

IS2013

International Conference on the Initial Stages in High-Energy Nuclear Collisions



8-14 September, Illa da Toxa (Galicia-Spain)

Abstract submission is open - send your abstracts before the **deadline July 7th 2013**

<http://igfae.usc.es/is2013/>

jets and nPDFs

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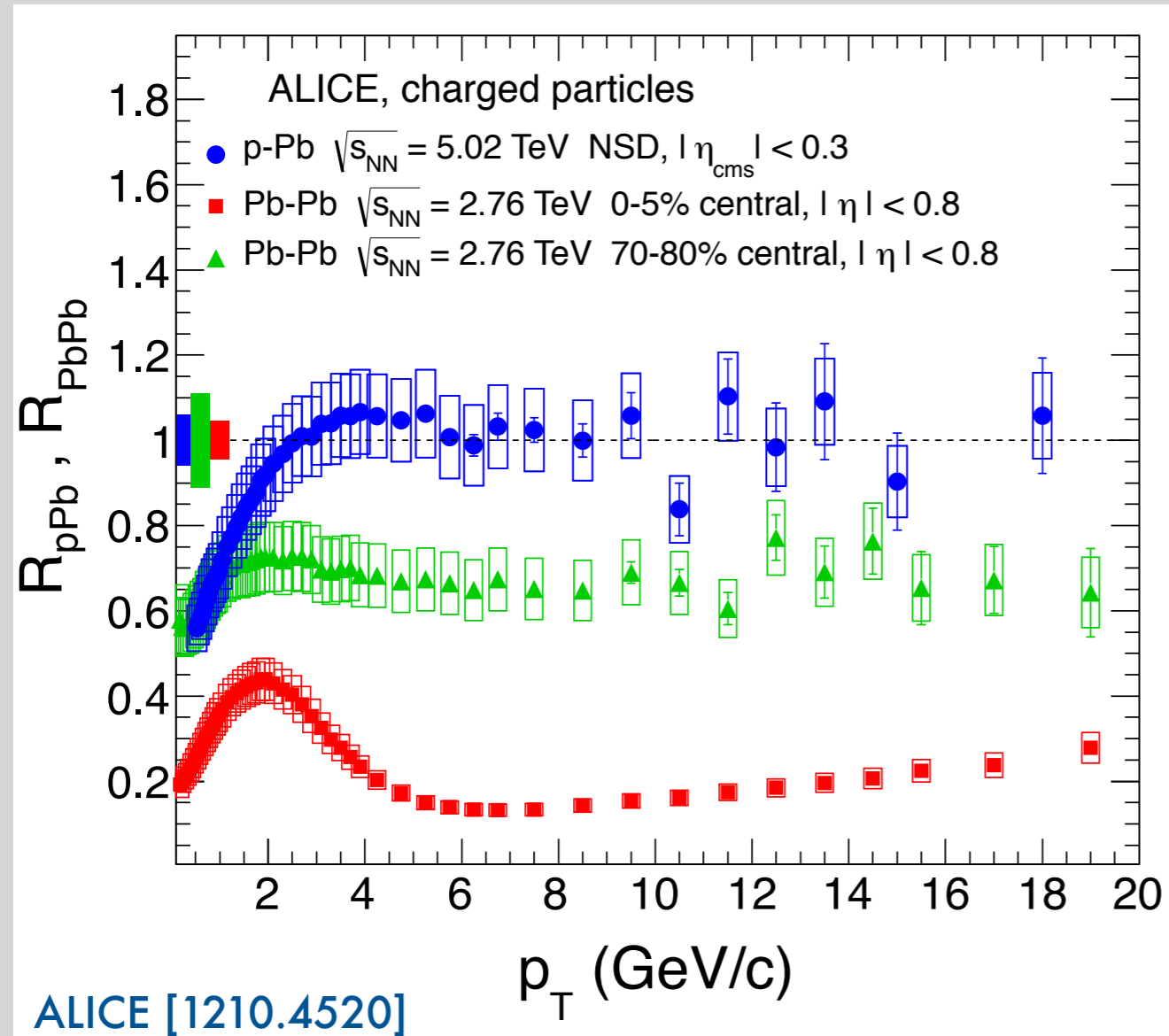
Jet workshop, Jussieu — Paris, 3th Julz 2013



discussions with and various material from:
Néstor Armesto, Doğa Gülham, Yen-Jie Lee,
Gavin Salam, Carlos Salgado, Urs Wiedemann,
Korinna Zapp

#1 jet quenching in pA ?

R_{pPb} [charged hadrons]

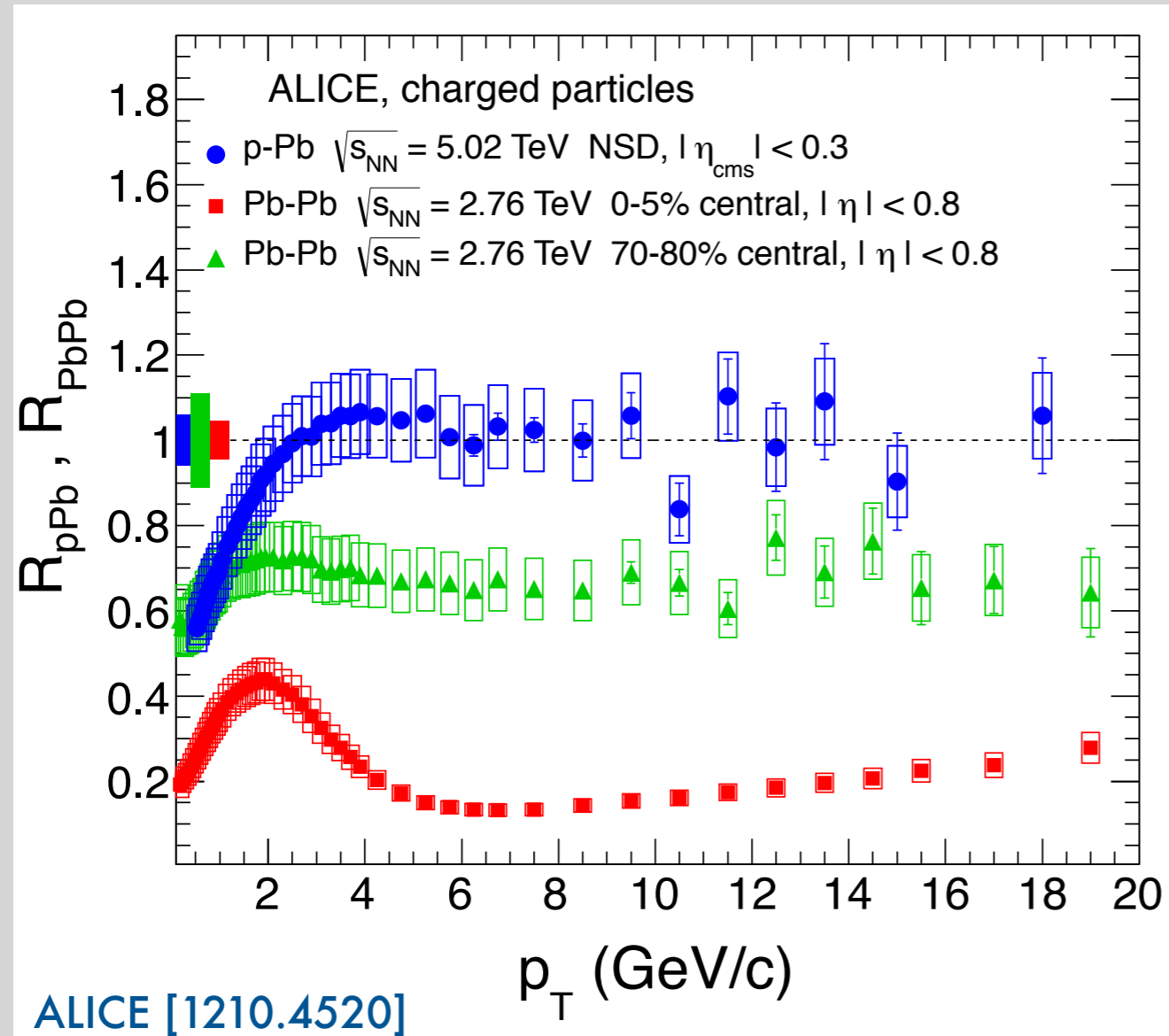


○ consistent with 1 at high- p_T for MB

○ NO quenching

○ need centrality dependence for definite answer

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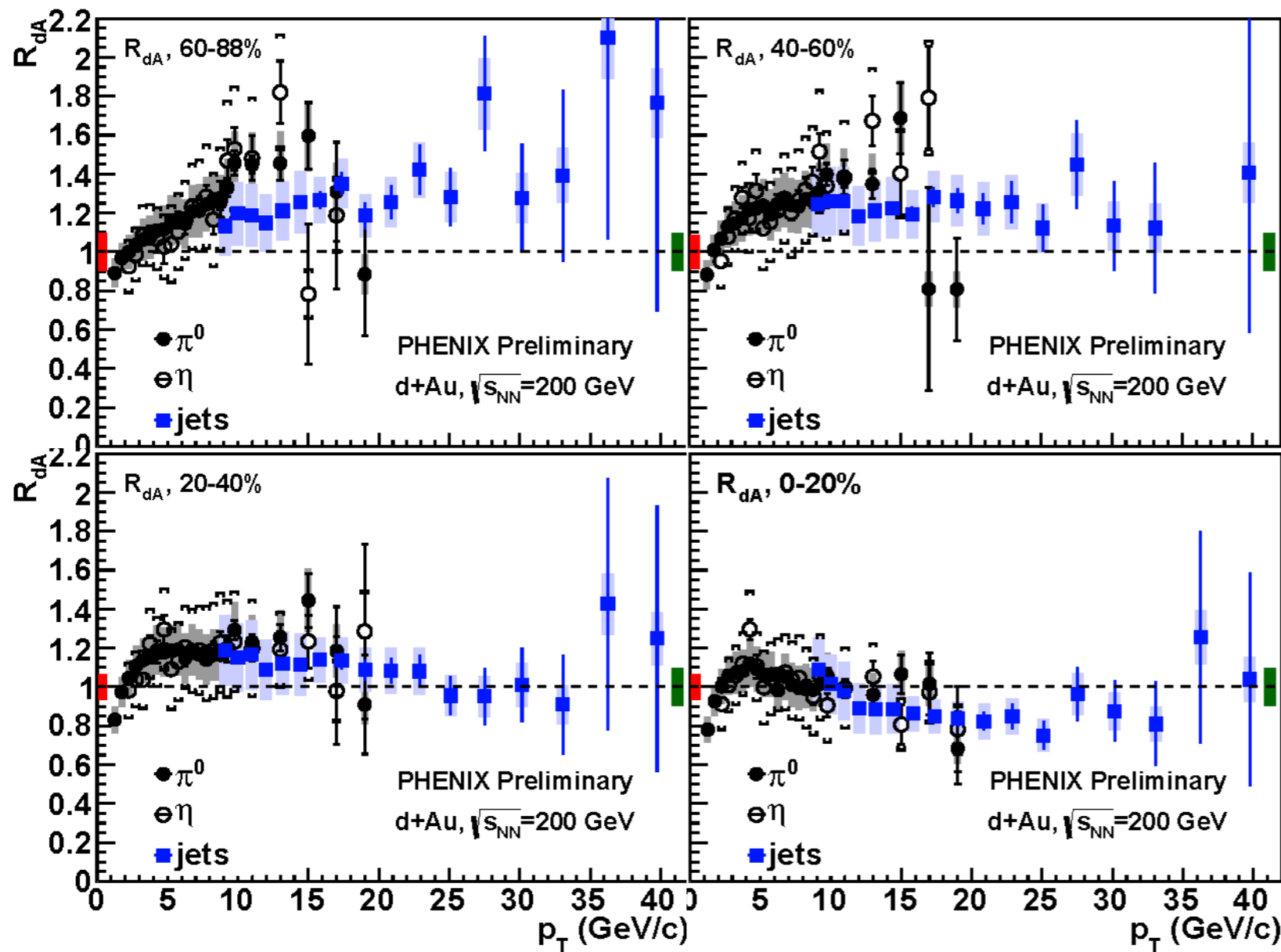
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how to measure centrality in pA collisions ?

centrality dependence of R_{dAu} [π^0 and jets]

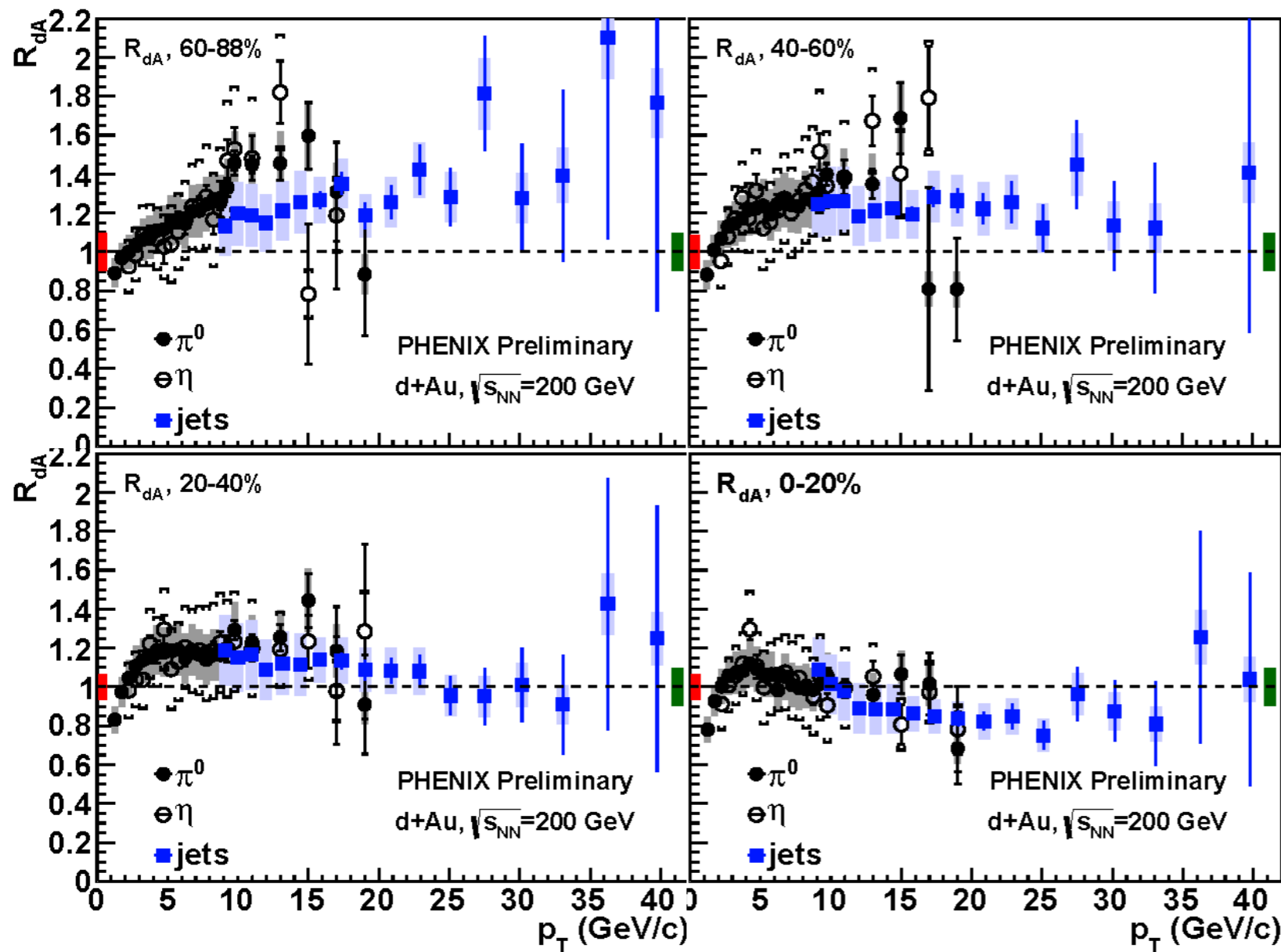


PHENIX [Bathe@h3qcd ECT* Trento]

—○ quenching ?

↪ something MUST not be quite right here

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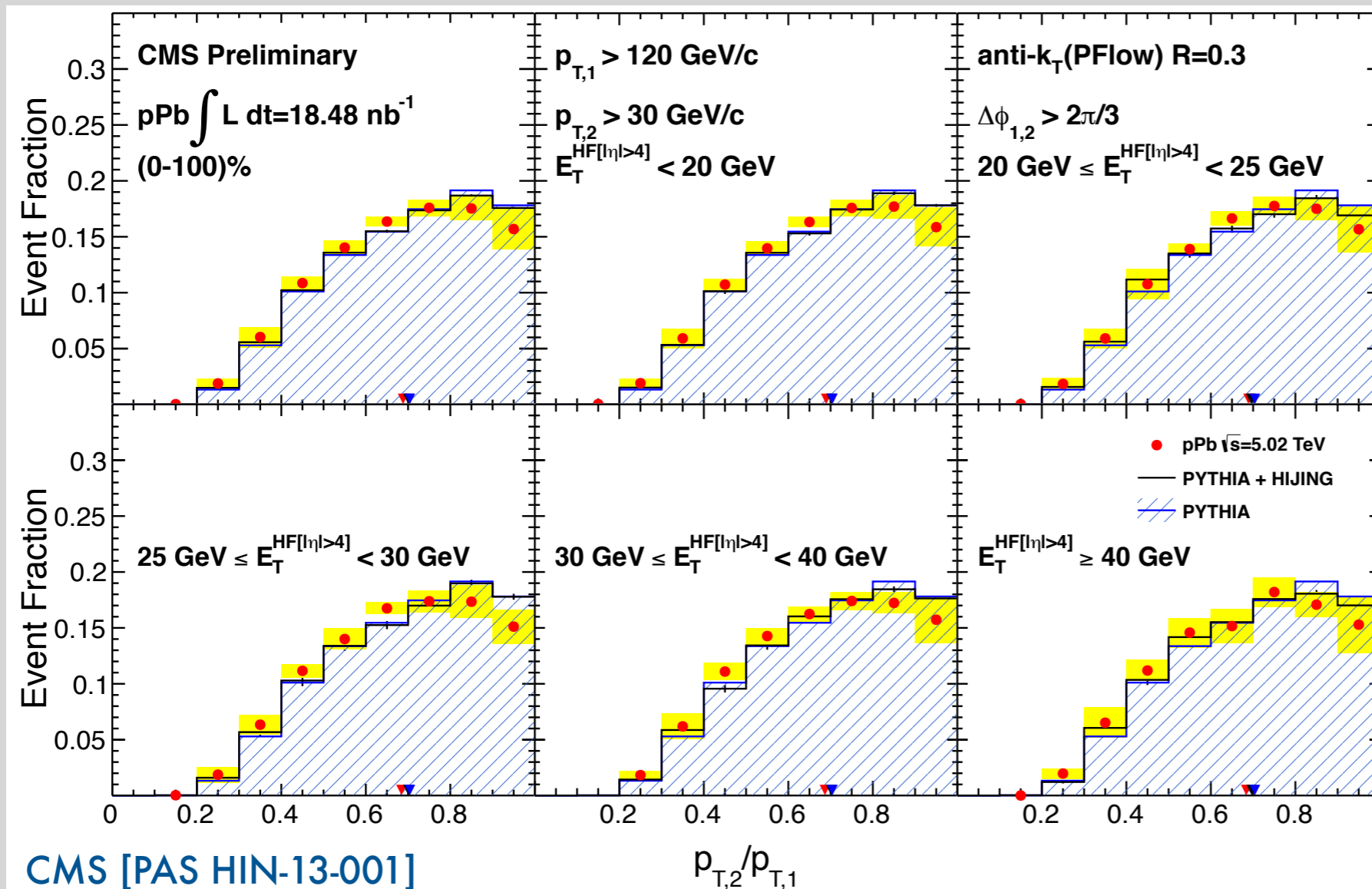
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how to measure centrality in pA collisions ?

dijet asymmetry



- no [$<2\%$] enhanced asymmetry [also, as in PbPb, no disturbance of azimuthal distribution] for all 'centrality' classes :: NO quenching
- HOWEVER, asymmetry rather insensitive to small losses
- ↪ compare with 15% effect for most central PbPb

where [else] to look ?

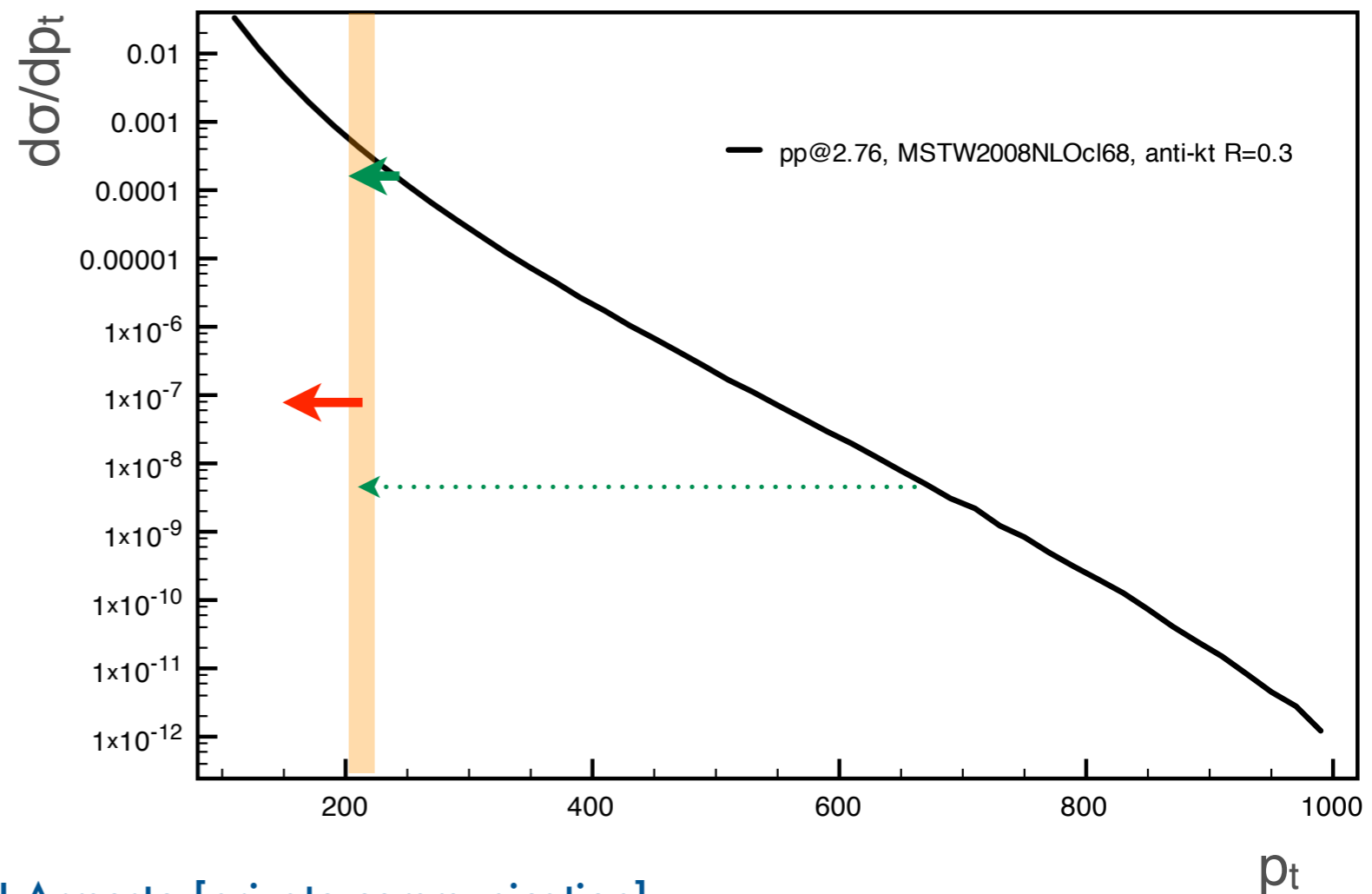
—○ jet $R_{[p/A]A}$ very sensitive to small losses

→ in fact, totally insensitive to energy loss distribution

- $R_{AA} = \text{jets in bin} - \text{all losses} + \text{'feed down'} = \text{unmodified jets}$

→ $R_{AA} < 1$ even for rather non-central collisions

→ centrality dependence of R_{pA}



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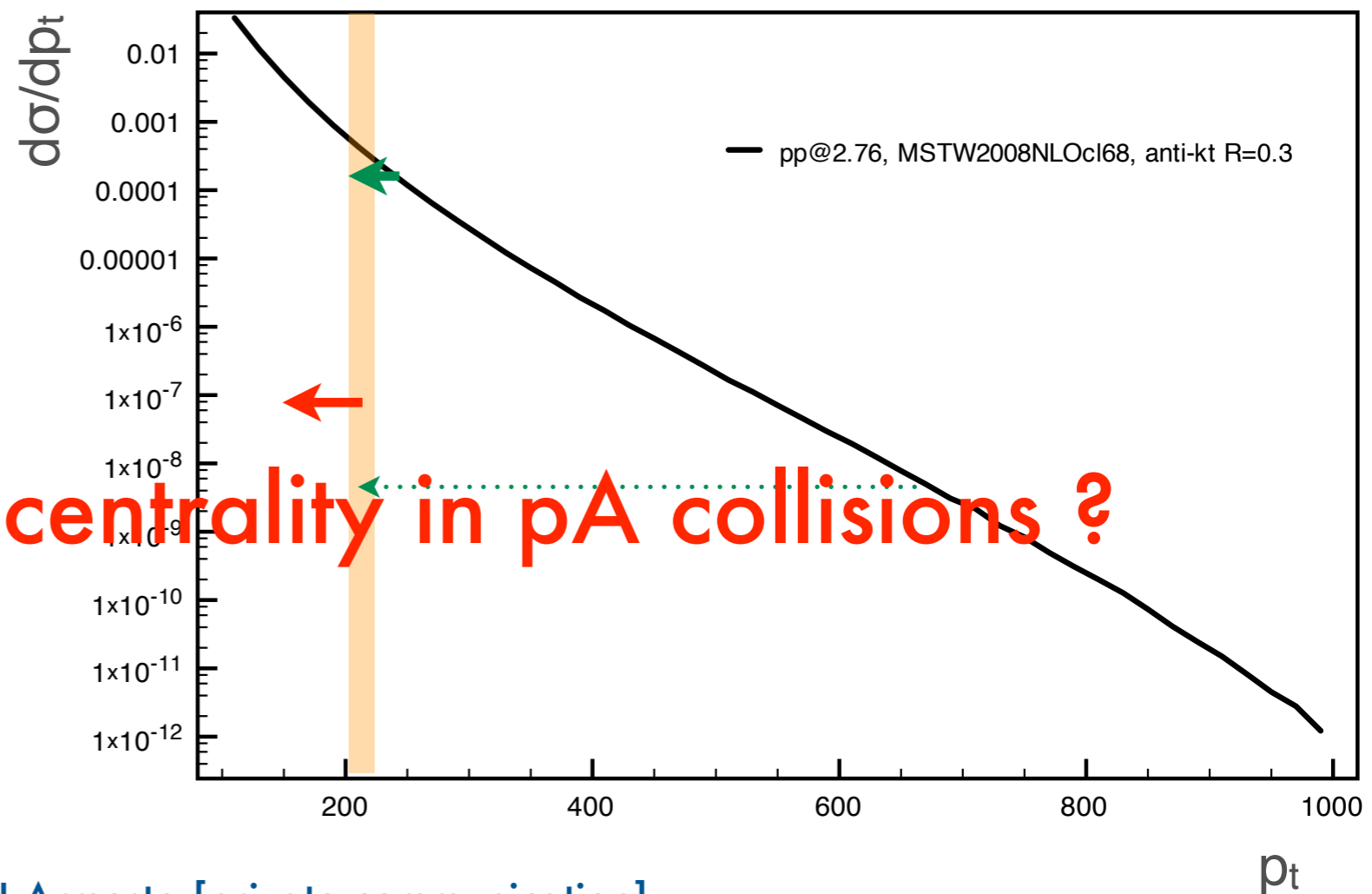
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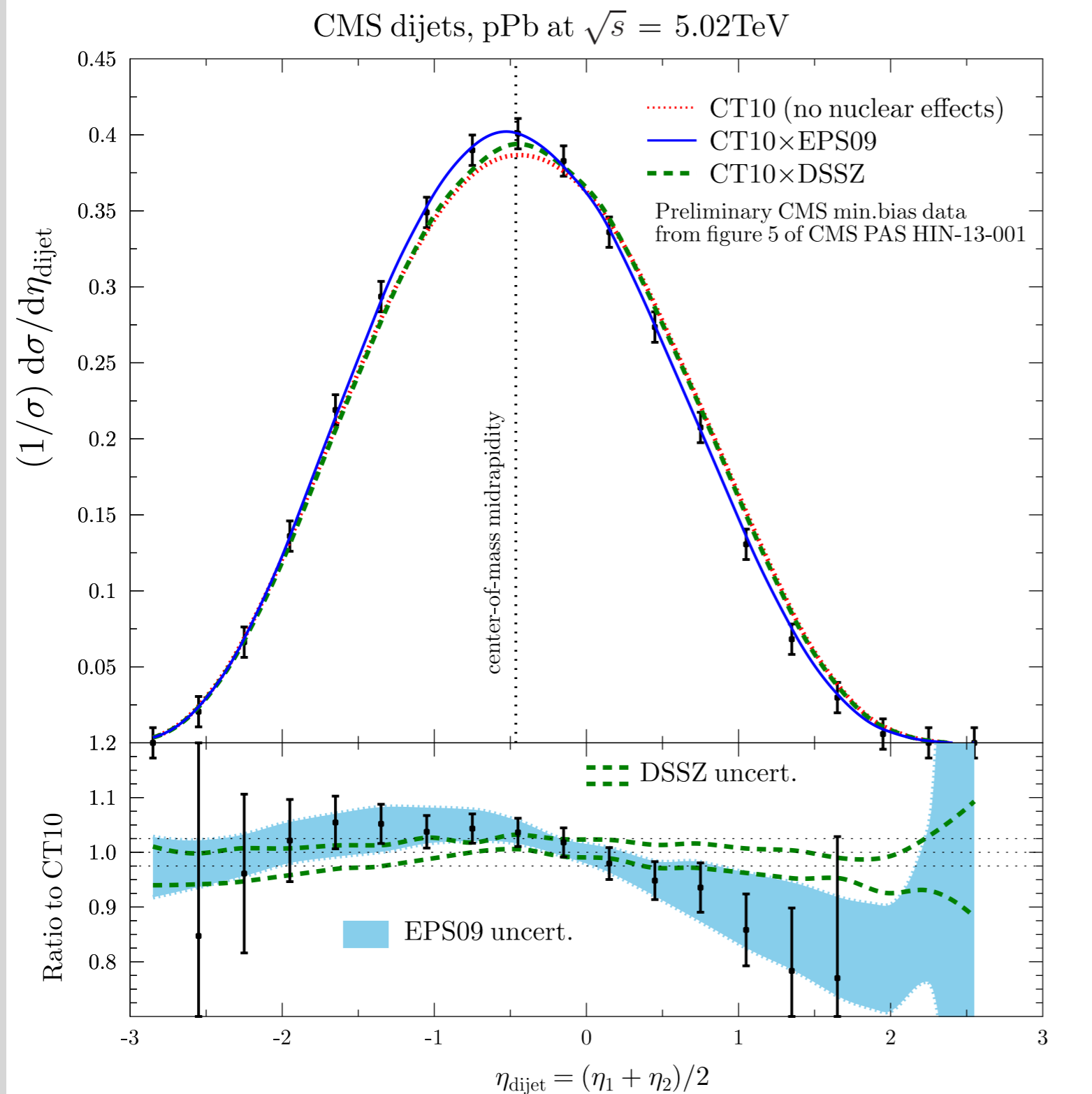
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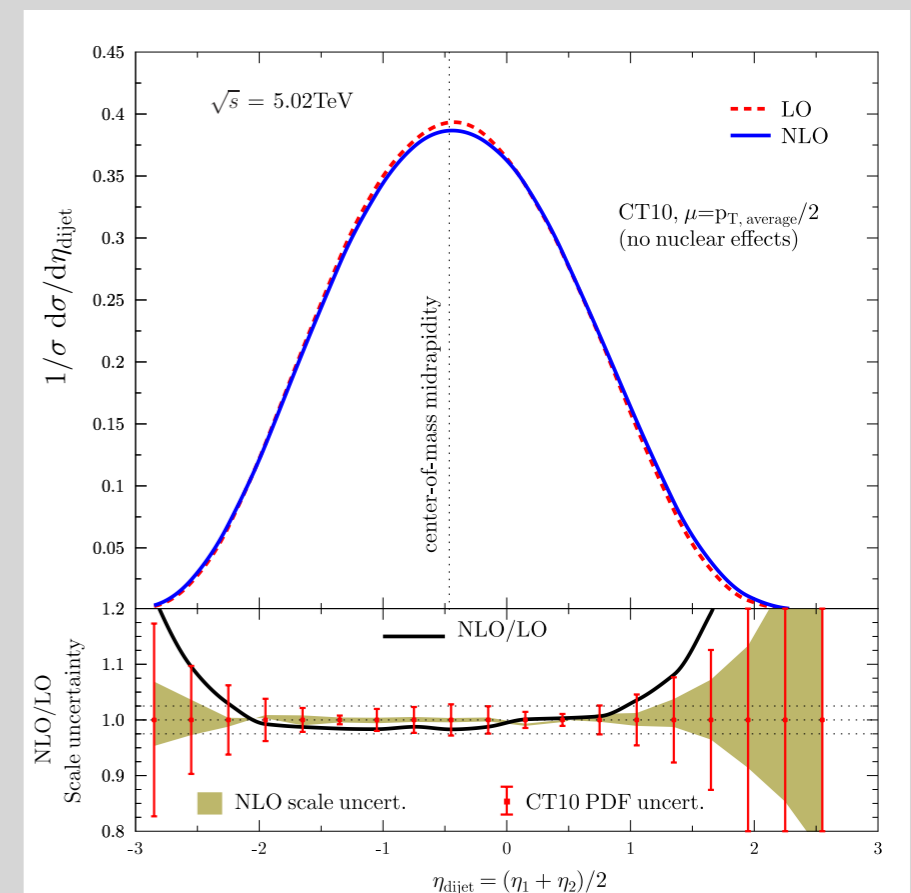
final state effects [quenching] sufficiently small for reliably
use of jet observables to test/constrain initial state [nPDFs]

excellent news



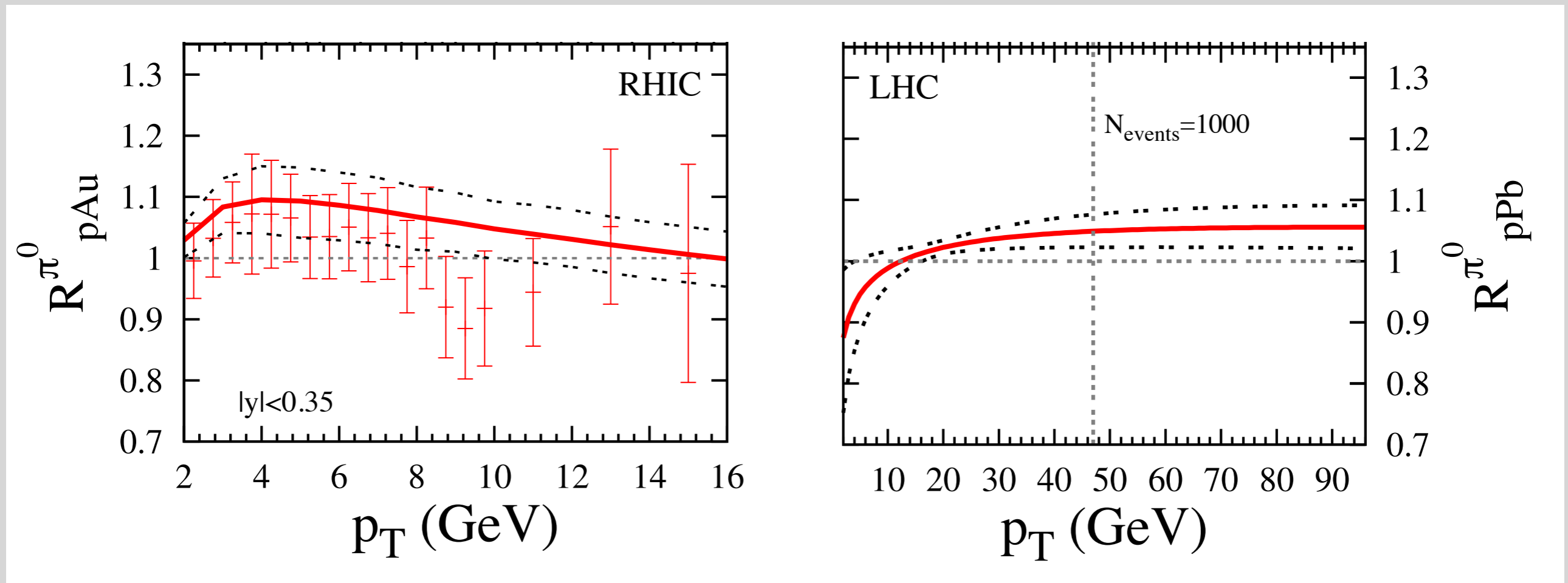
H Paukkunen [private communication]

- excellent EPS09NLO description of dijet pseudo-rapidity distribution for MB data
- data sufficient to distinguish between parametrizations [EPS vs DSSZ]



further nPDF tests [with MB data]

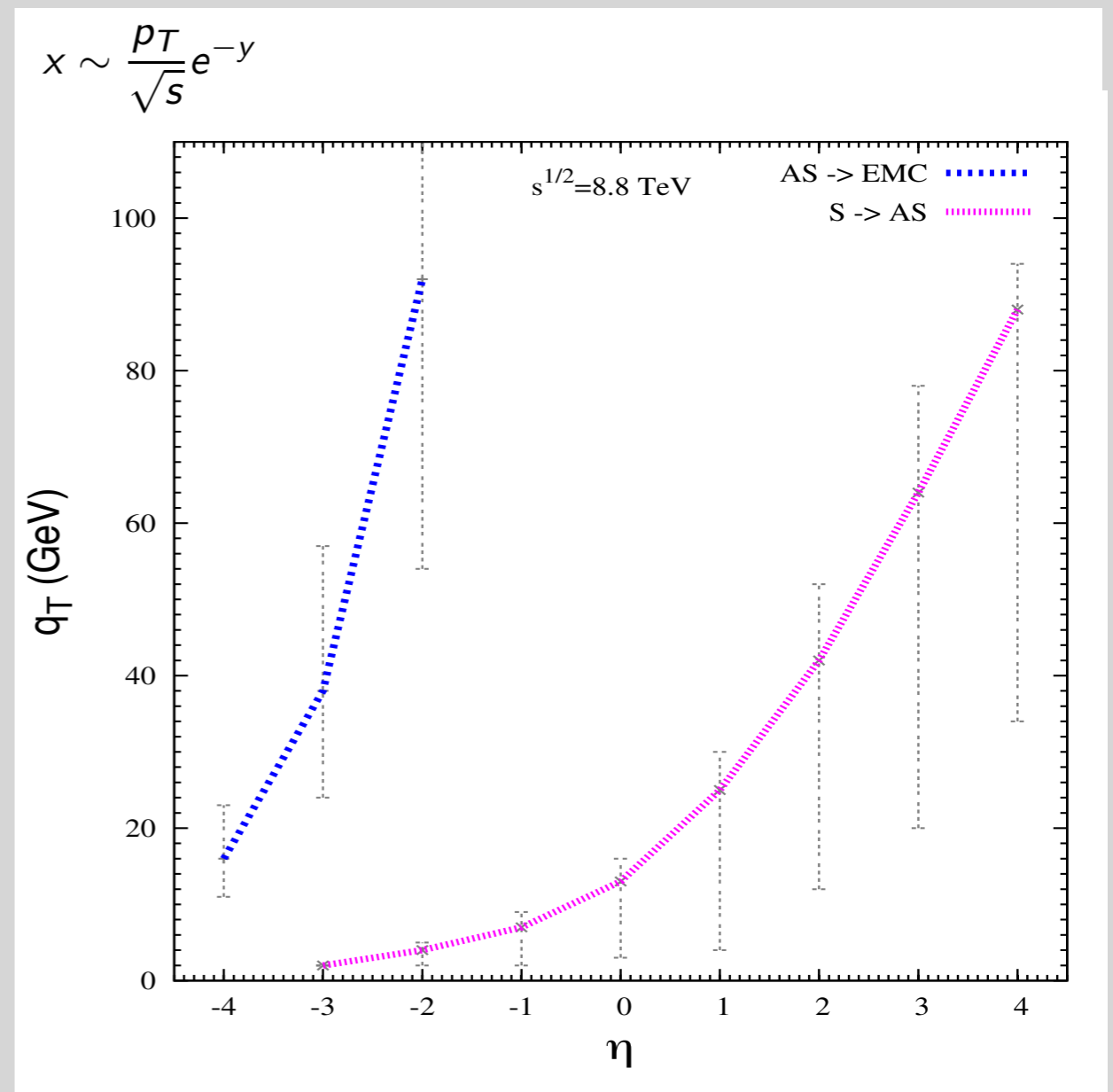
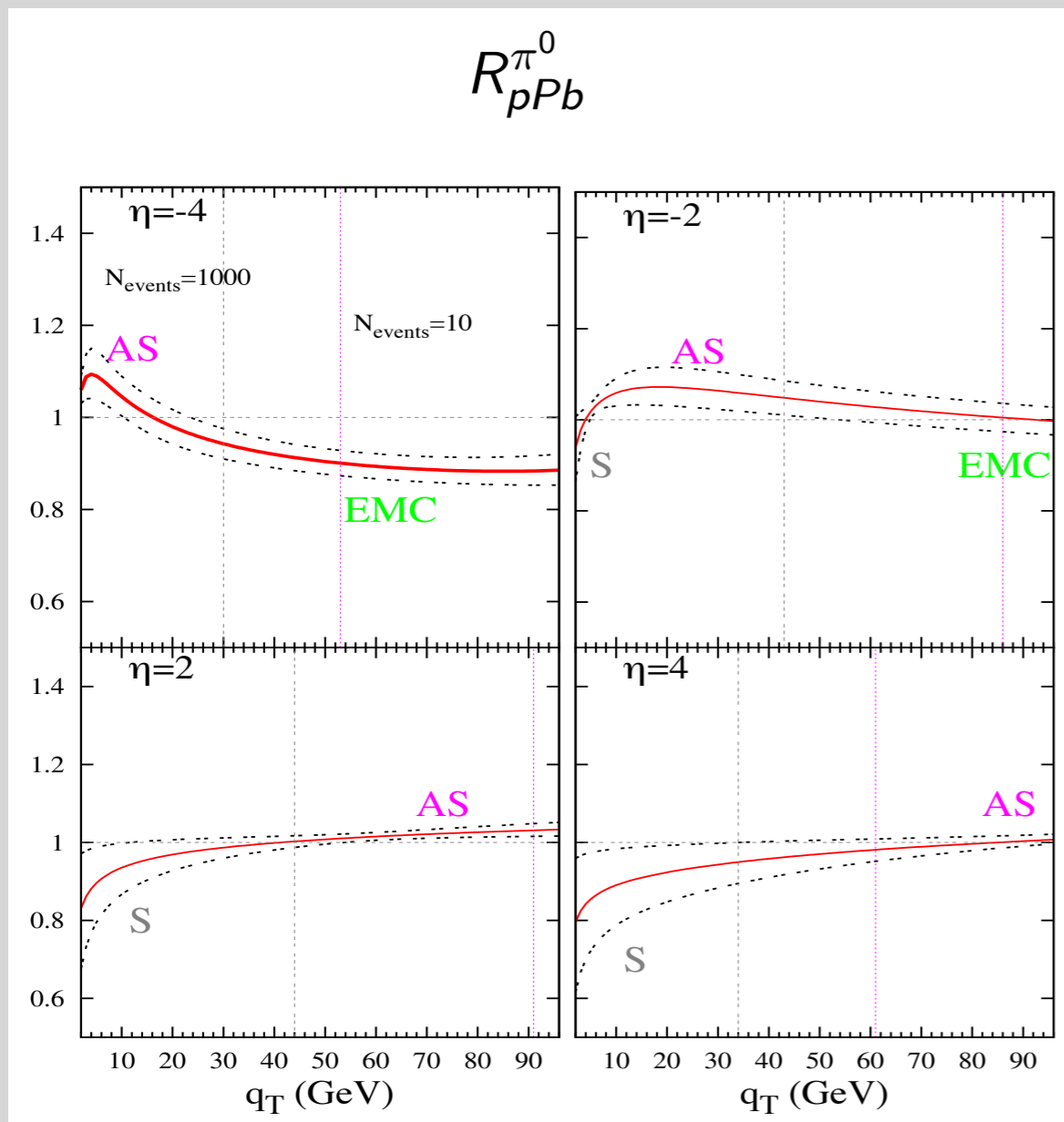
- RHIC and LHC probe different regions of nuclear modification



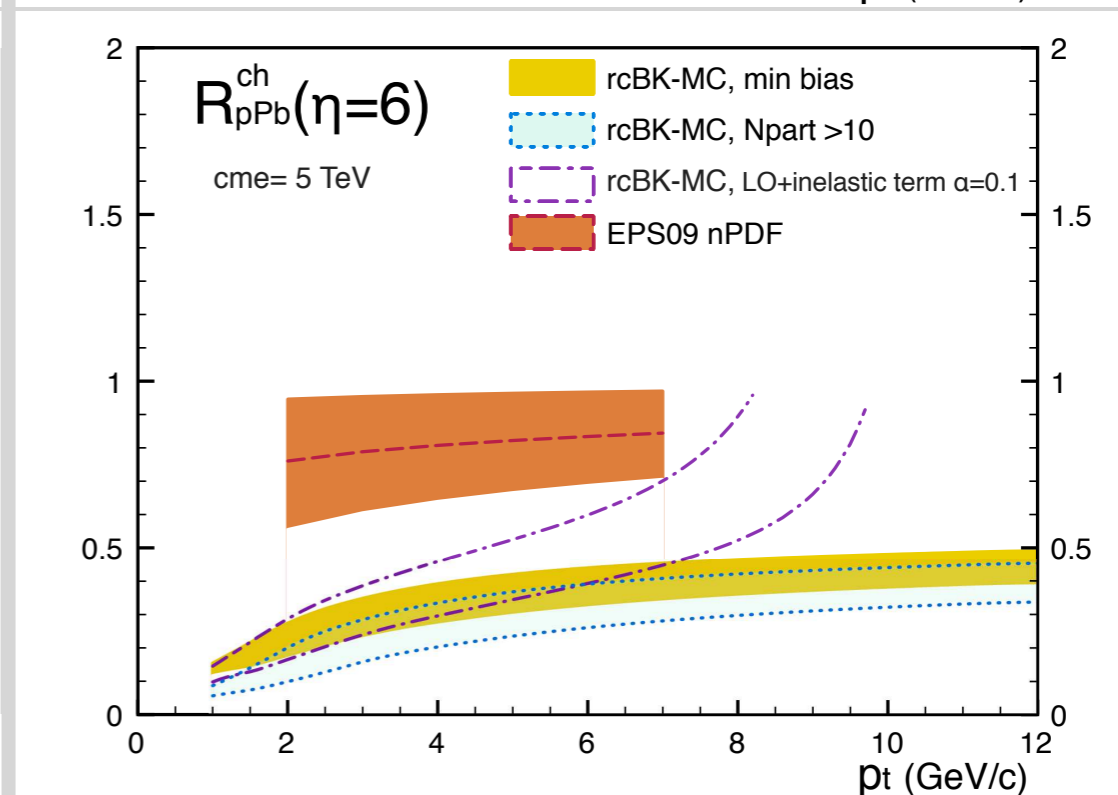
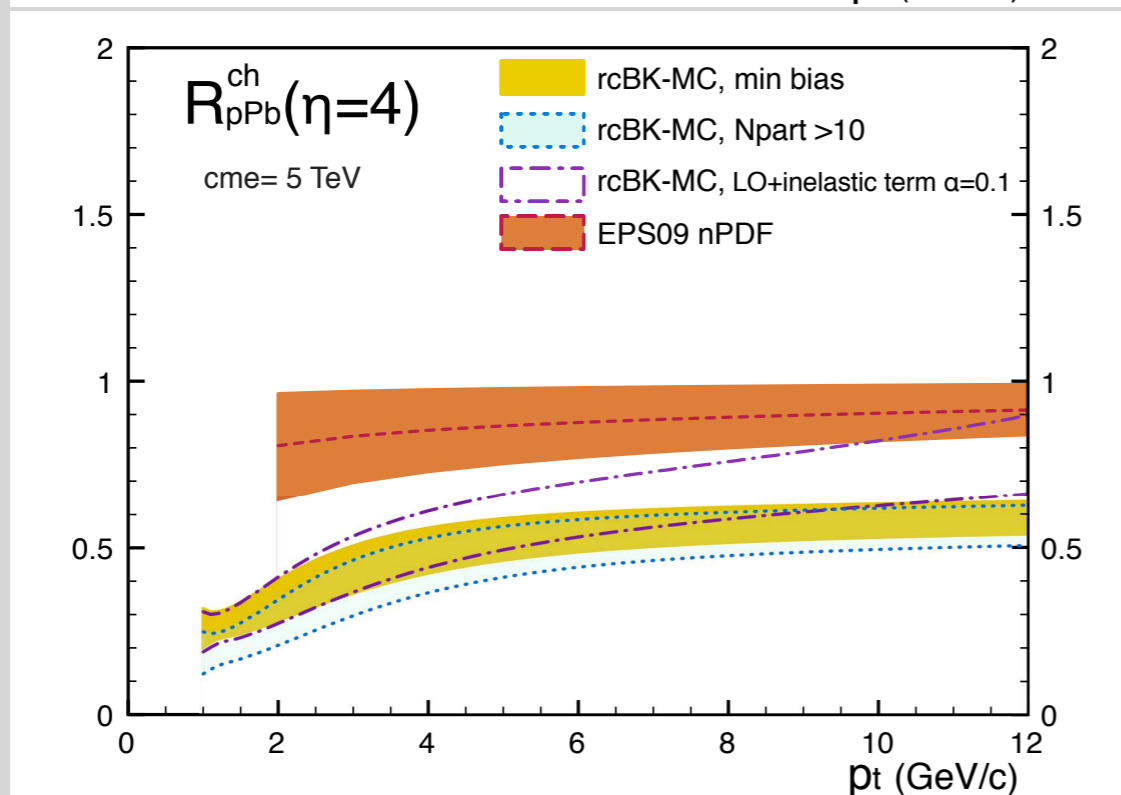
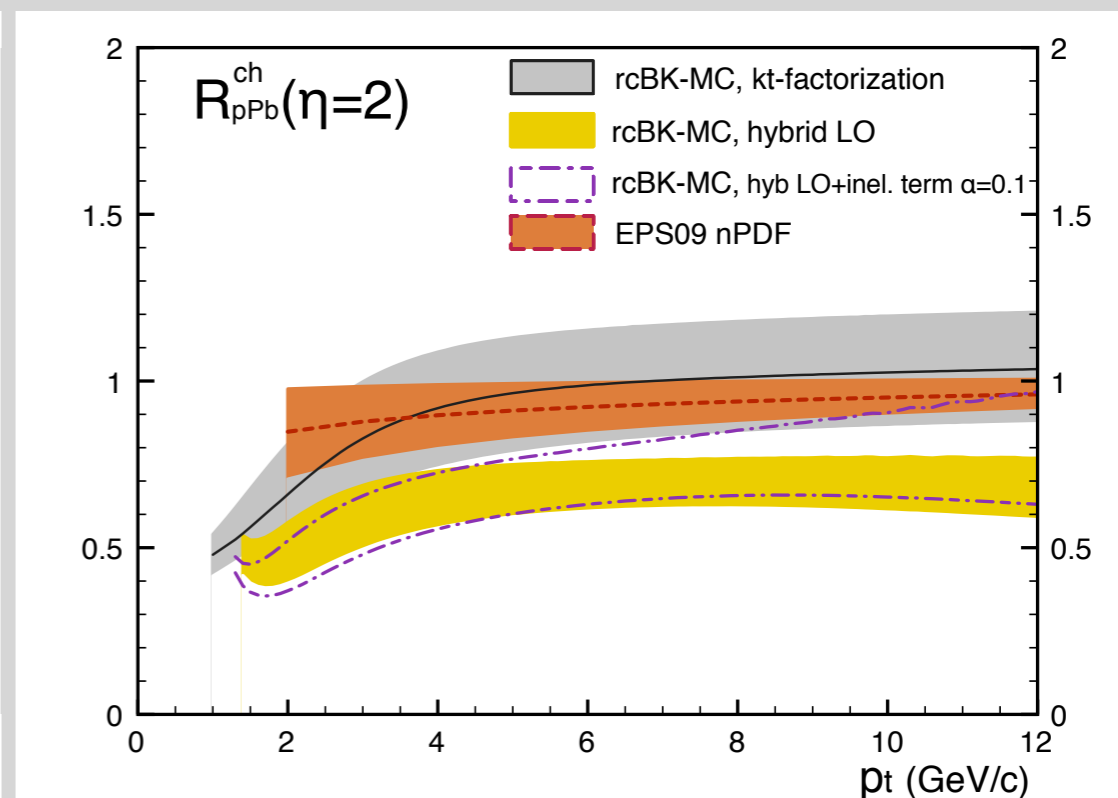
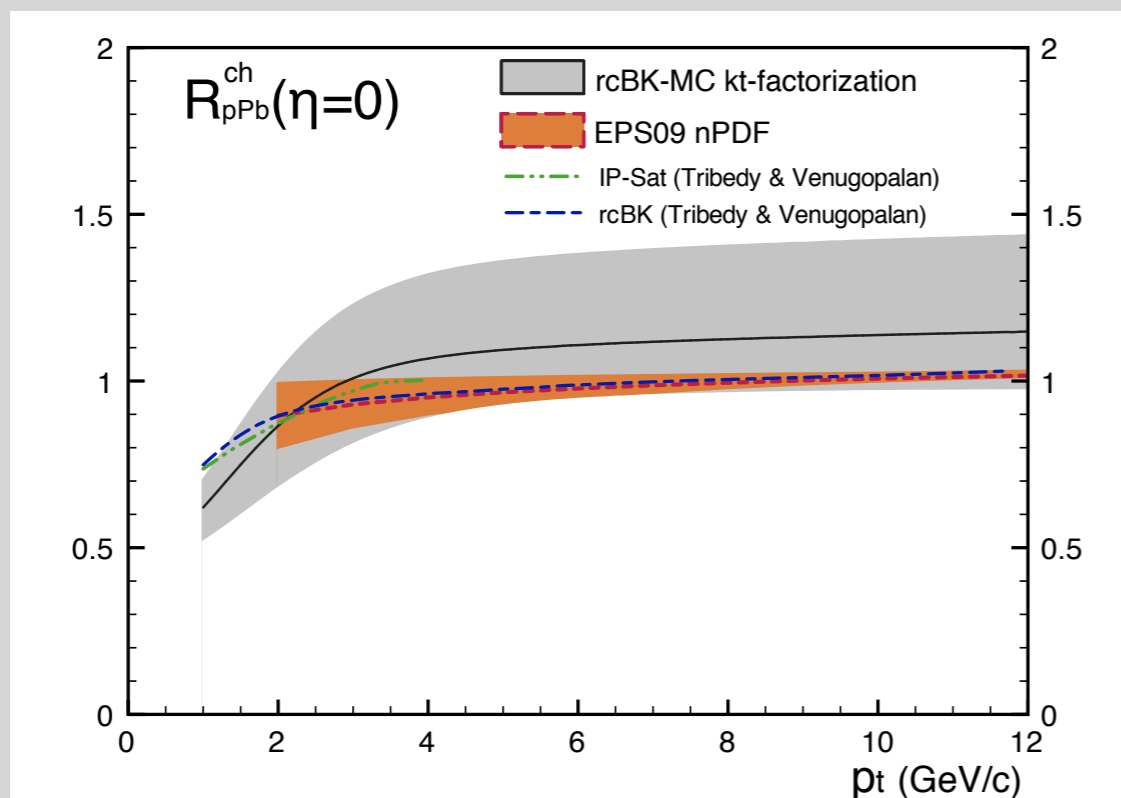
- migration of maximum beyond reach follows from [as in DGLAP evolution] nuclear modification of the longitudinal parton momentum distribution
- other approaches [CGC, final state rescattering] involve transverse dynamics
 - ↪ result in mild shift :: test collinear factorization

rapidity scan

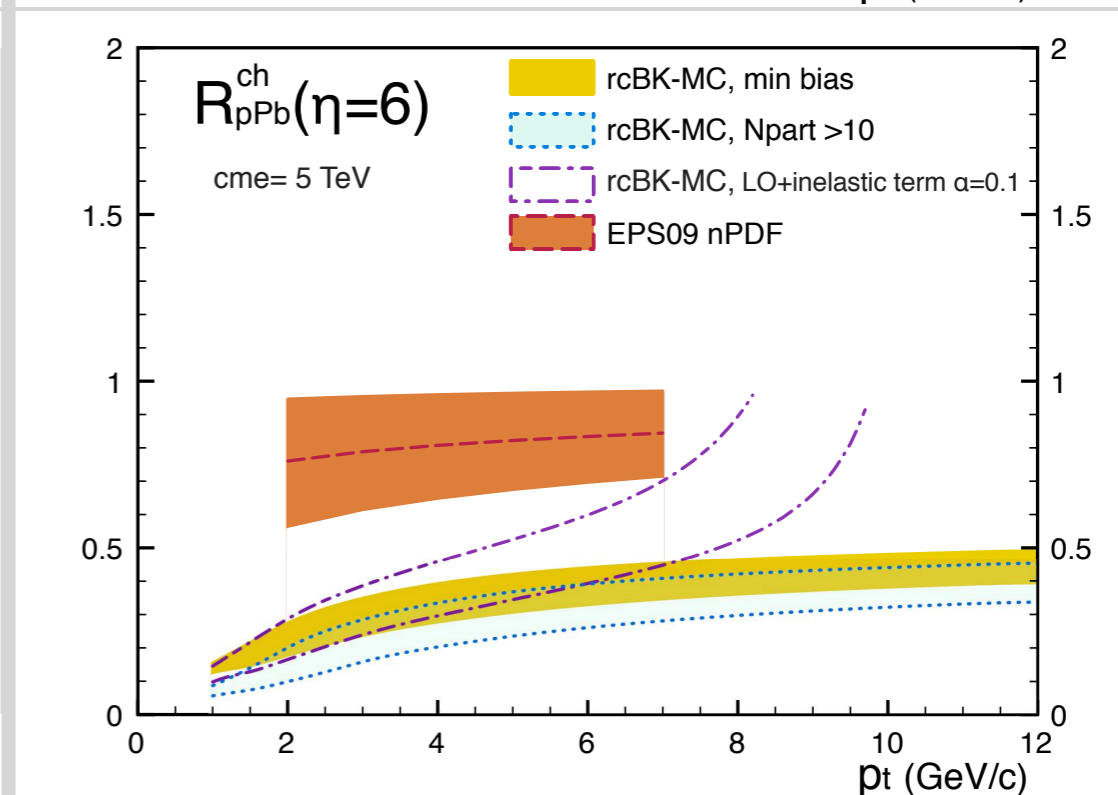
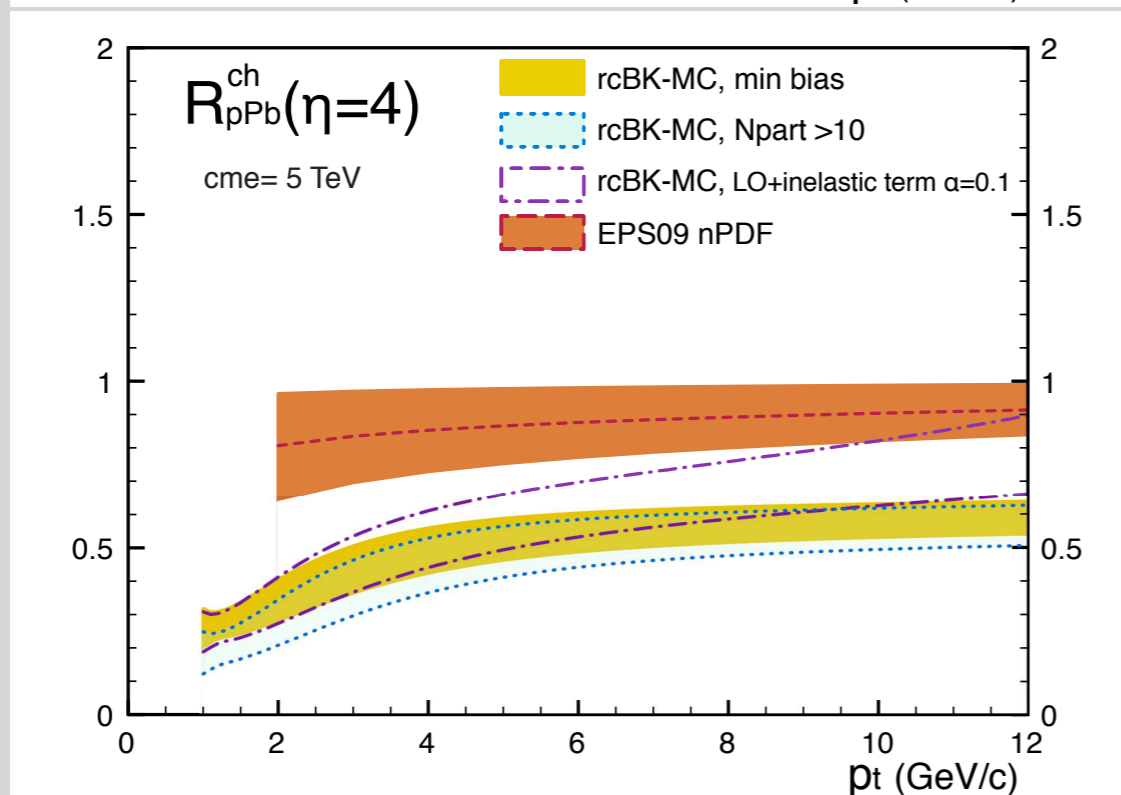
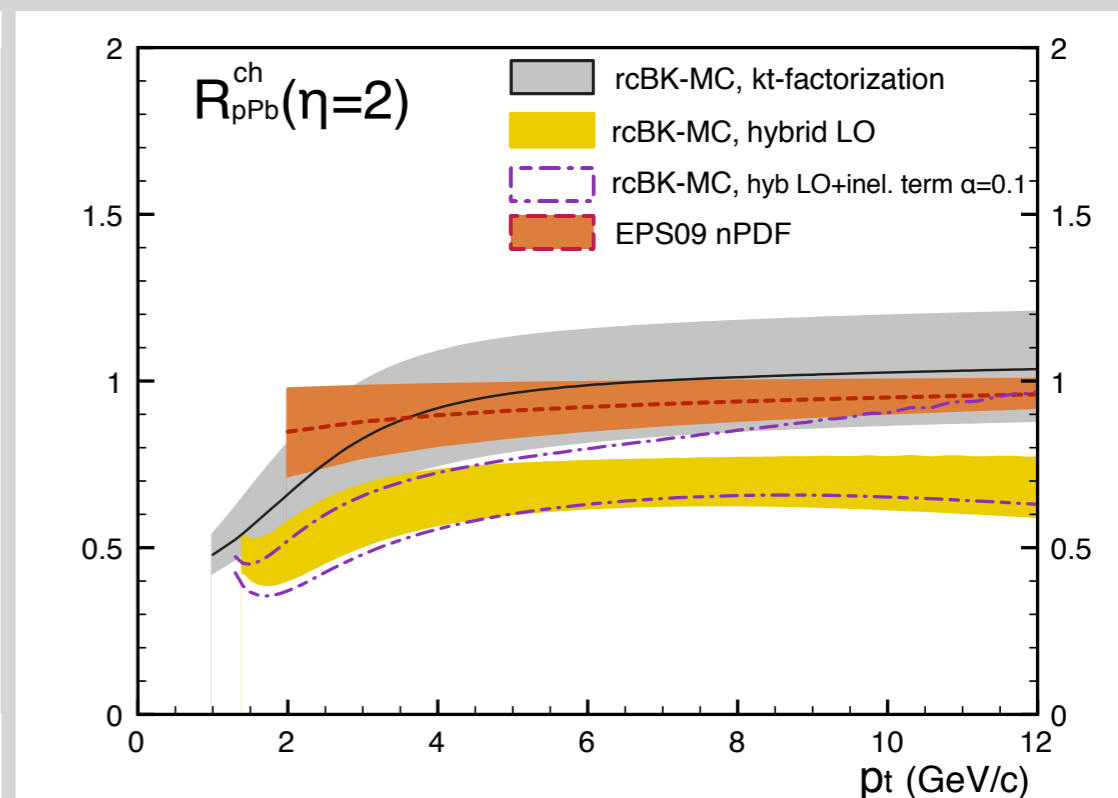
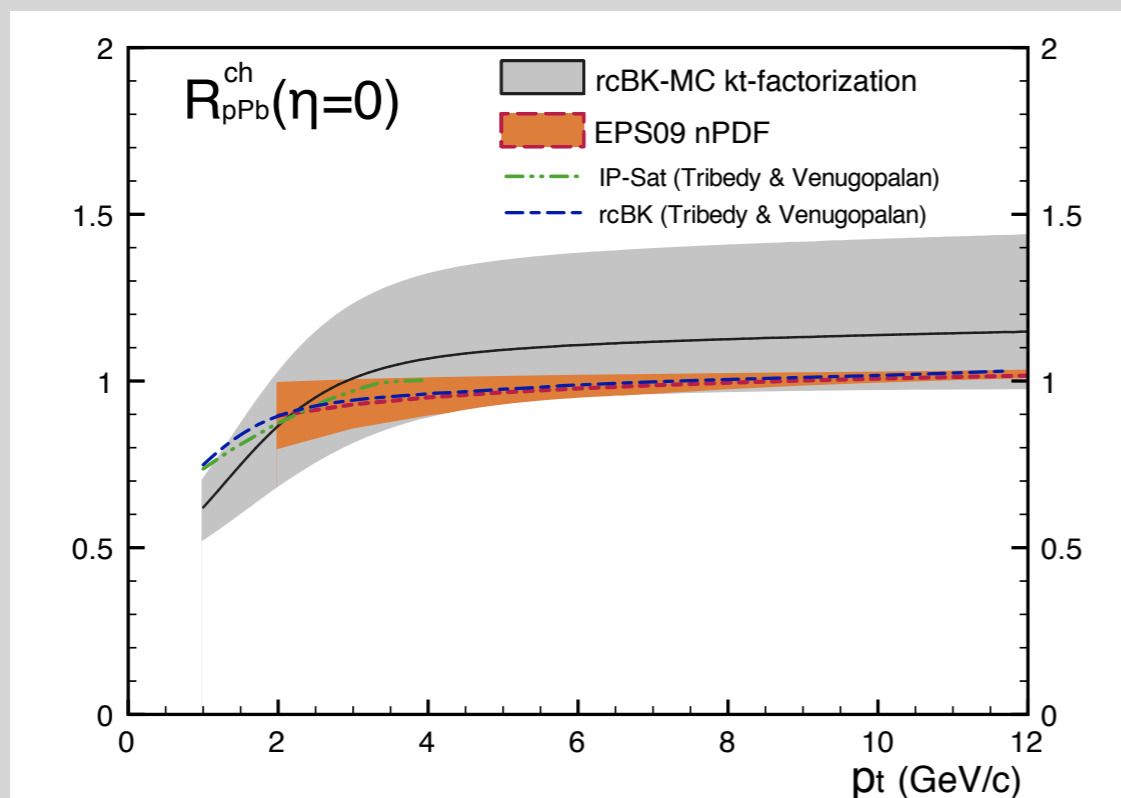
- measurements in different rapidity windows probe different x regions
- displacement of transitions a definite [and qualitative] test of collinear factorization



DGLAP [EPS09] vs CGC [rcBK]



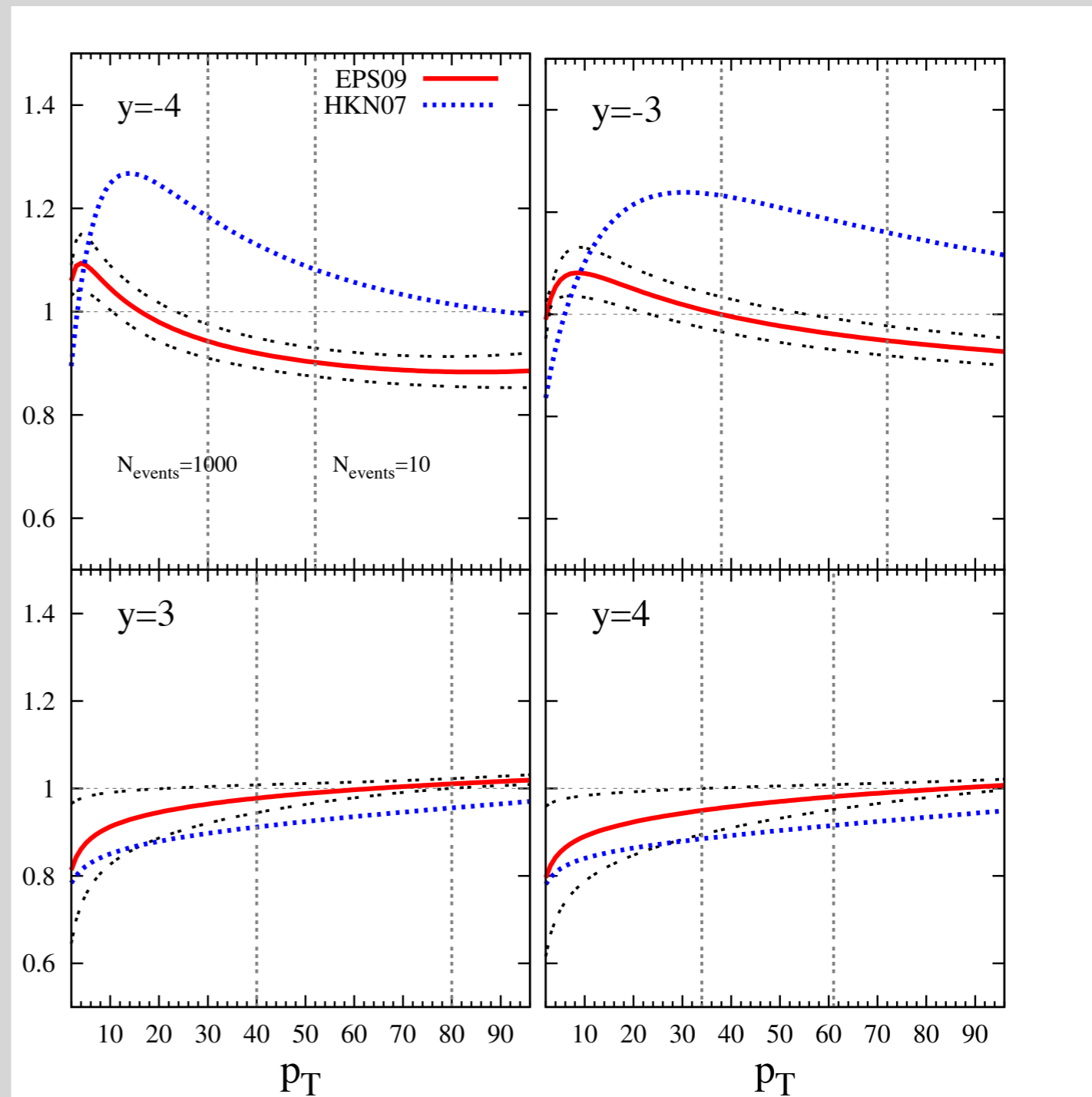
DGLAP [EPS09] vs CGC [rcBK]



nPDF vs nPDF

—○ if collinear factorizability survives pA data

↪ rapidity scan can distinguish between parametrizations



quenching in small media

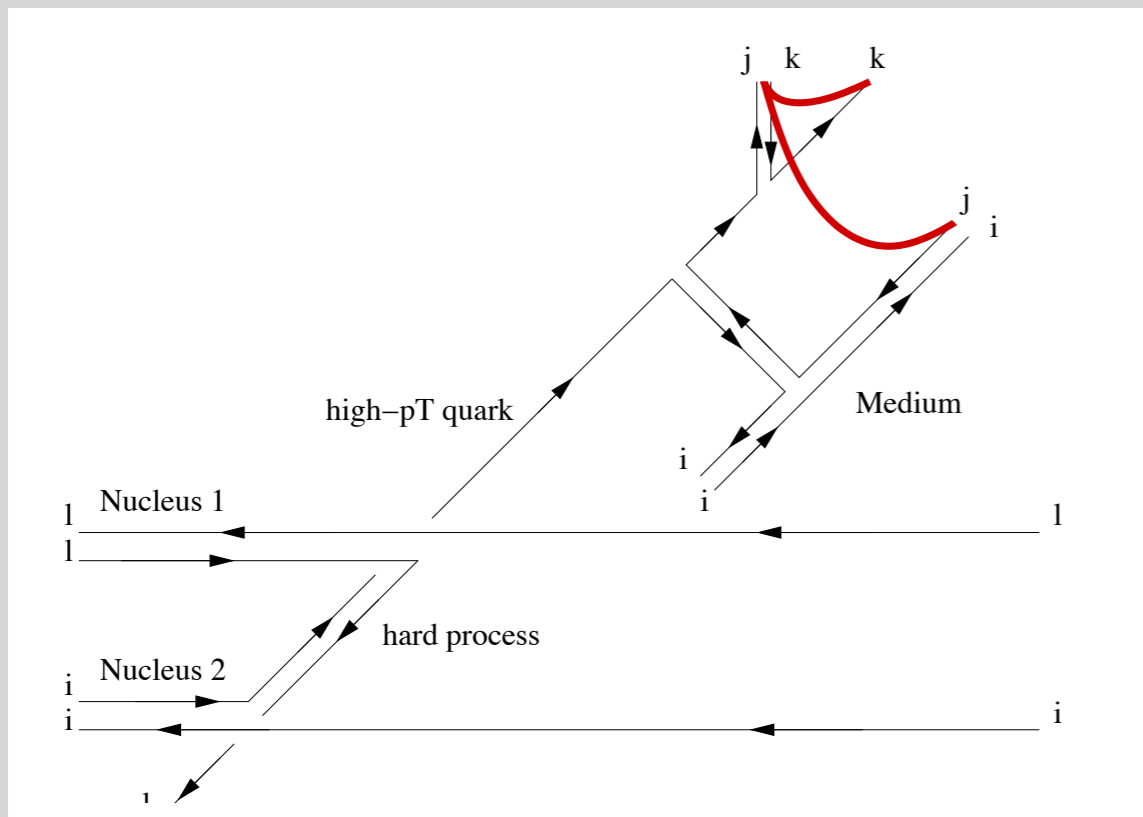
- if there is flow [free path length $\ll L$], a medium is formed
 - ↪ the presence of a medium leads to colour decorrelation effects which result in modifications of hadronic outcome which subsist for large p_t
 - single colour exchange with medium sufficient to 'quench' hard partons [break-up of colour flow]
- if there is a medium, 'jet quenching' effects should be seen
- final state dynamics precludes direct use of pA data for nPDF extraction when quenching present

colour flow and hadronization

- colour of all jet components rotated by interaction with medium
 - ↪ colour correlations modified with respect to vacuum case
 - theoretically controllable within a standard framework [opacity expansion]

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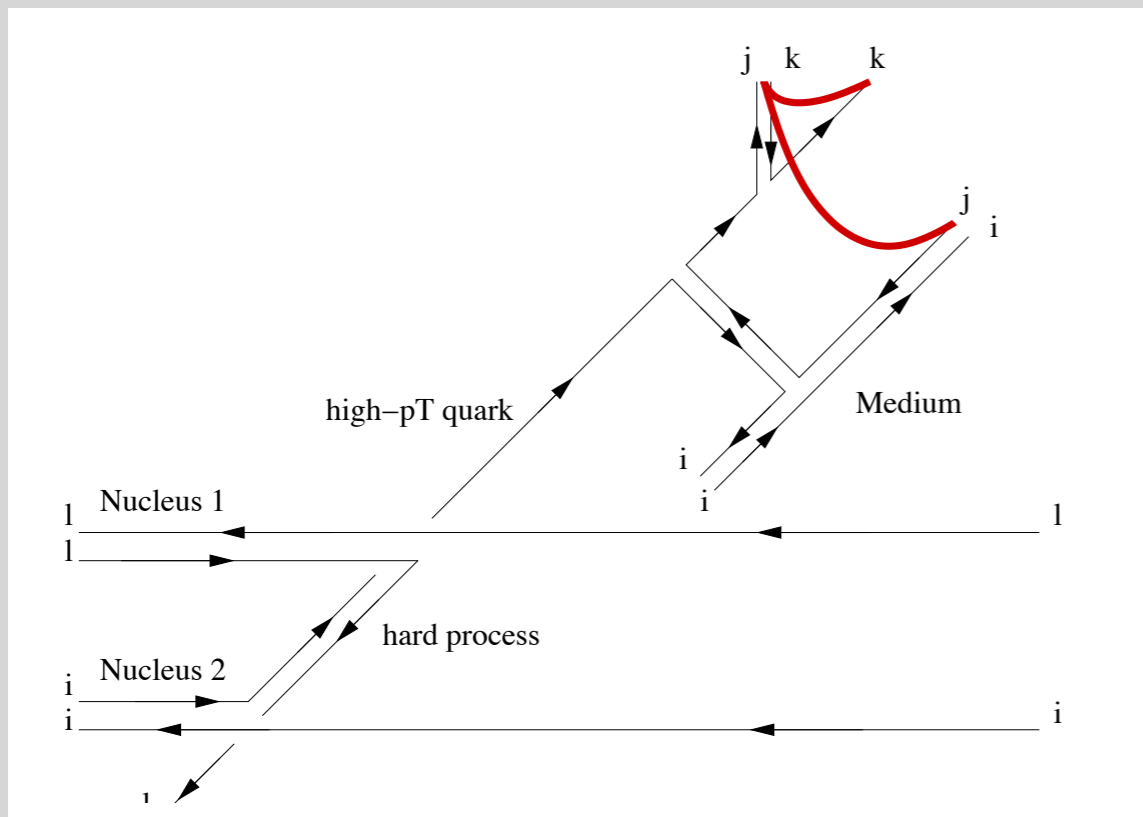


no medium interaction after radiation

- colour properties of hadronizing system vacuum-like
- radiated gluon belongs to system

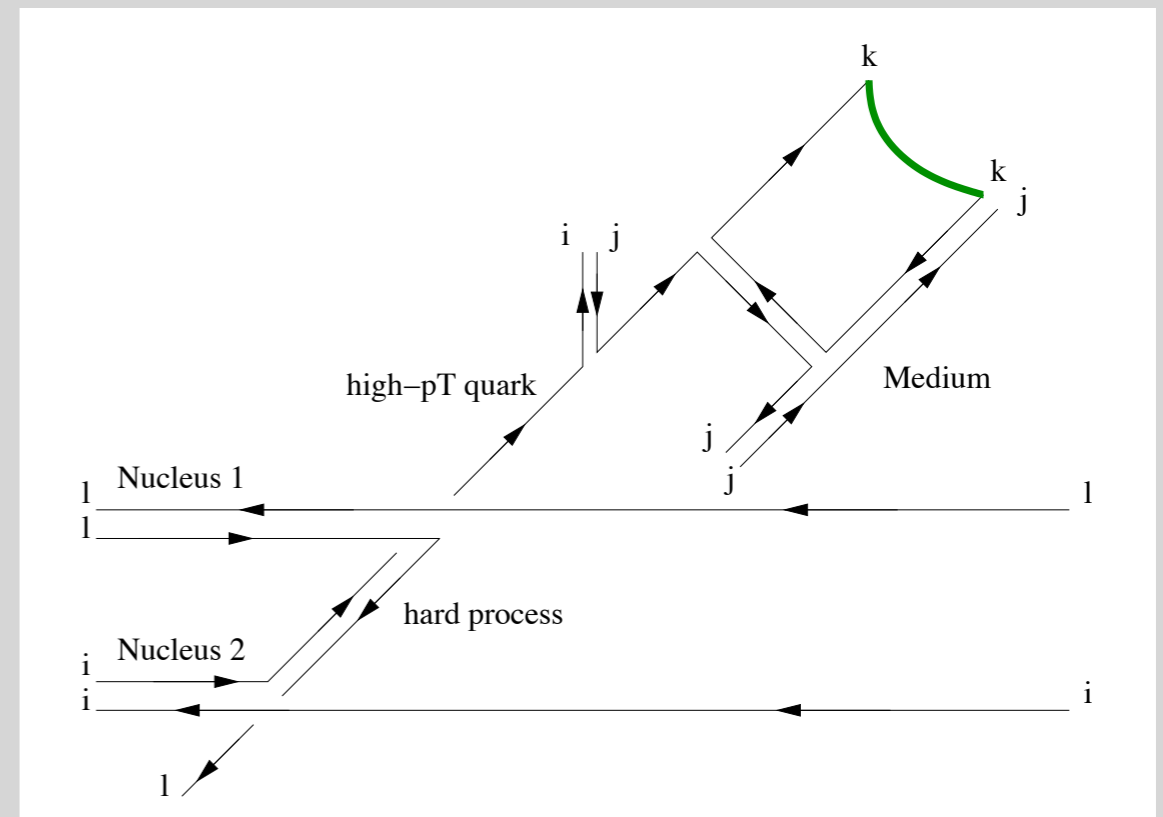
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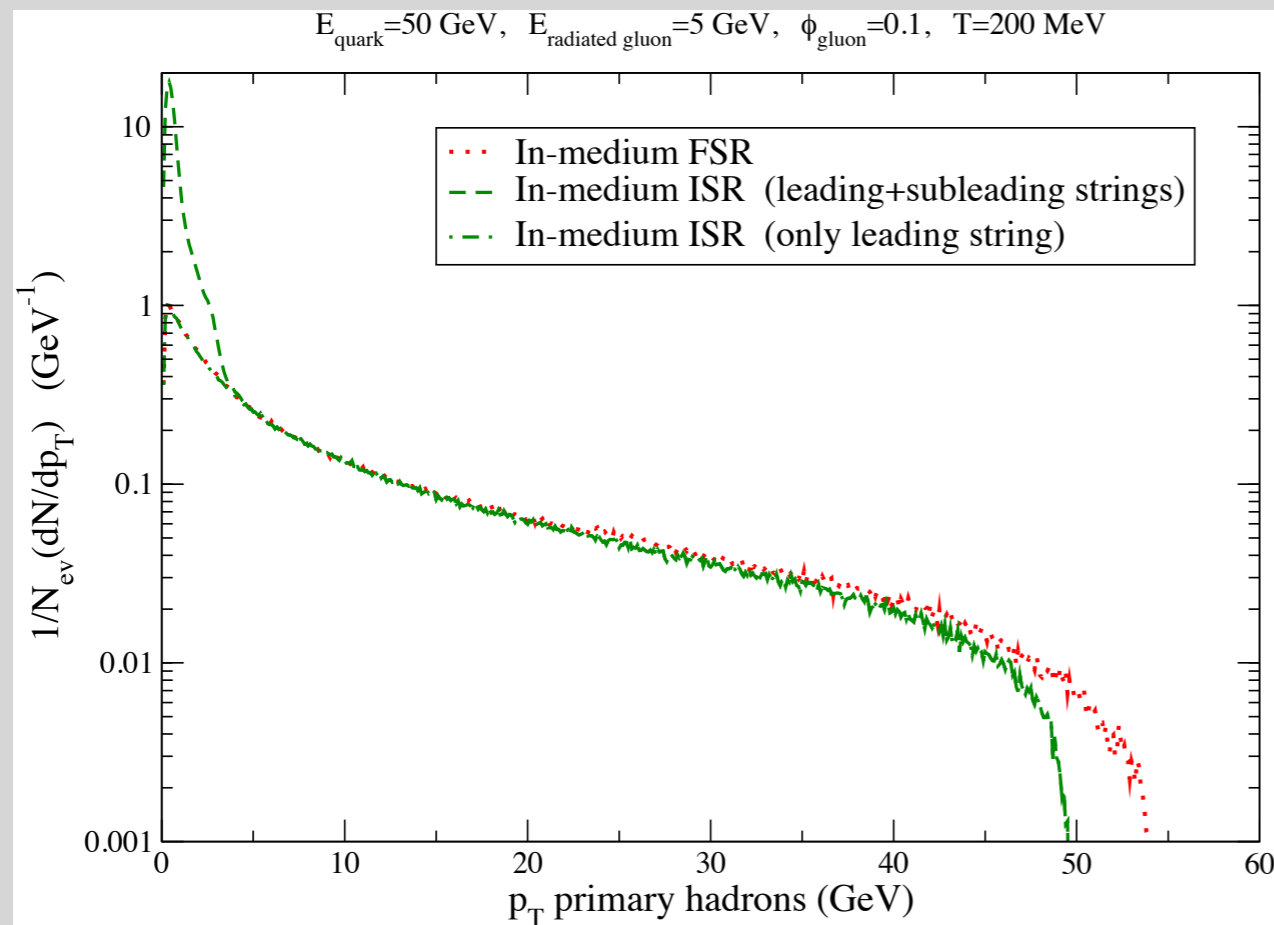
medium interaction after radiation

- colour properties of hadronizing system modified
- radiated gluon LOST

colour flow and hadronization

—○ colour correlations modified with respect to vacuum case

↪ essential input for realistic hadronization schemes



generic [robust] effects:

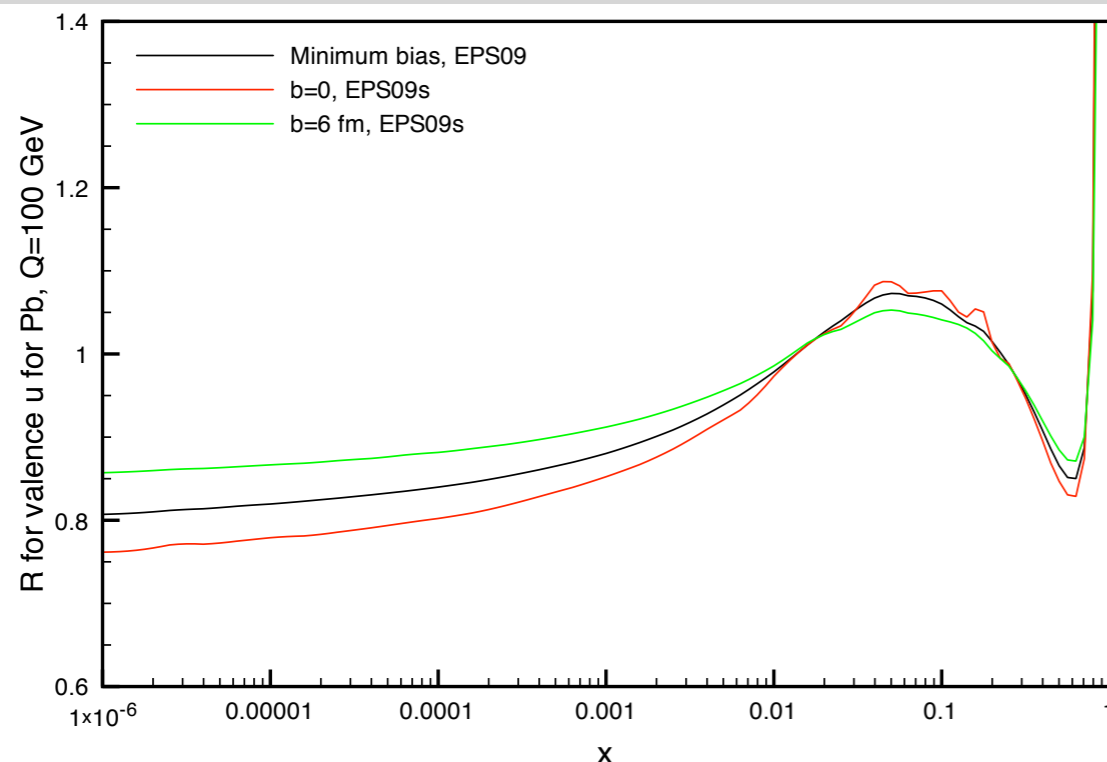
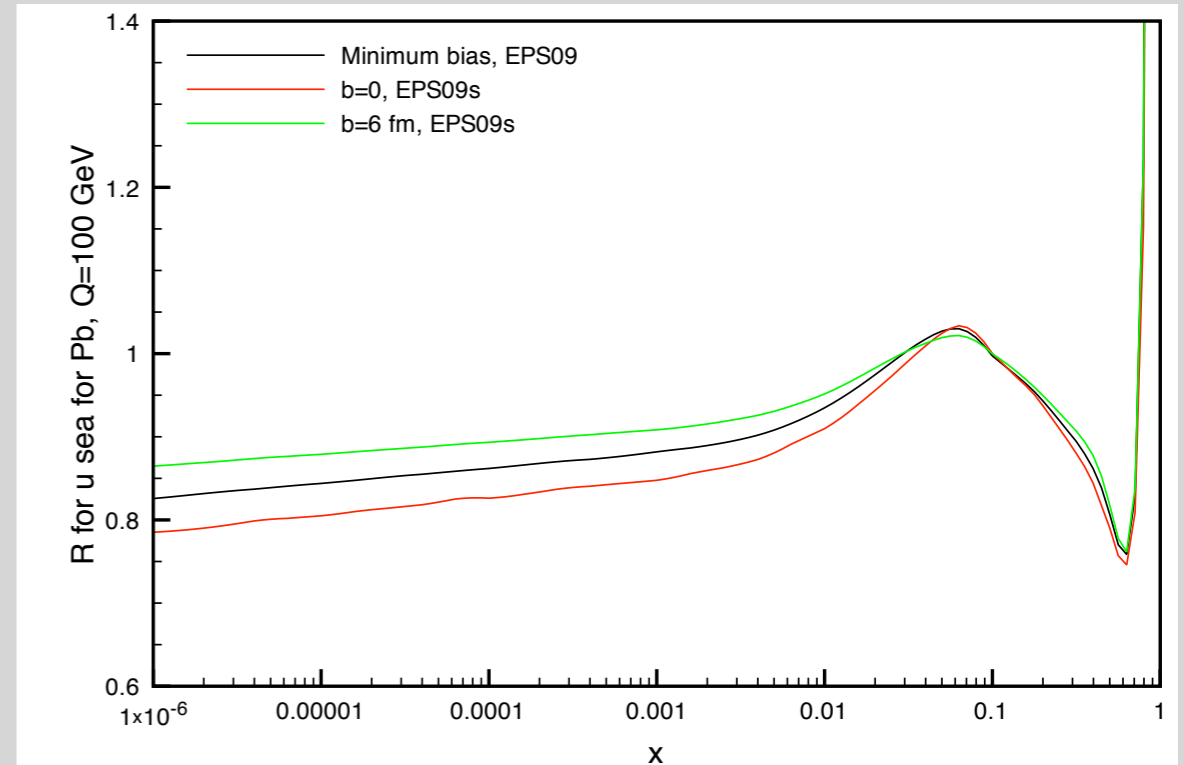
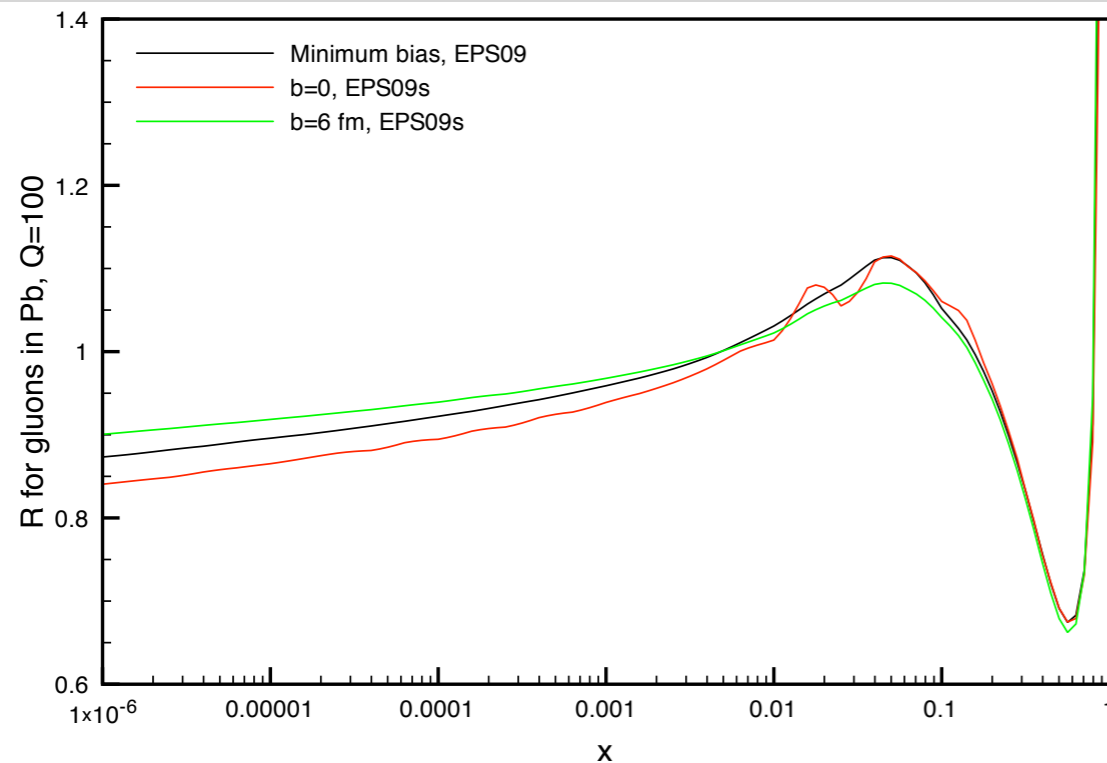
- softening of hadronic spectra
- lost hardness recovered as soft multiplicity
- at work even if radiative energy loss kinematically unviable
- single medium interaction sufficient
- survives branching after medium escape

fragmentation in vacuum NOT the same as using vacuum FFs = final state nuclear effects

#2 centrality dependence

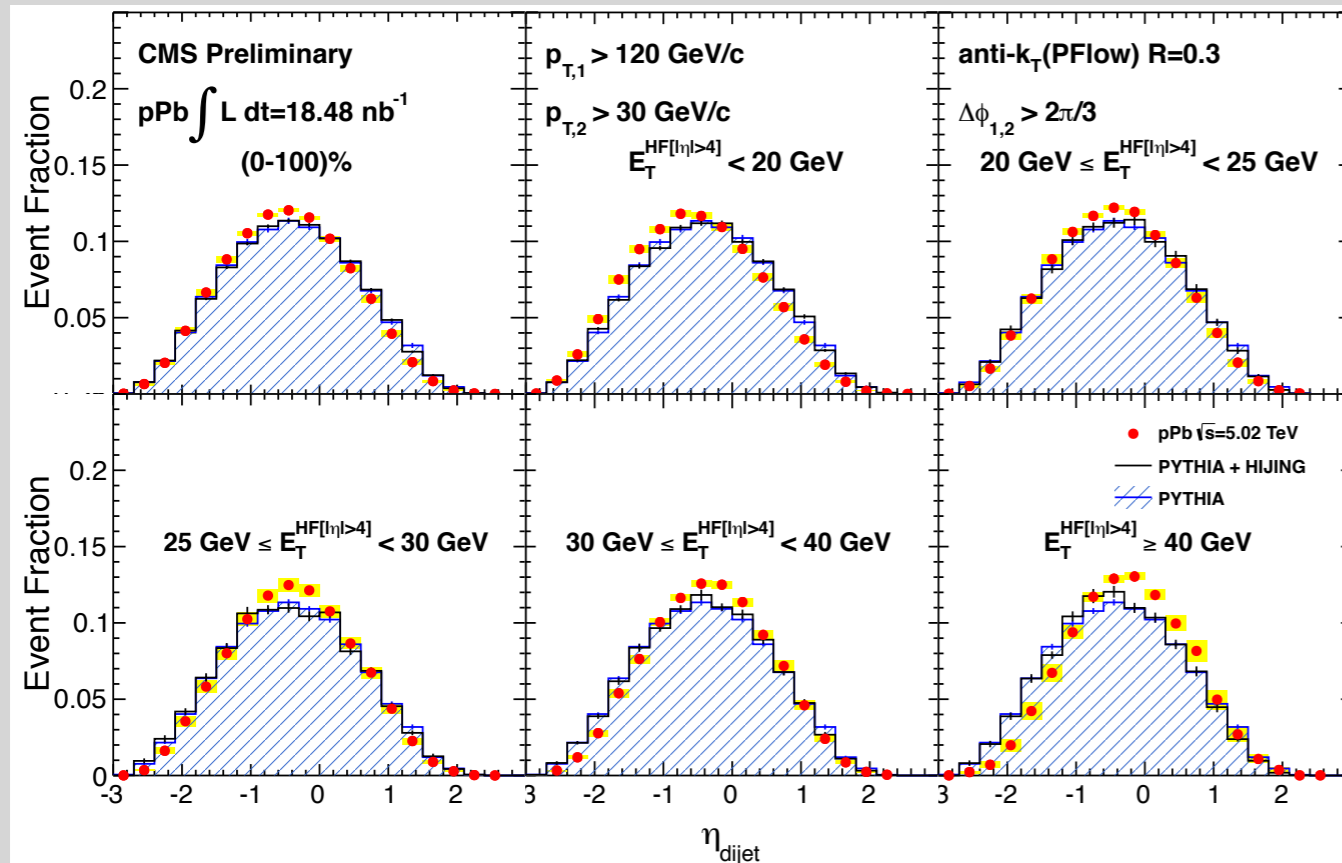
EPS09sNLO

thanks to N Armesto

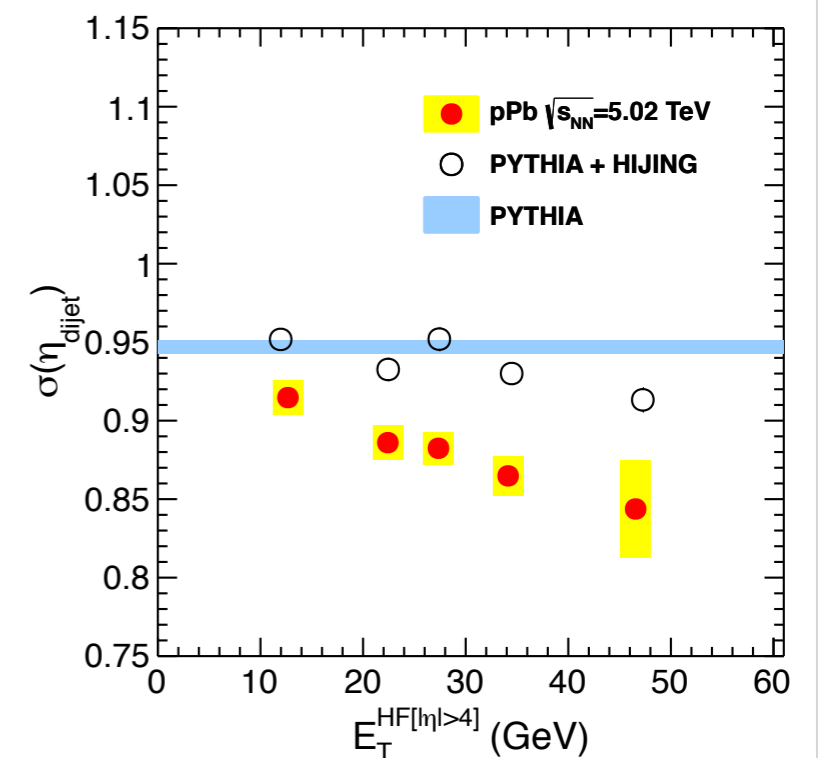
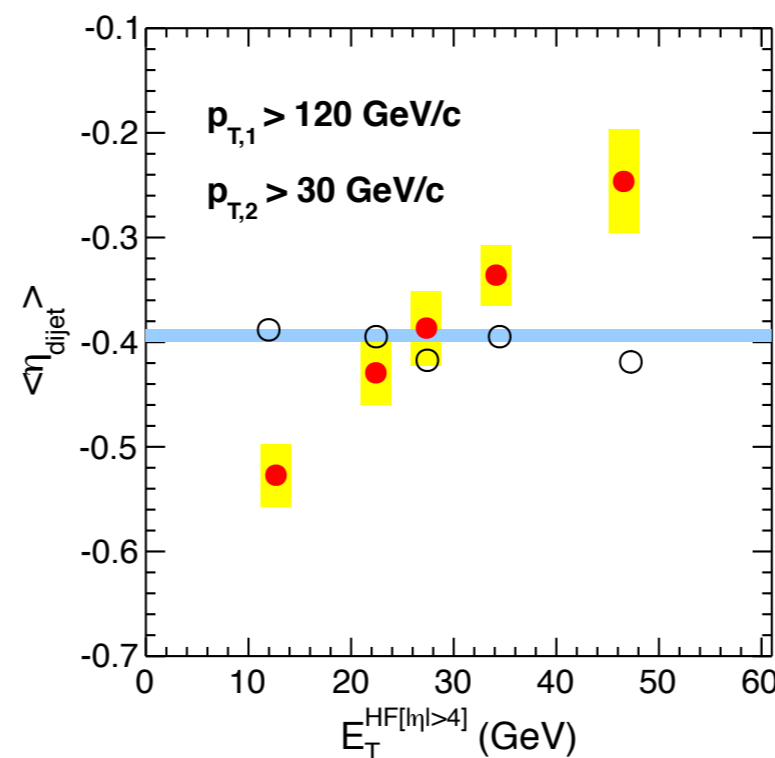


- factorized dependence on nuclear thickness
- very mild [as in tiny] dependence at scales relevant for CMS measurement [$Q^2 = 10^4 \text{ GeV}^2$, $x > 0.001$]

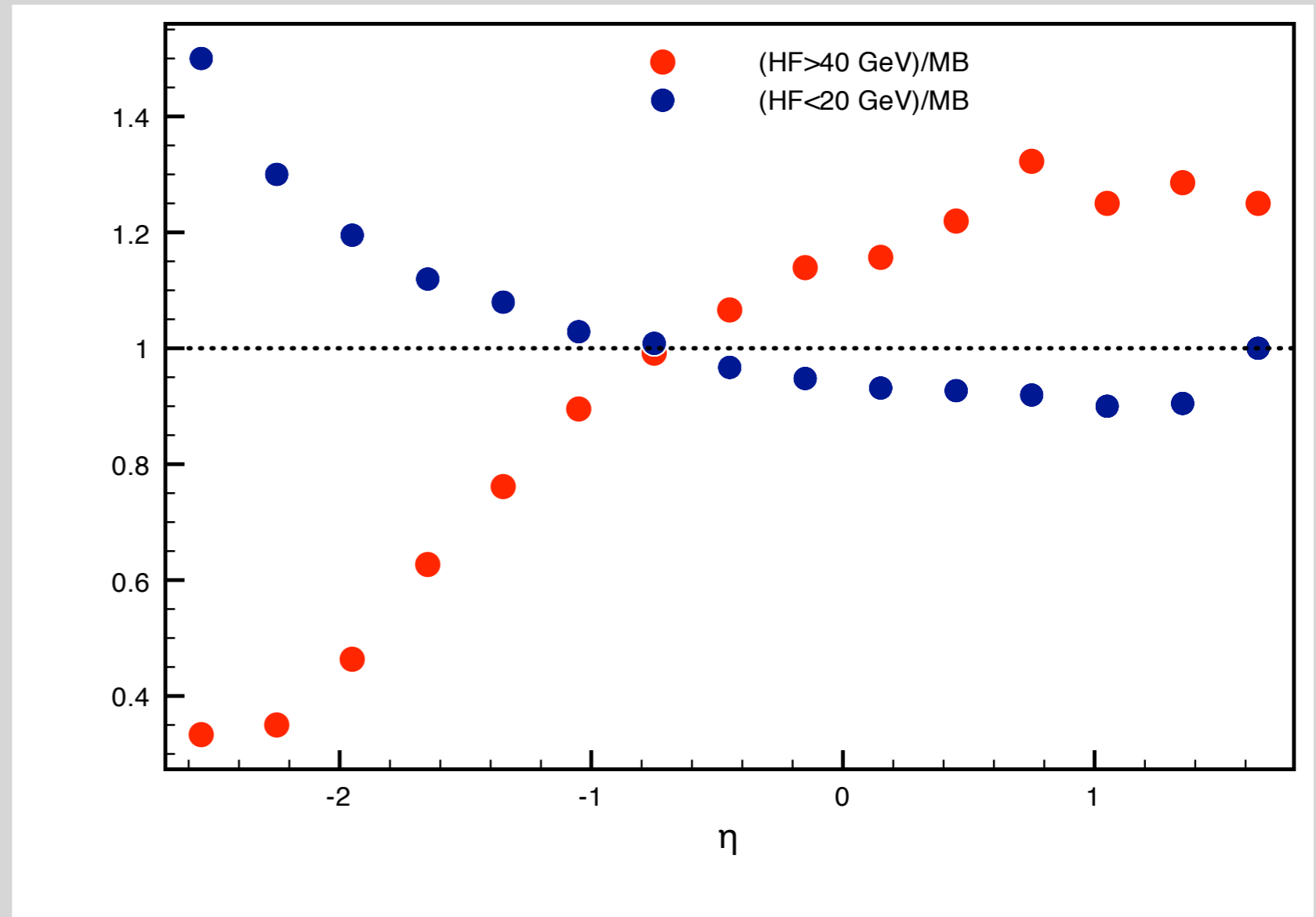
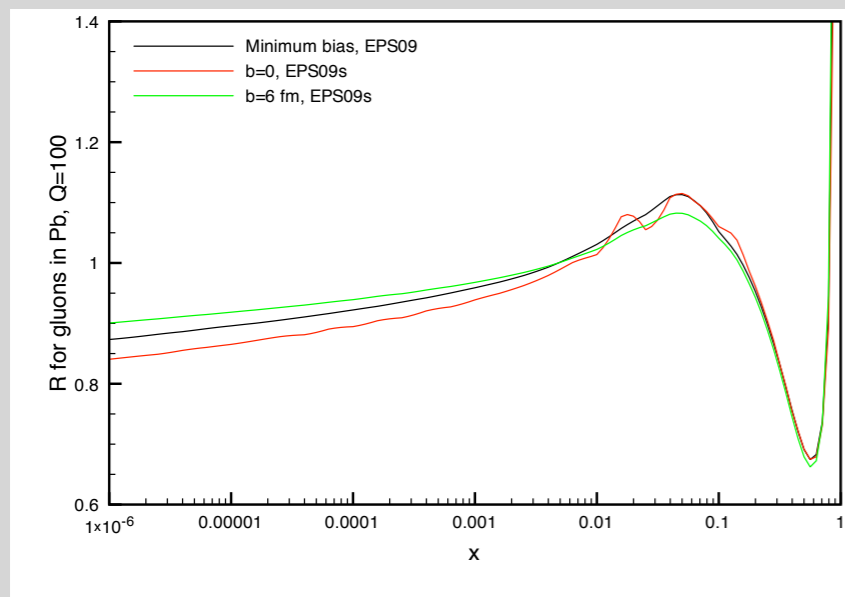
dijet η distribution :: centrality dependence



- forward $[4 < |\eta| < 5]$ activity E_T^{HF} as centrality proxy
- with increasing 'centrality'
- very large shift of average
- significant narrowing



dijet η distribution :: centrality dependence

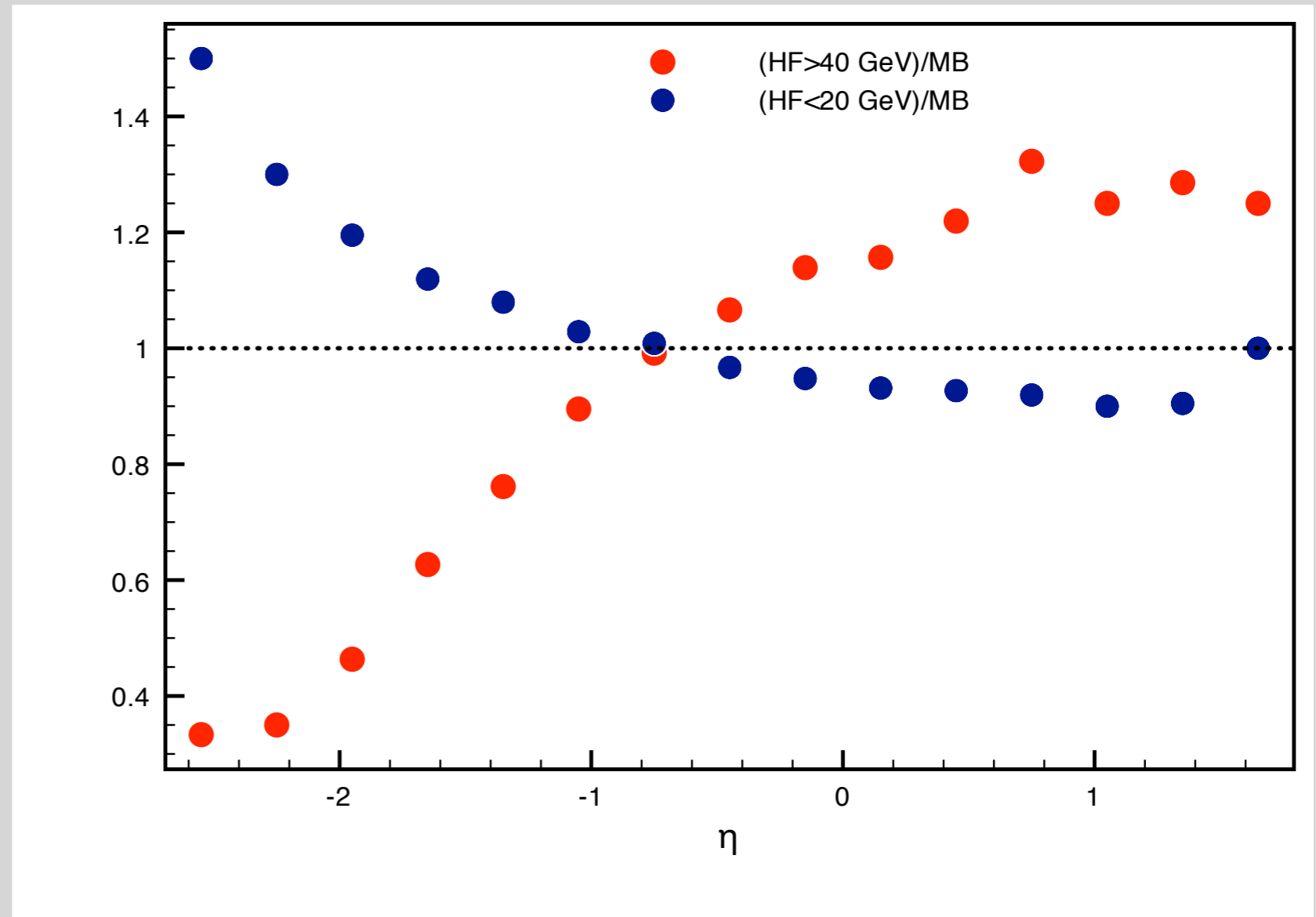
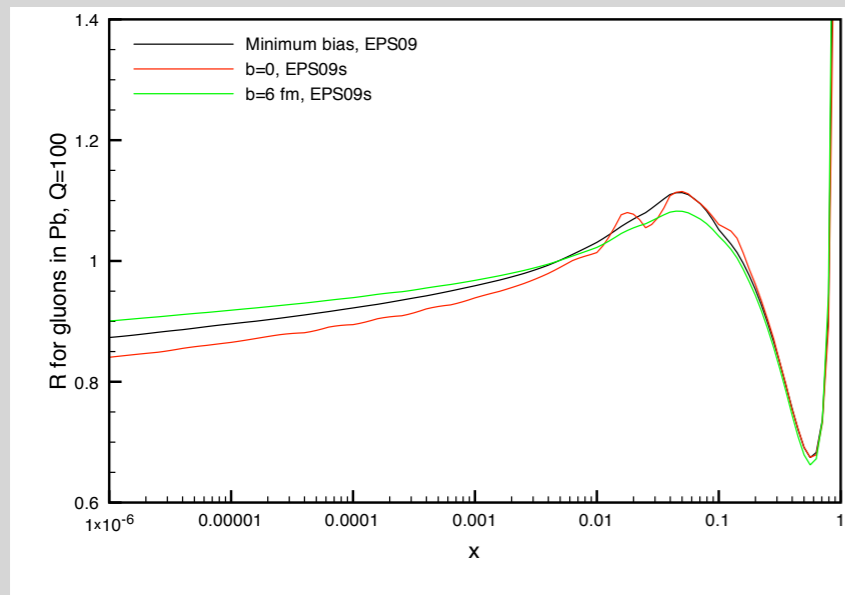


—○ MB as reference [excellent EPS09NLO description]

↪ very large 'centrality' dependence

- EPS09s impact parameter dependence can account at most for a few %

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what does E_T^{HF} select ?

a possible physical bias

—○ dijet system with $p_{t,1} = 120 \text{ GeV}$

↪ both jets with $\eta \approx 0 :: E_{\text{dijet}} \approx 240 \text{ GeV}$

- minimal constraint on available energy for UE

↪ $\eta_{\text{dijet}} \approx -2$ [relative to CM] :: $E_{\text{dijet}} \approx 1 \text{ TeV}$

- could constrain energy available for UE

—○ the other way round

↪ low forward activity :: minimal constraint on energy available for hard process

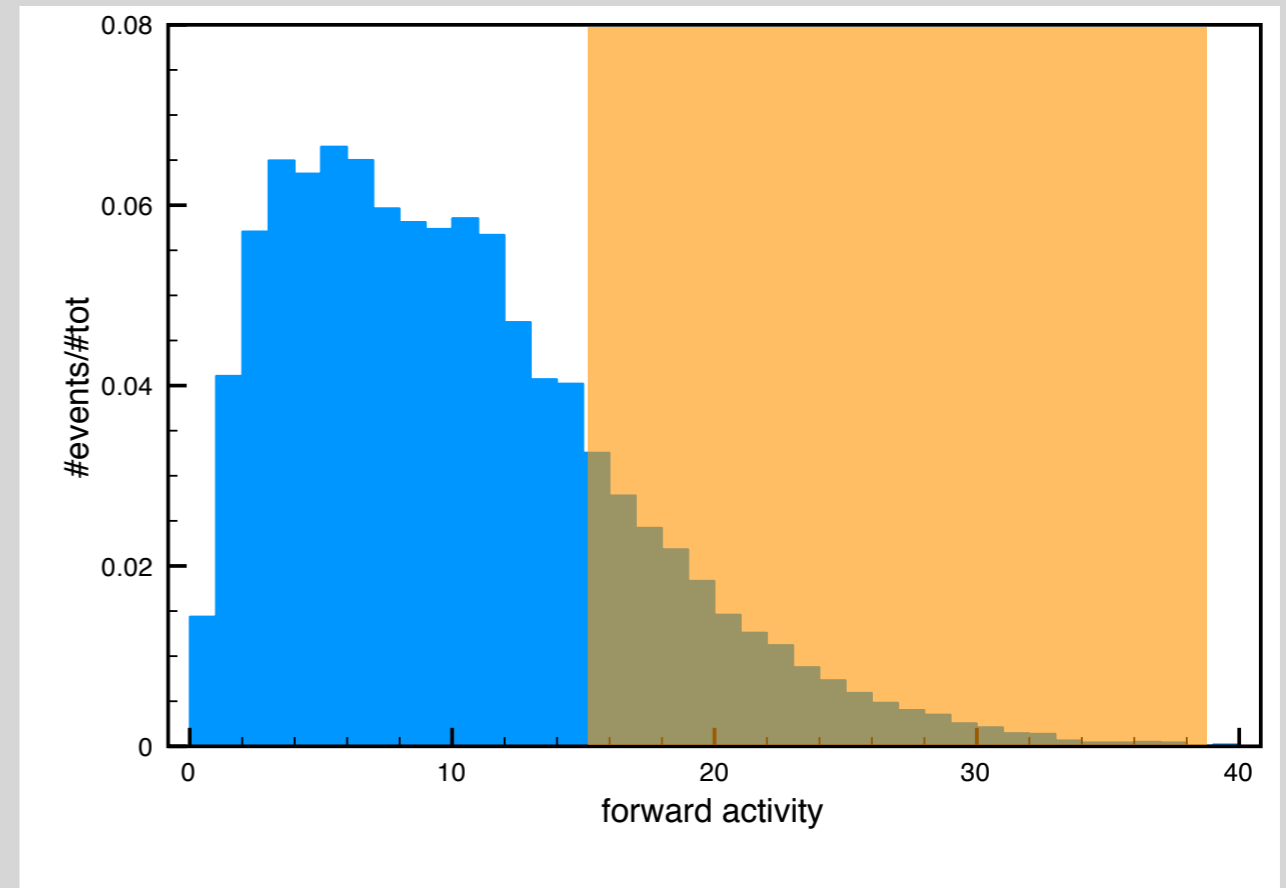
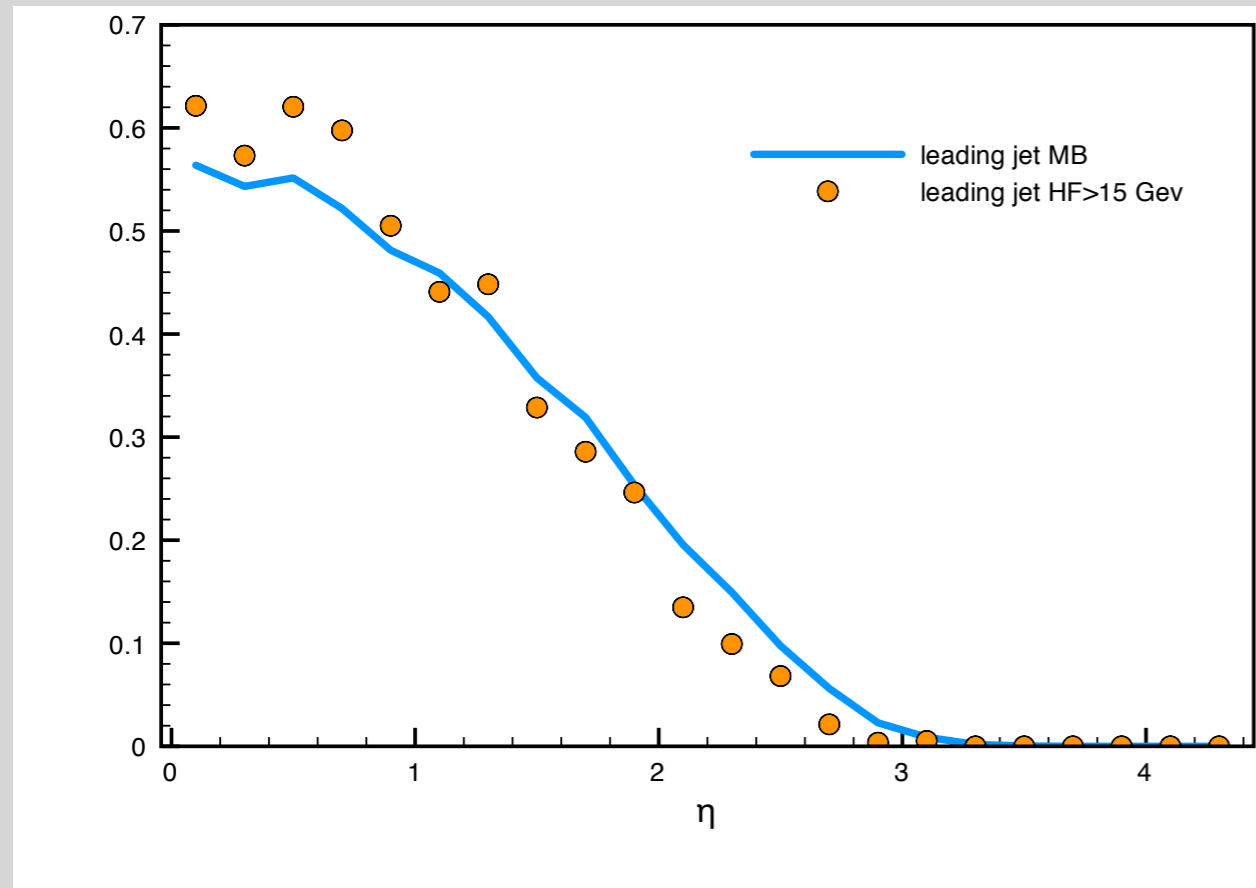
↪ high forward activity :: limited energy for hard process

- suppression of dijets with large $|\eta_{\text{dijet}}| ::$ narrowing of distribution

↪ should also be present in pp...

a possible physical bias :: pp sketch

thanks to G Salam



—○ pp@5 TeV with UE, PYTHIA8, anti- k_t $R=0.4$

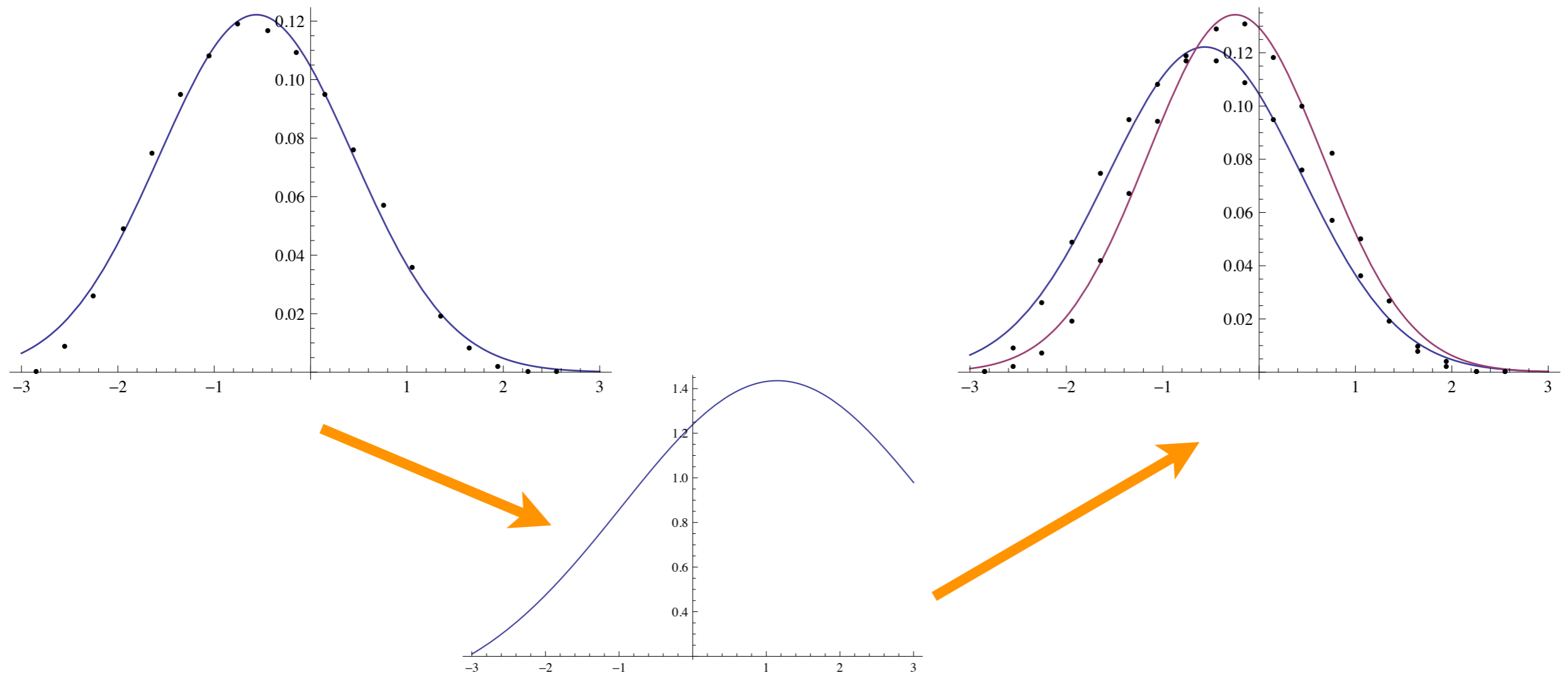
↪ small but clear narrowing [modest activity :: statistics]

↪ correlation between activity and hard process

a possible physical bias :: pA sketch

- reliable MC with correlated hard process + UE
 - ↪ HIJING/HYDJET ????????
- increase in activity on nuclear fragmentation side [HF^{plus}] comes cheaply
 - ↪ REALLY should be related to centrality
- increase in activity on proton fragmentation side [HF^{minus}] has a high price
 - ↪ only one nucleon available
 - ↪ high HF^{minus} activity implies reduction of energy available for hard process
 - ISR :: softening of PDF :: depletion of hard modes :: displacement of CM of hard process
 - ↪ from lowest to highest total activity, HF^{minus} grows by factor 2.5
 - extremely naively CM of hard process displaced by $\text{arccosh}[2.5] \approx 1.5$ from pA CM
 - ↪ suppression of large η dijets centered around $\eta \approx 1.1$

a possible physical bias :: gaussian game



- gaussian fit lowest activity distribution
- introduce distortion to mimic energy interplay of hp and UE [also gaussian]
- fit distortion to reproduce highest activity distribution

to discuss

can what I discussed be argued away ?

if not, can the bias be removed from data

:: increasing HF^{plus} at fixed HF^{minus} ?

relation of increasing HF^{minus} to ISR is very interesting physics

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