the two jets. They supersede the earlier dijet data which were included in the EPPS16 analysis

The cross sections are normalized to the rapidity-integrated cross section, so that most of the systematic uncertainties cancel

$$\eta_{\text{dijet}} = \frac{1}{2}\left(\eta^{\text{leading}} + \eta^{\text{subleading}}\right)$$

$$p_{\text{T}}^{\text{ave}} = \frac{1}{2}\left(p_{\text{T}}^{\text{leading}} + p_{\text{T}}^{\text{subleading}}\right)$$

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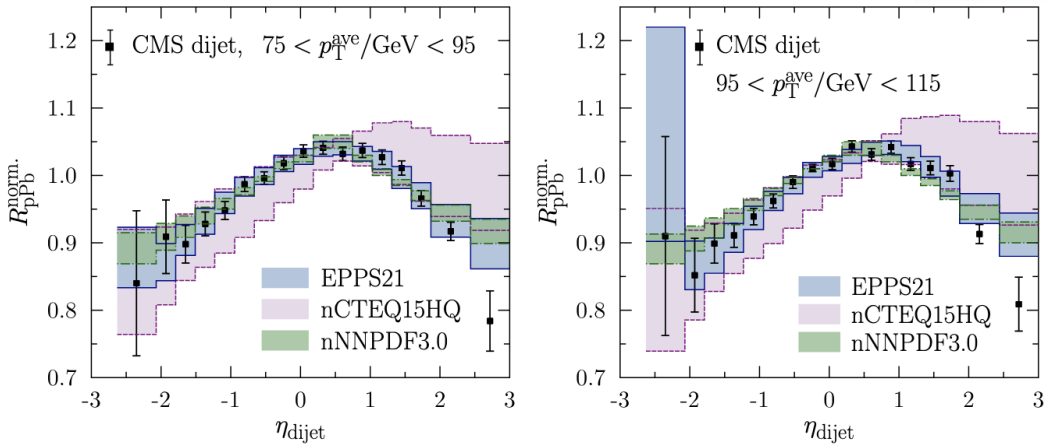

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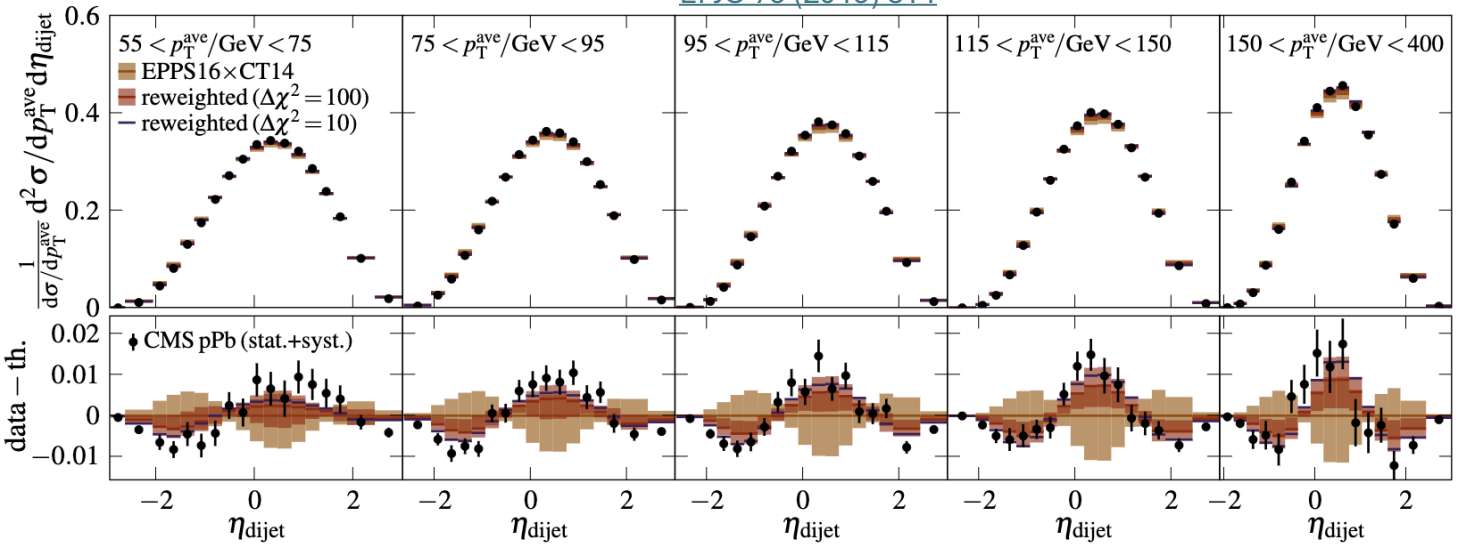
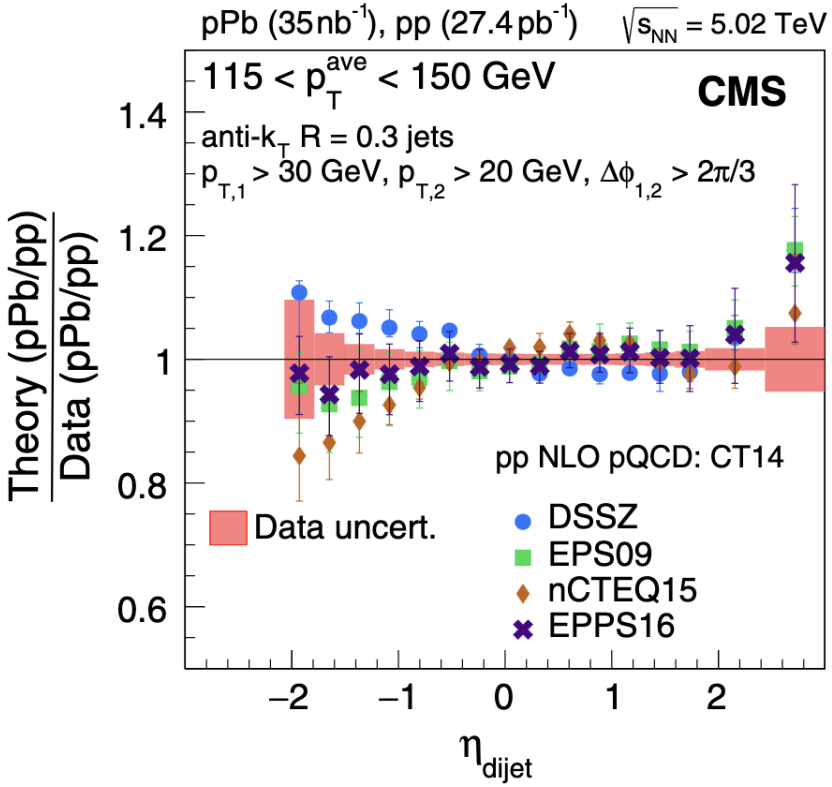




Event, jet and dijet selection criteria

Triggers

- Minimum bias (to access low-p_T jets)
- Jet triggers (to access high-p_T jets)

Jet selection

- Anti-k_T R = 0.4
- Leading jet p_T > 50.0 GeV
- Subleading jet p_T > 40.0 GeV
- Pseudorapidity : $|\eta^{jet}| < 3$

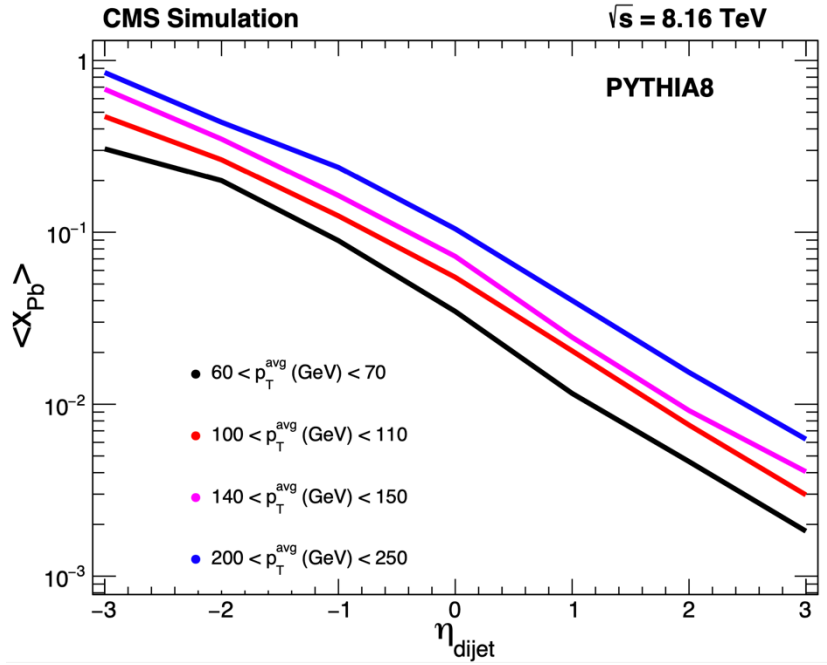
Dijet selection

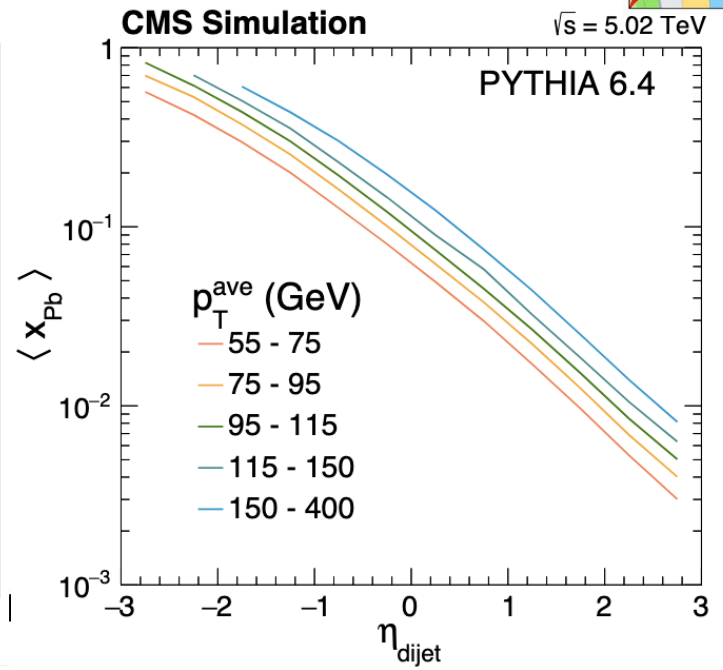
- $\Delta\phi > 5\pi/6$
- 16 bins in p_T^{ave}

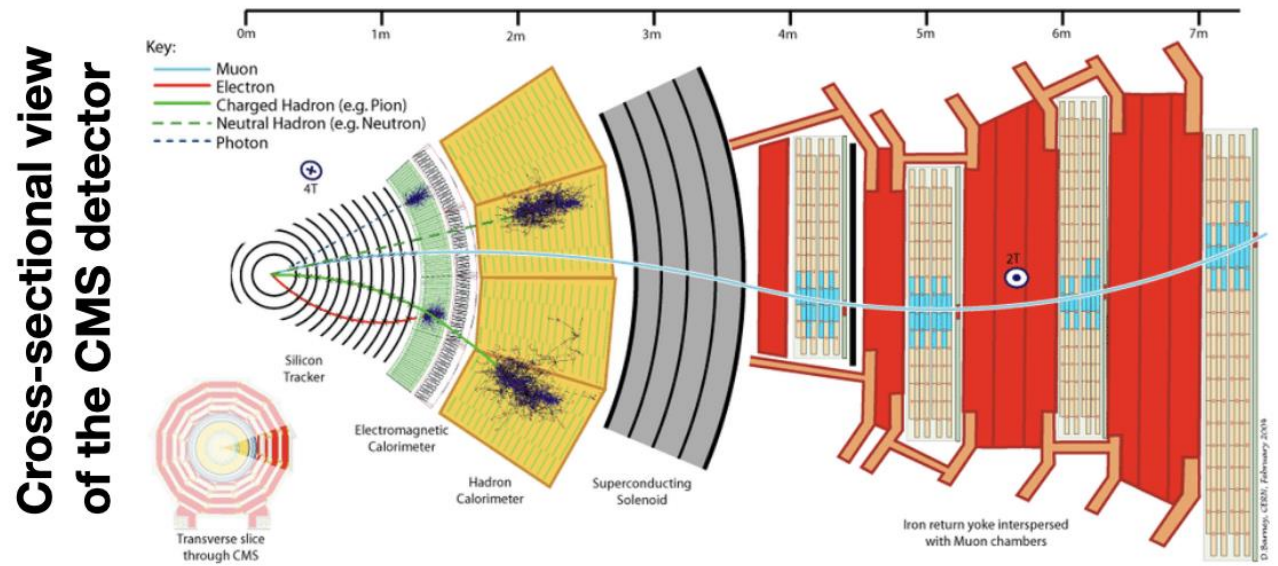
Observables

$$\eta_{\mathrm{dijet}} = \frac{1}{2}\left(\eta^{\mathrm{leading}} + \eta^{\mathrm{subleading}}\right)$$

$$p_{\mathrm{T}}^{\mathrm{ave}} = \frac{1}{2}\left(p_{\mathrm{T}}^{\mathrm{leading}} + p_{\mathrm{T}}^{\mathrm{subleading}}\right)$$



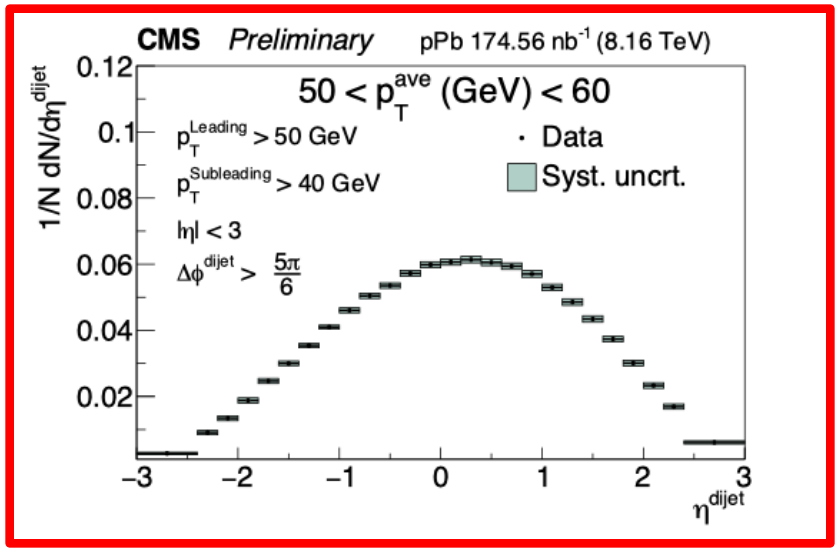


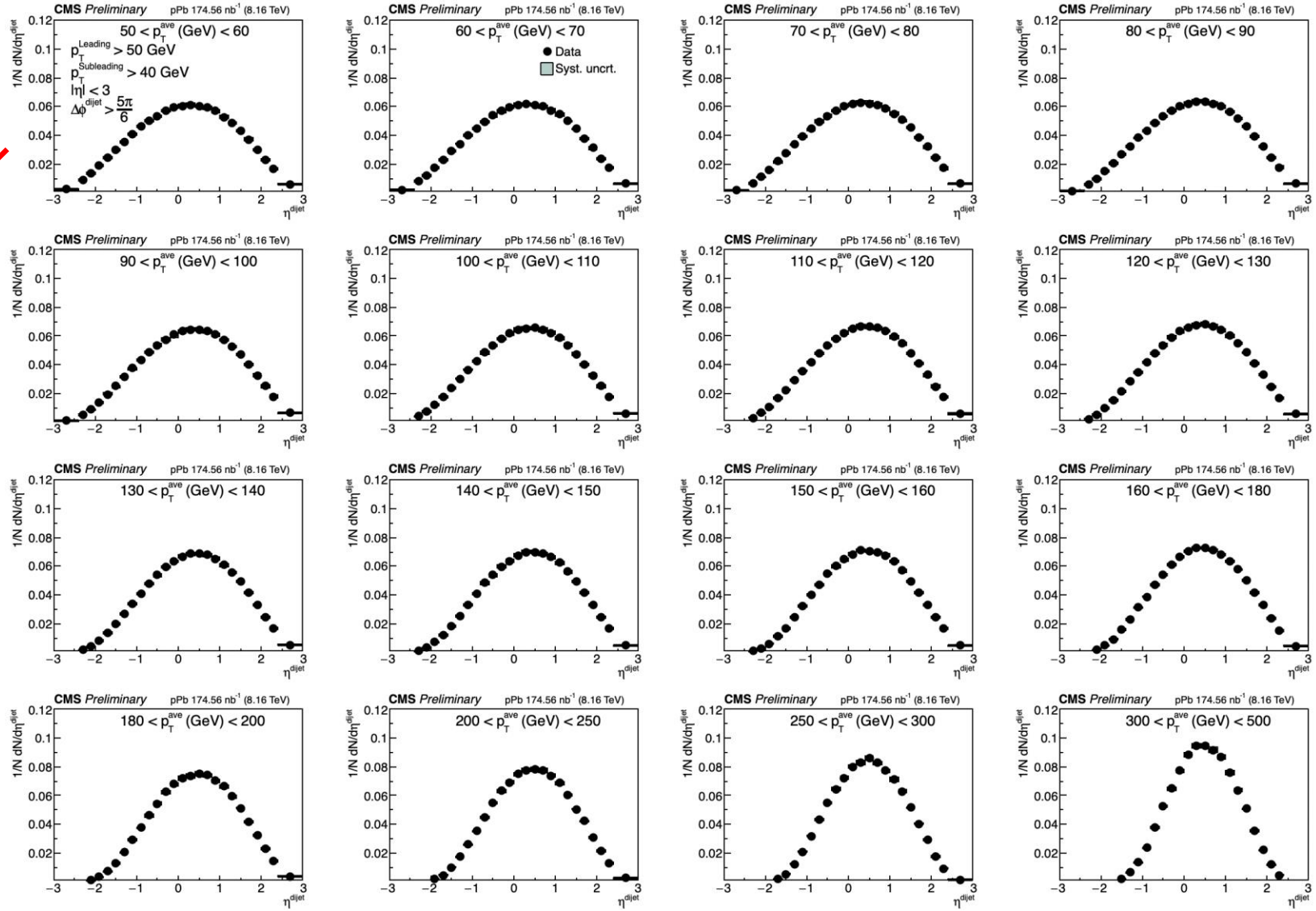


Dijet pseudorapidity distributions in pPb collisions at 8.16 TeV

$\langle x_{Pb} \rangle \sim 10^{-3}$

Provide unique set of measurements to provide constraints on nPDF parametrizations!

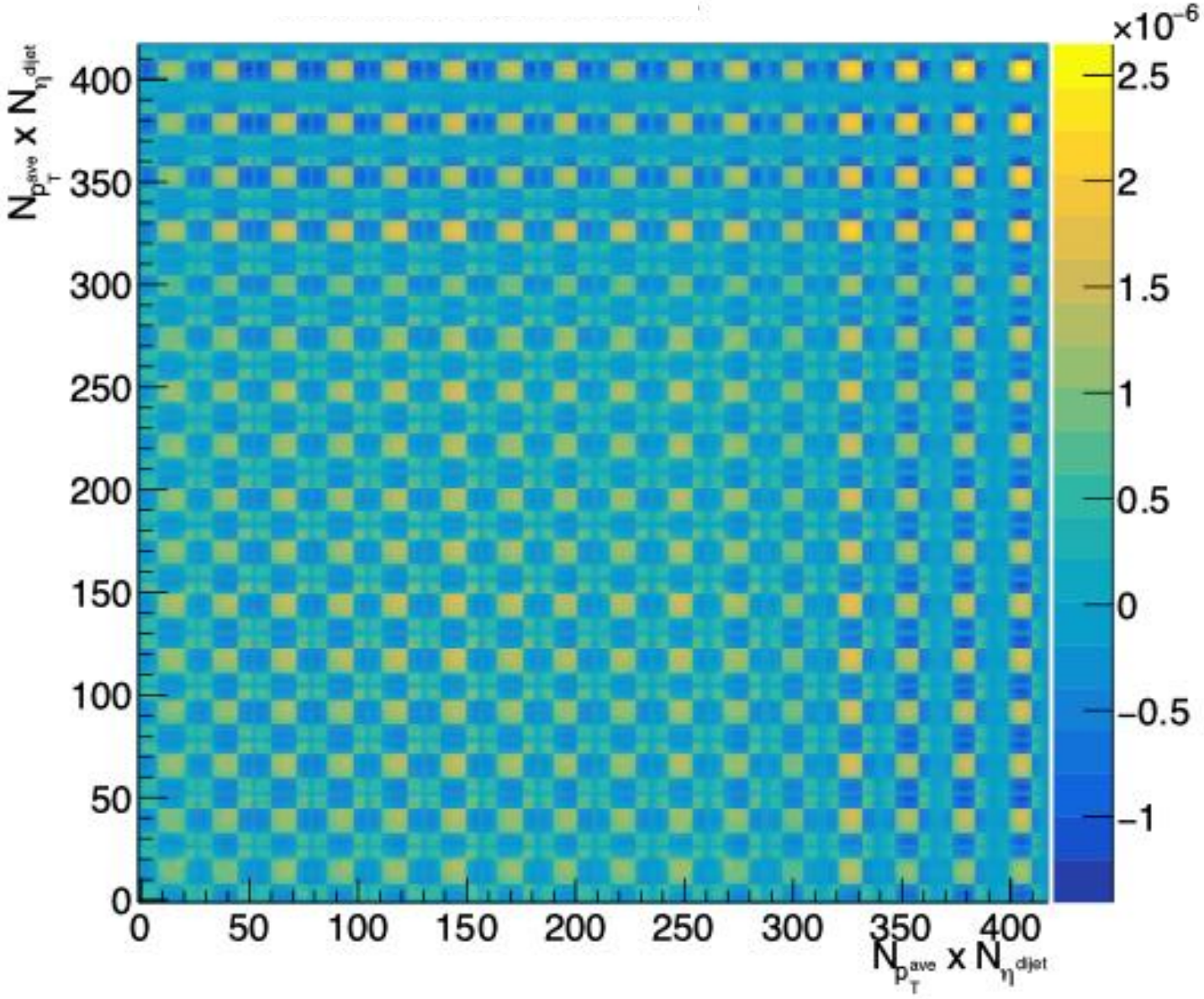




$\langle x_{Pb} \rangle \sim 0.5$

Covariance matrix

- Covariance matrix contains **~100000** unique entries
- Allows fits across full kinematic range with no assumptions regarding correlations between points



Summary

- First measurement of dijet pseudorapidity distributions in pPb collisions at 8.16 TeV
- Unique and high-constraining set of η^{dijet} for 16 p_T^{ave} intervals utilizing MB and jet triggers
- Important data for nPDF global analysis and constraints