Anne M Sickles
ILLINOIS

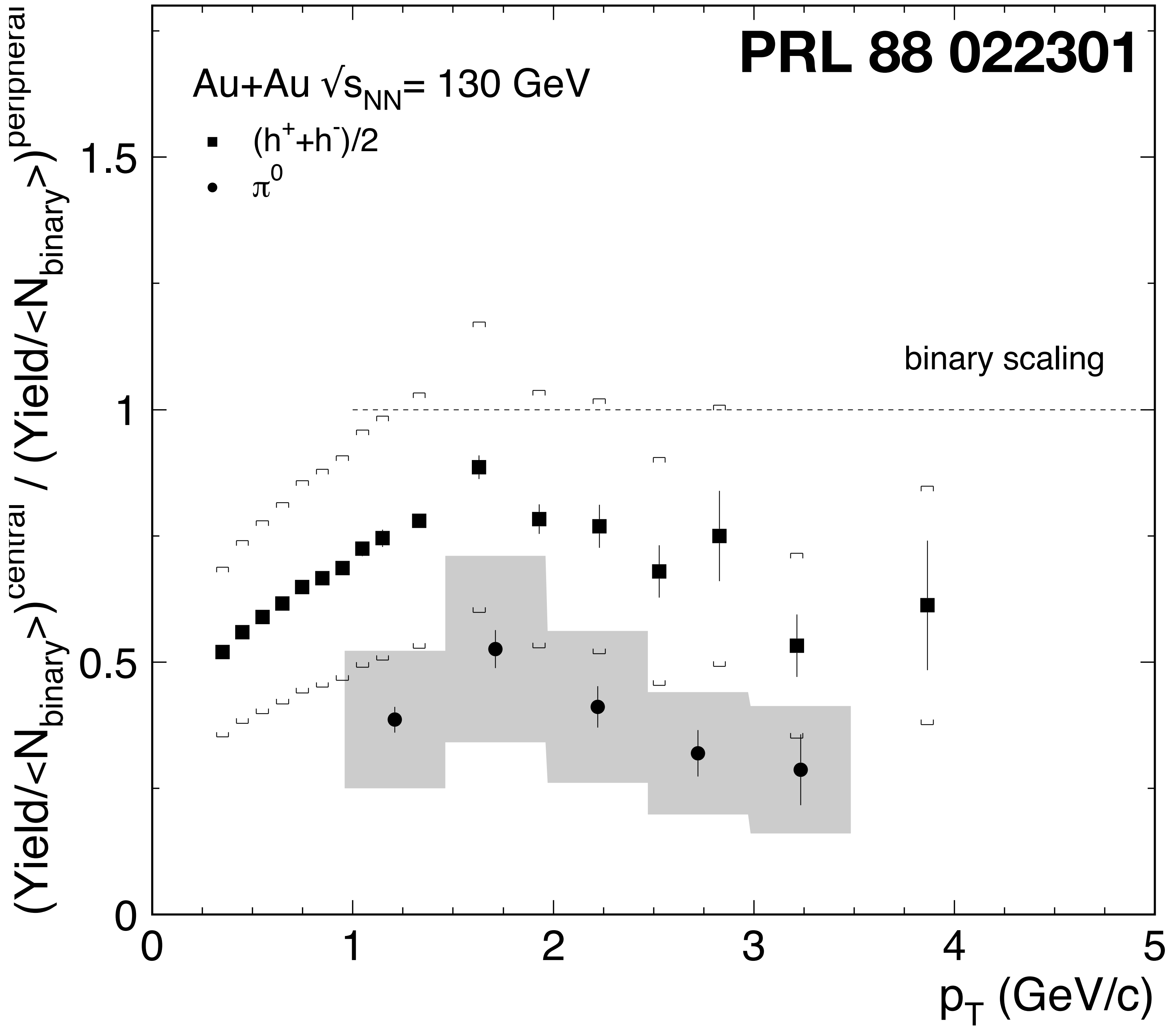
Jets in Nuclear Collisions

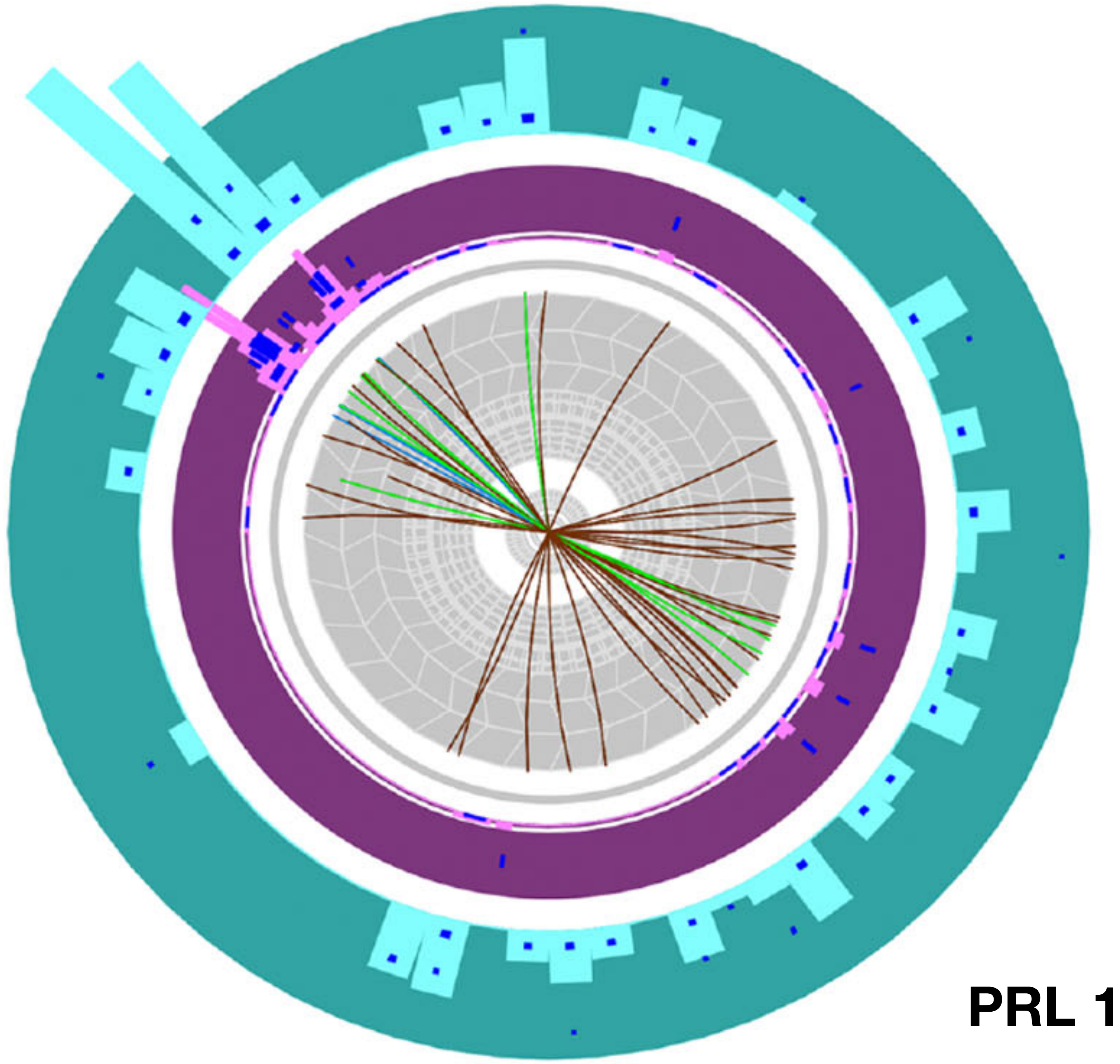
there are a lot of new jet results!

	Perla 1st Floor	Casinò 1st Floor	Volpi 1st Floor	Mosaici-1 3rd Floor	Mosaici-2 3rd Floor
Monday PM2	COR	ELW	INI	SMA	QRK
Tuesday AM1	JET	INS	QHT	COL	CHI
Tuesday AM2	JET	QRK	INI	COL	SMA
Tuesday PM1	COR	HMU	THD	SMA	OHF
Wednesday AM1	JET	NTH	PHA	OHF	CHI
Wednesday AM2	JET	ELW	QHT	COL	PHA
Wednesday PM1	COR	INS	PHA	NTH	OHF
Wednesday PM2	JET	CHI	INI	COL	QRK

A lot of talks—this overview is incomplete!

jet quenching observed from the earliest days of heavy ion running at the both RHIC and LHC



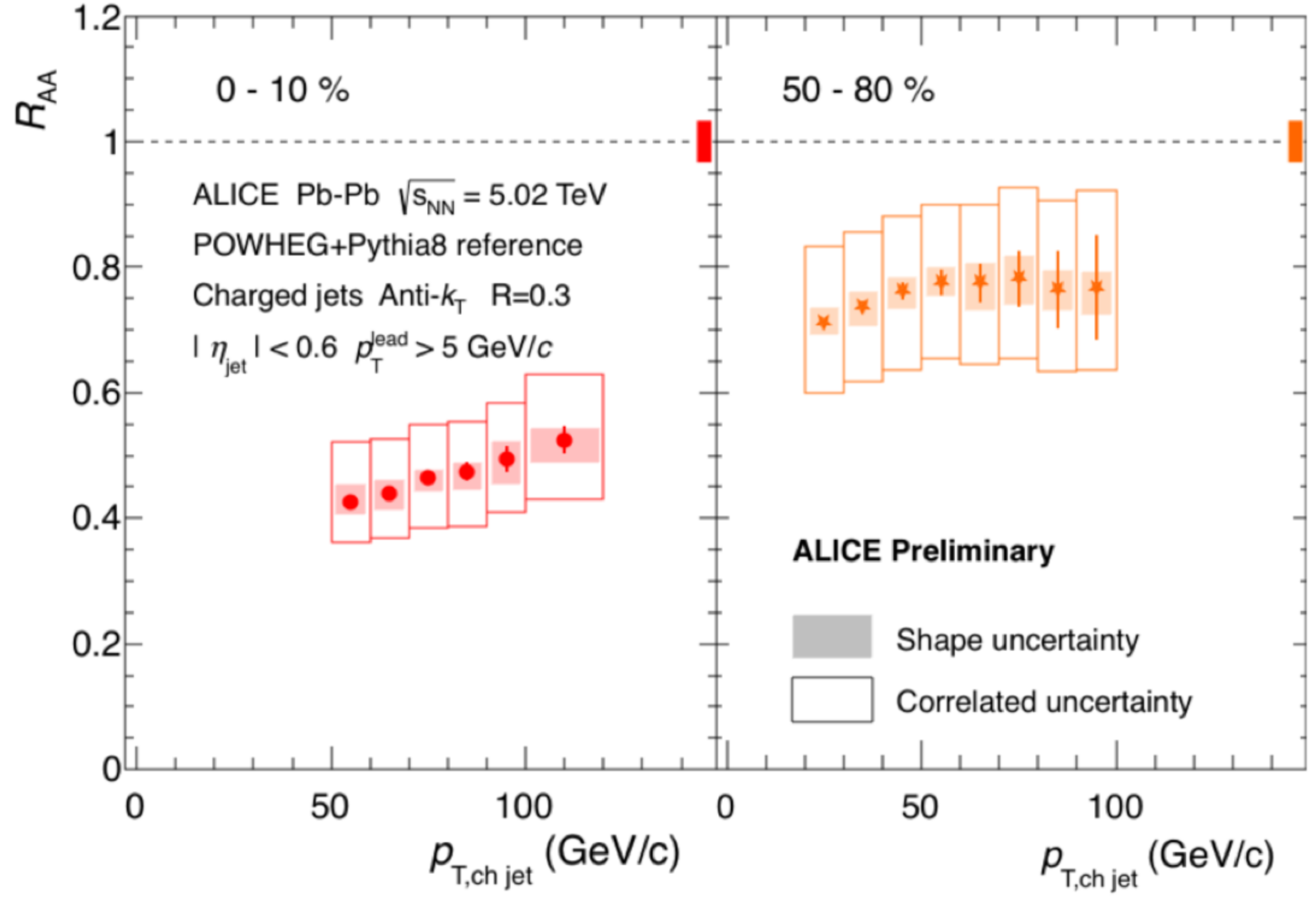


PRL 105 232303

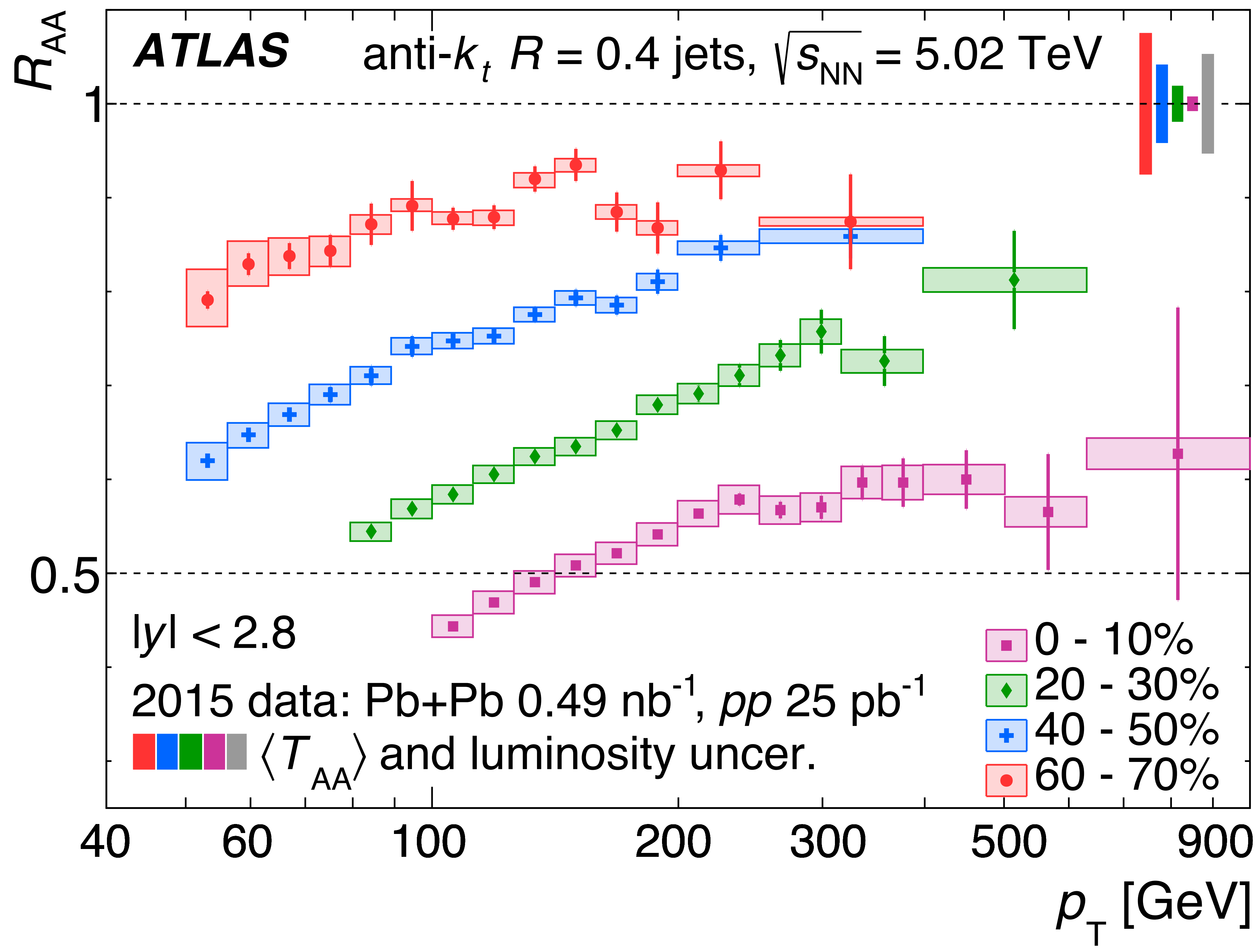
our task today is not to demonstrate that jets are still quenched, but to understand how these jets are modified and what that means about the inner workings of the QGP

this demands controlled, systematic measurements & systematic theory

charged particle jets



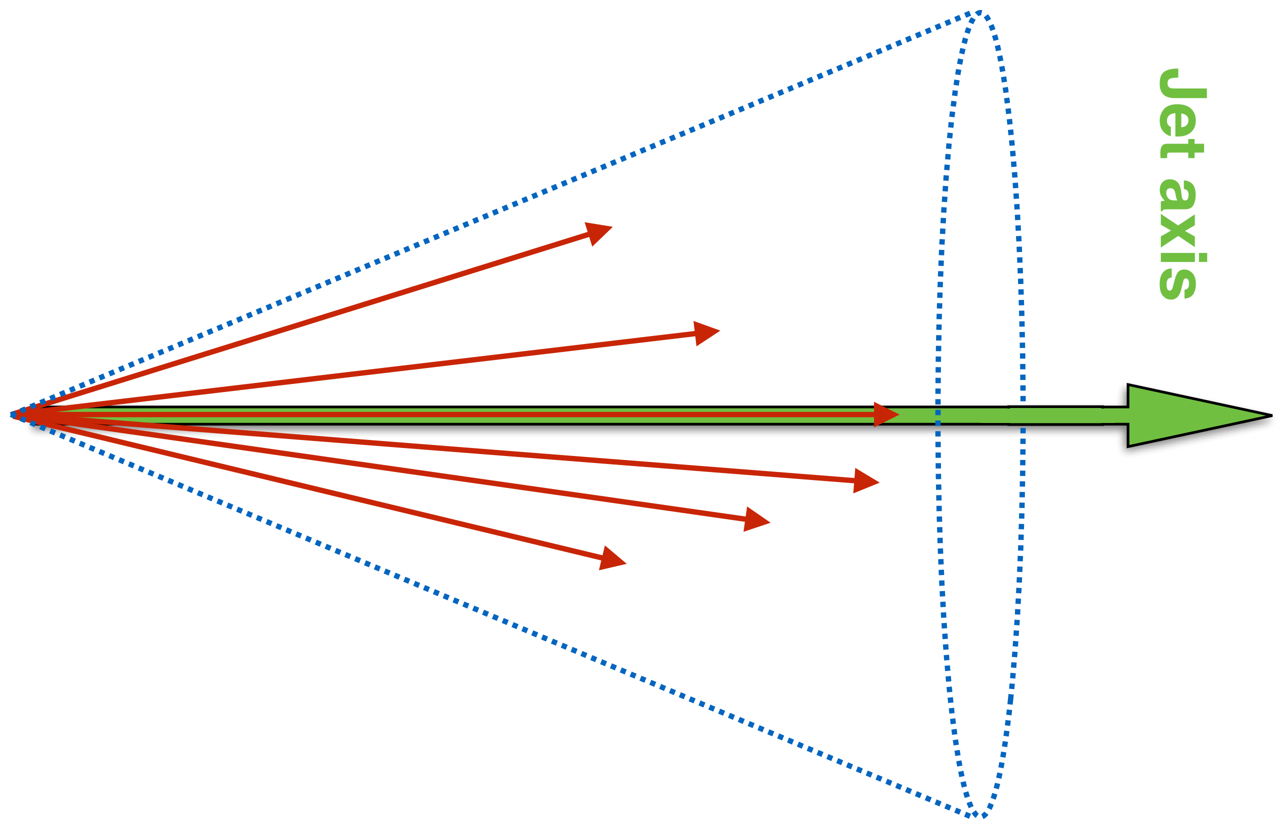
calorimeter jets



jet quenching from 50 GeV → 1 TeV

what do we know about how particles make up these jets?

measurement of fragmentation functions

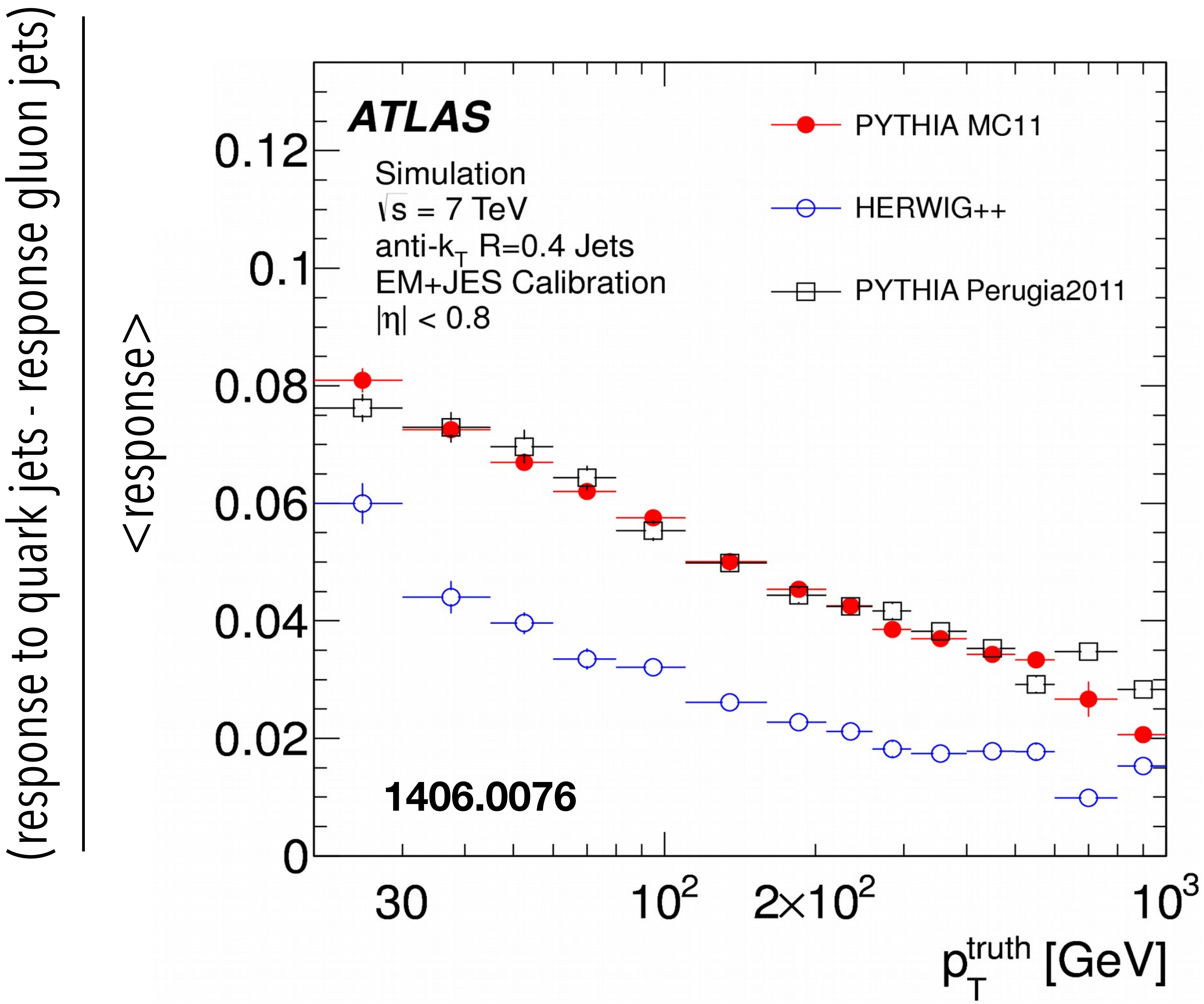


$$D(z) \equiv \frac{1}{N_{\text{jet}}} \frac{dn_{\text{ch}}}{dz}$$

$$z \equiv p_{\text{T}} \cos \Delta R \,/\, p_{\text{T}}^{\text{jet}}$$

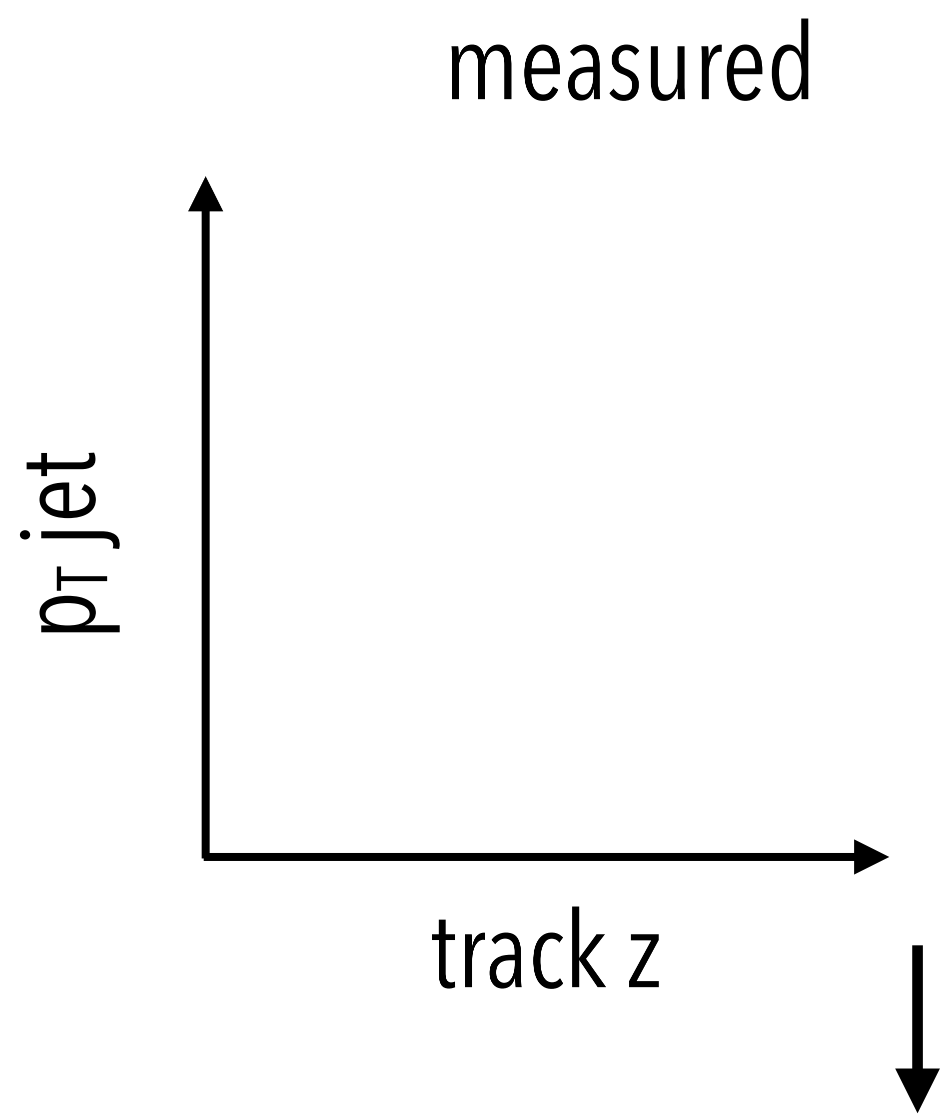
$$D(p_{\text{T}}) \equiv \frac{1}{N_{\text{jet}}} \frac{dn_{\text{ch}}}{dp_{\text{T}}}$$

Martin Rybar, Wednesday

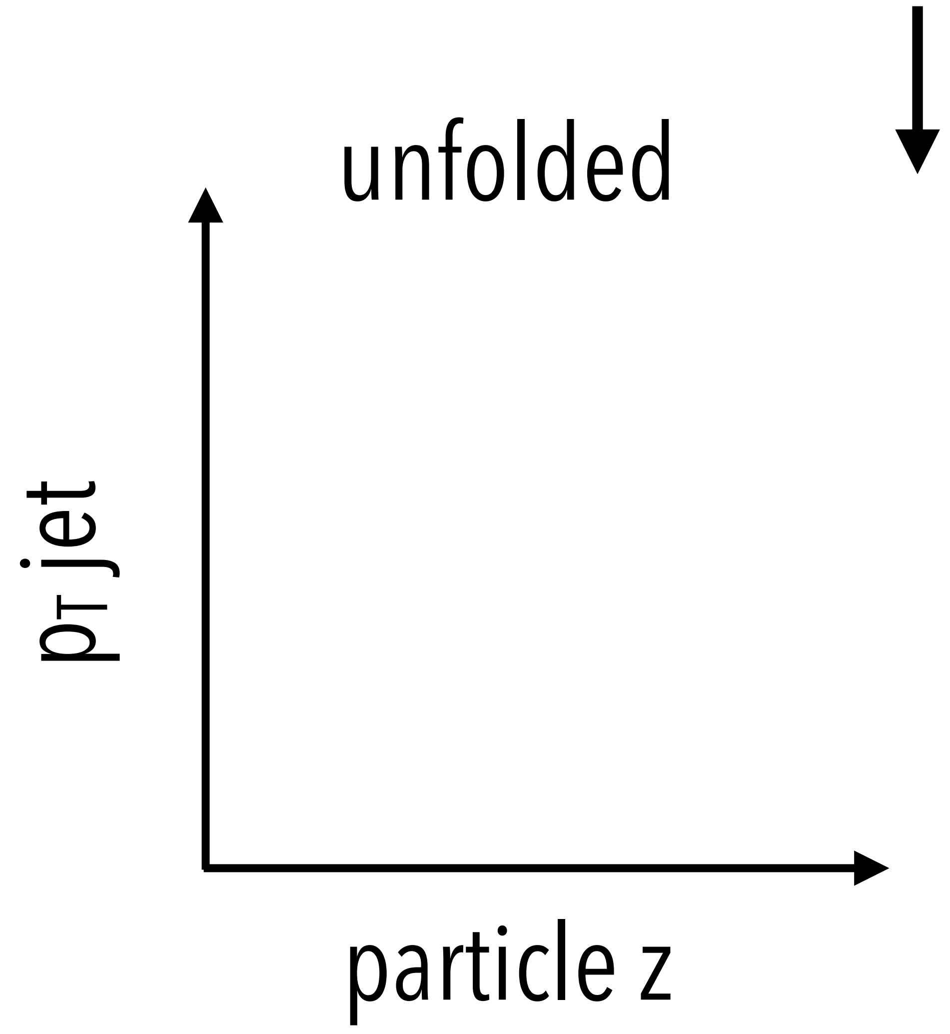


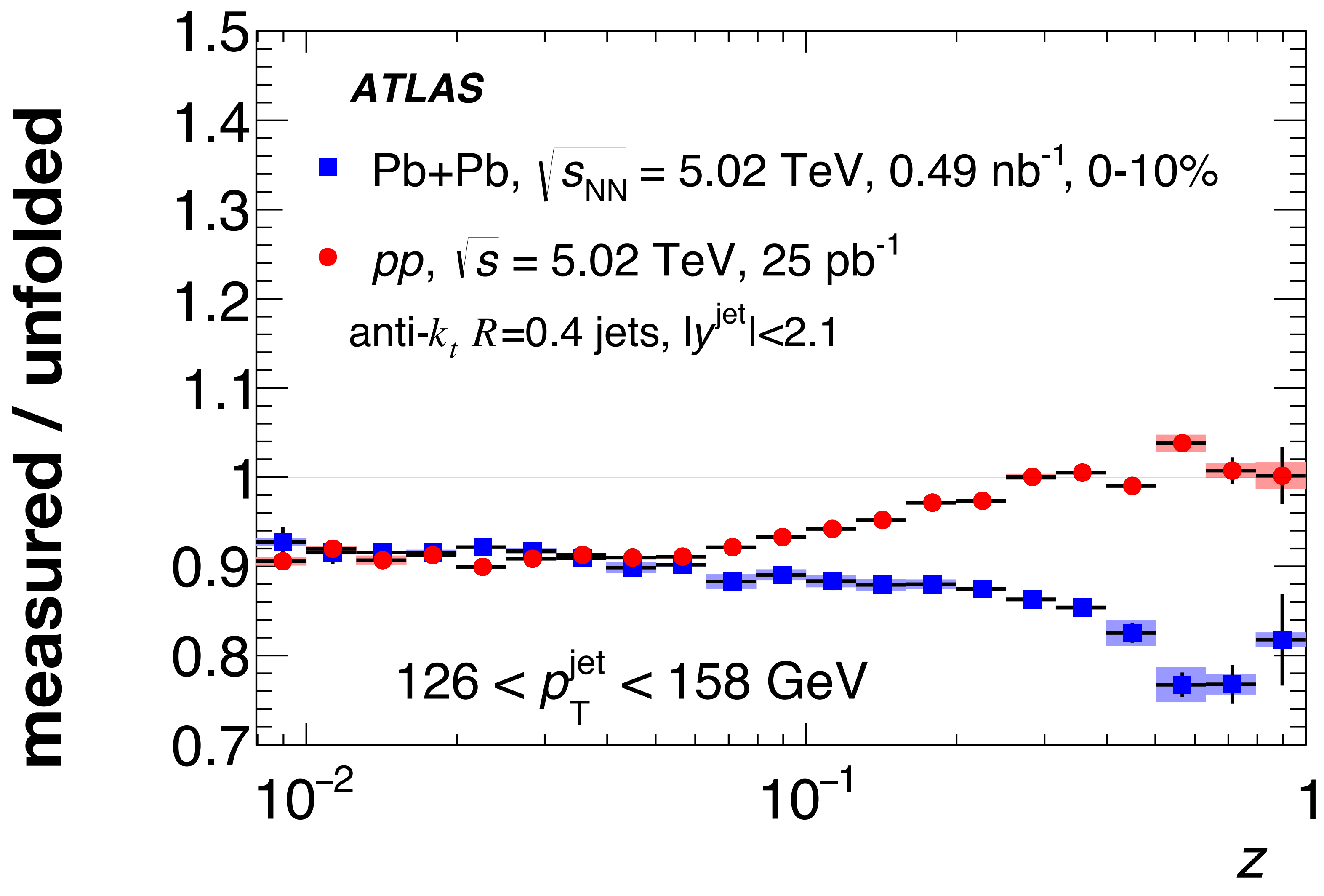
jet energy measurement is correlated with how the jet fragments!

2 -dimensional unfolding



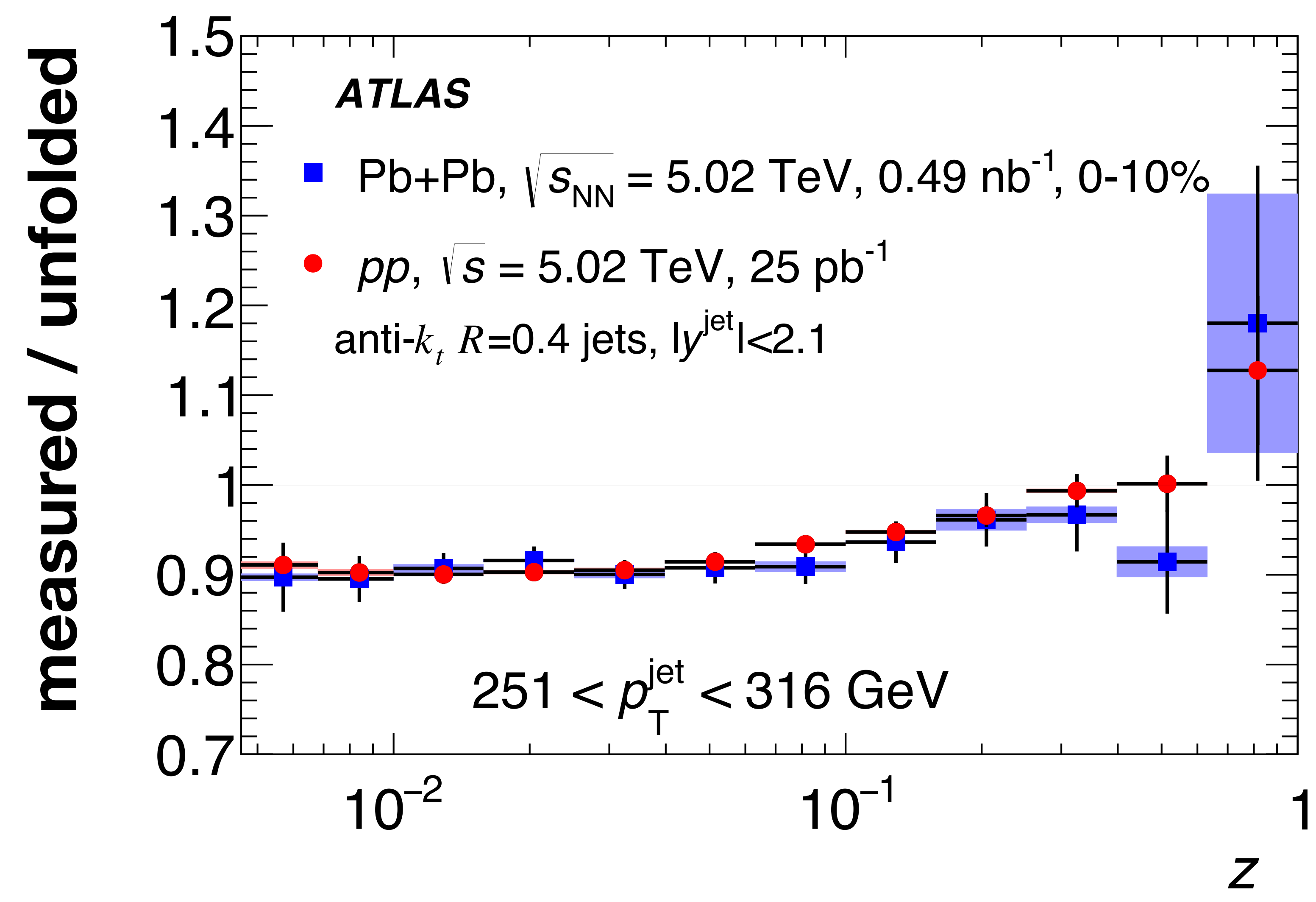
response matrix in $p_{T,meas}$, $p_{T,true}$, z_{meas}, z_{true}





p_{Tjet}: 126 - 158 GeV

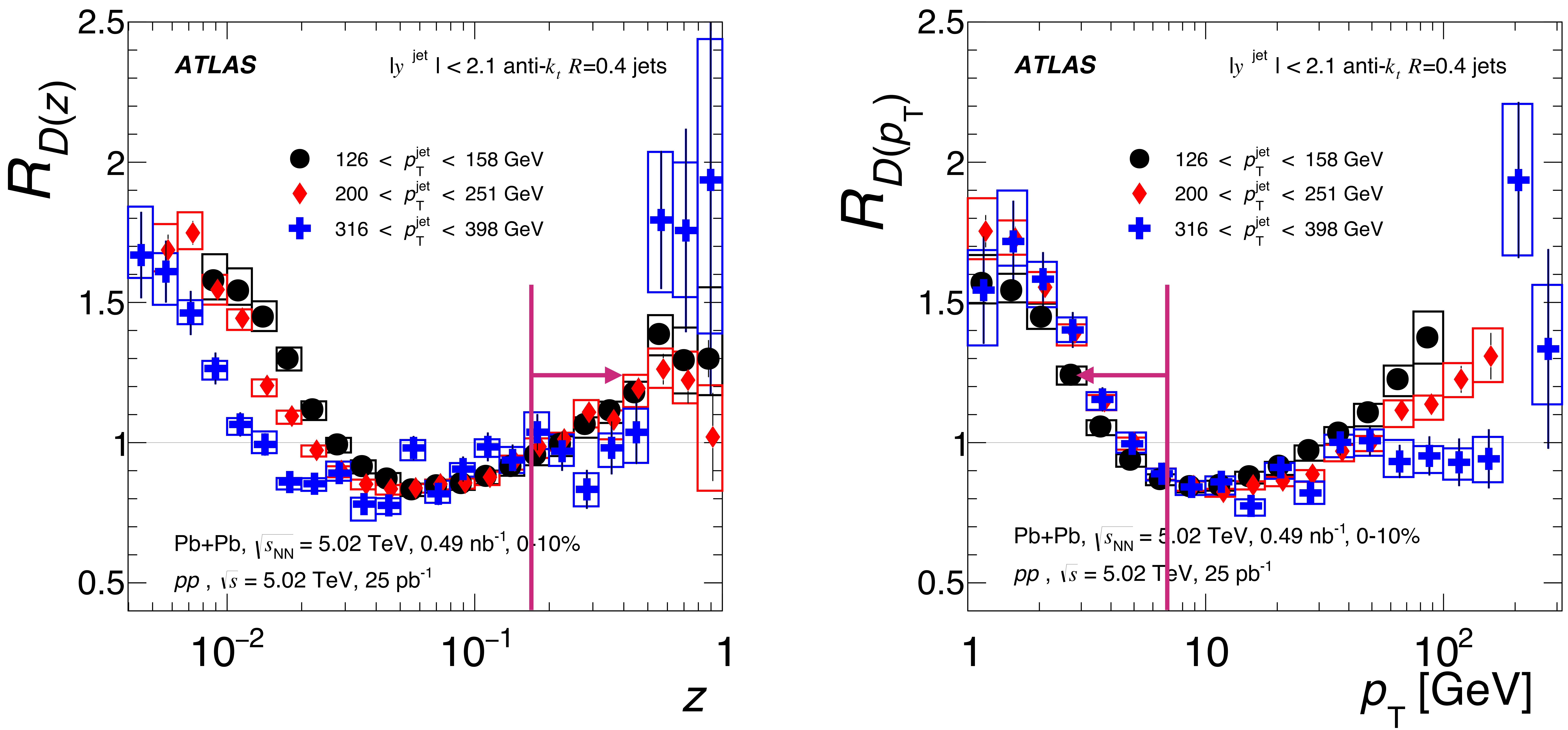
large JER centrality dependence to JER due to UE fluctuations



p_{Tjet}: 251-316 GeV

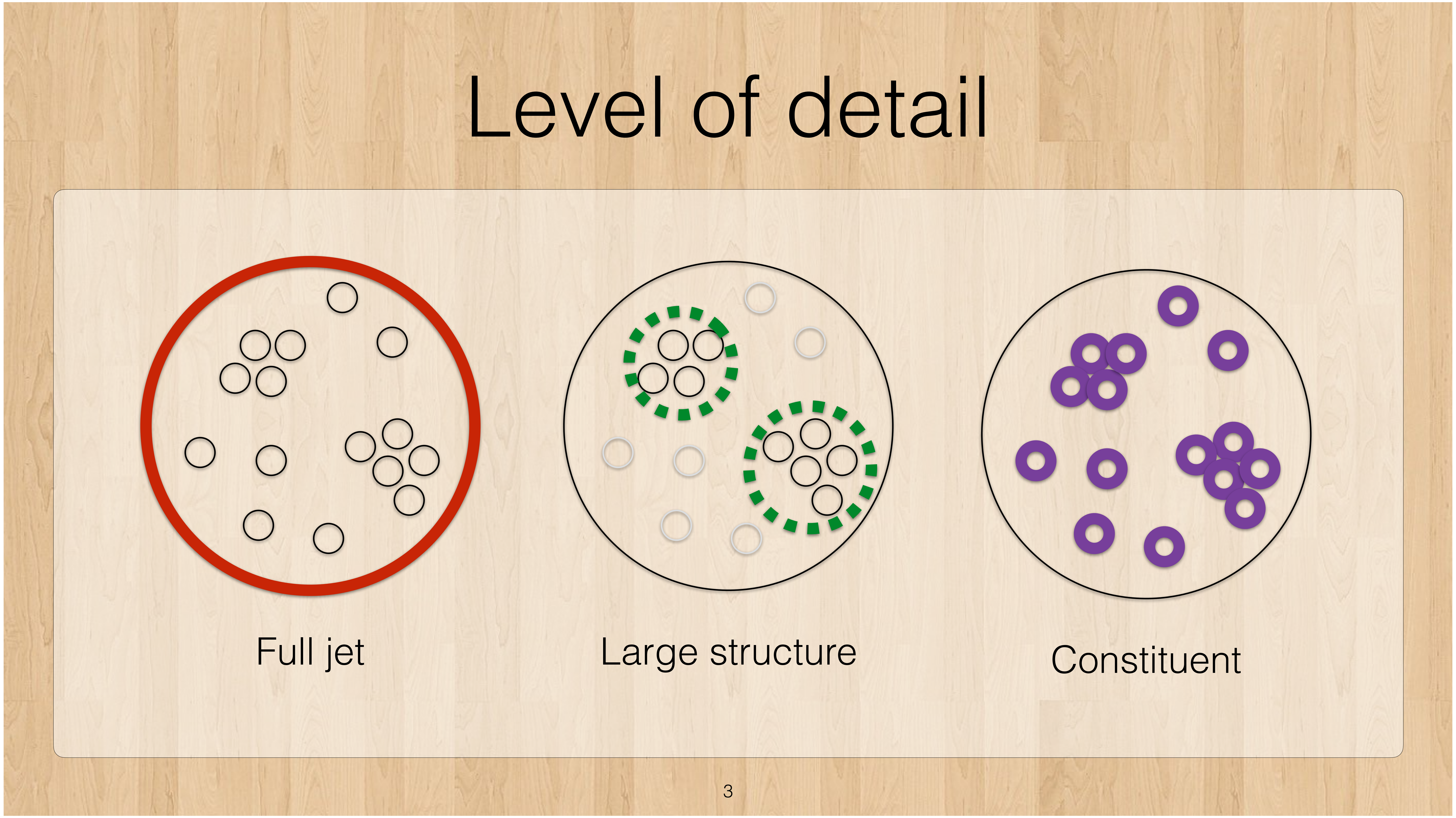
smaller UE effect similar unfolding change in pp & PbPb

ratios of fragmentation functions in PbPb / pp



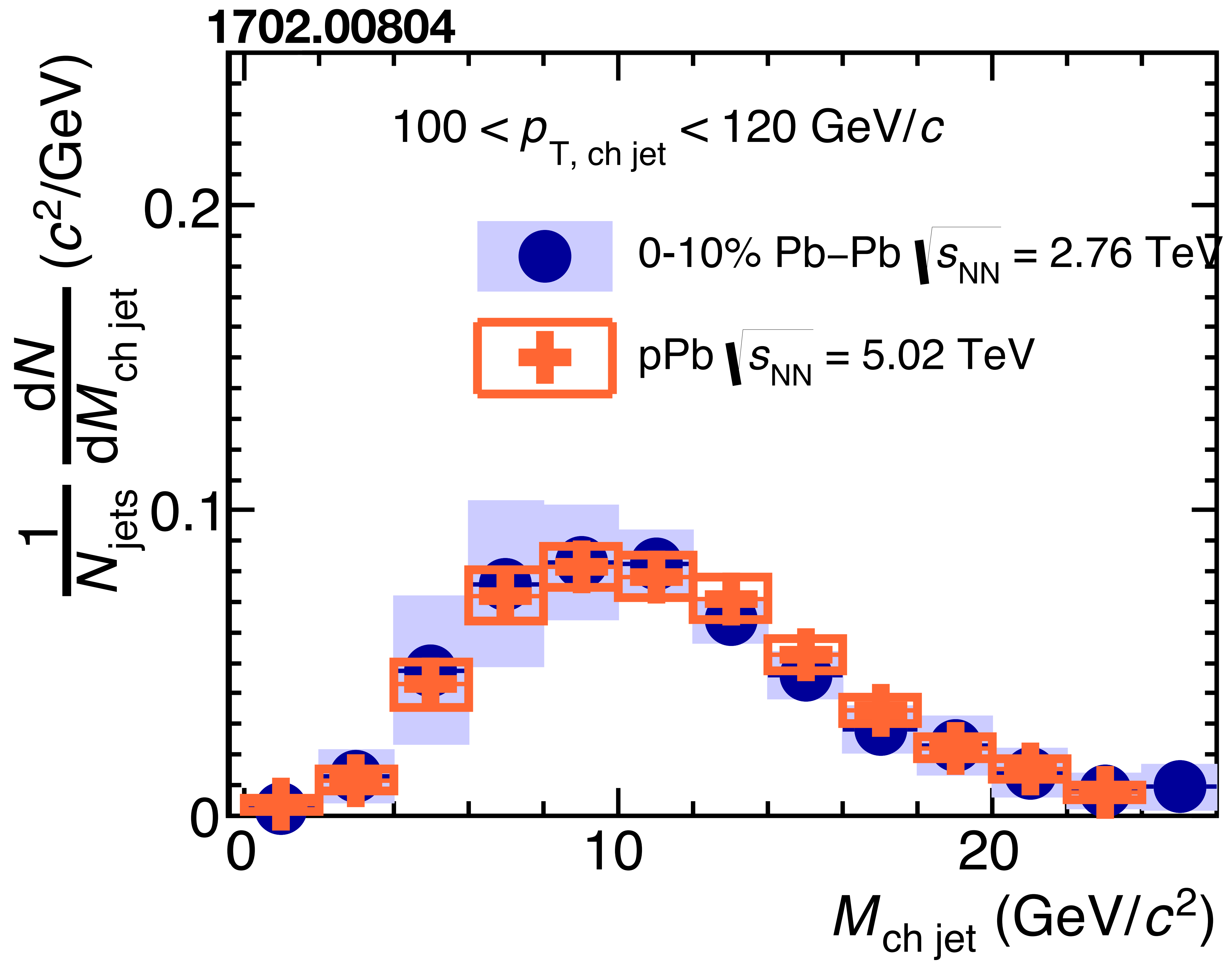
how do we look at jets?

Yi Chen, Wednesday afternoon

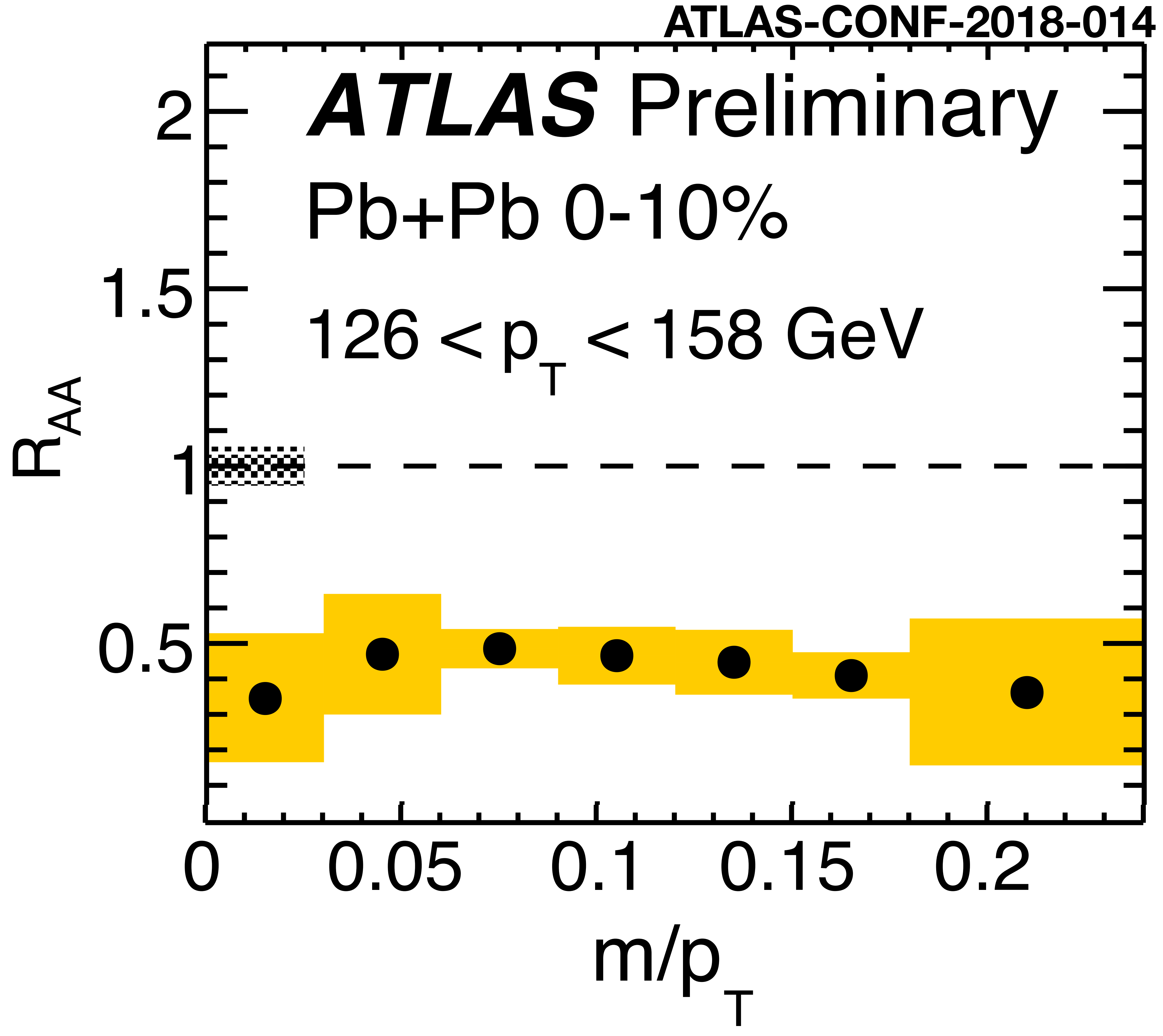


R_{AA} jet mass fragmentation functions

ALICE: mass from charged particles



ATLAS: mass from calorimeter towers

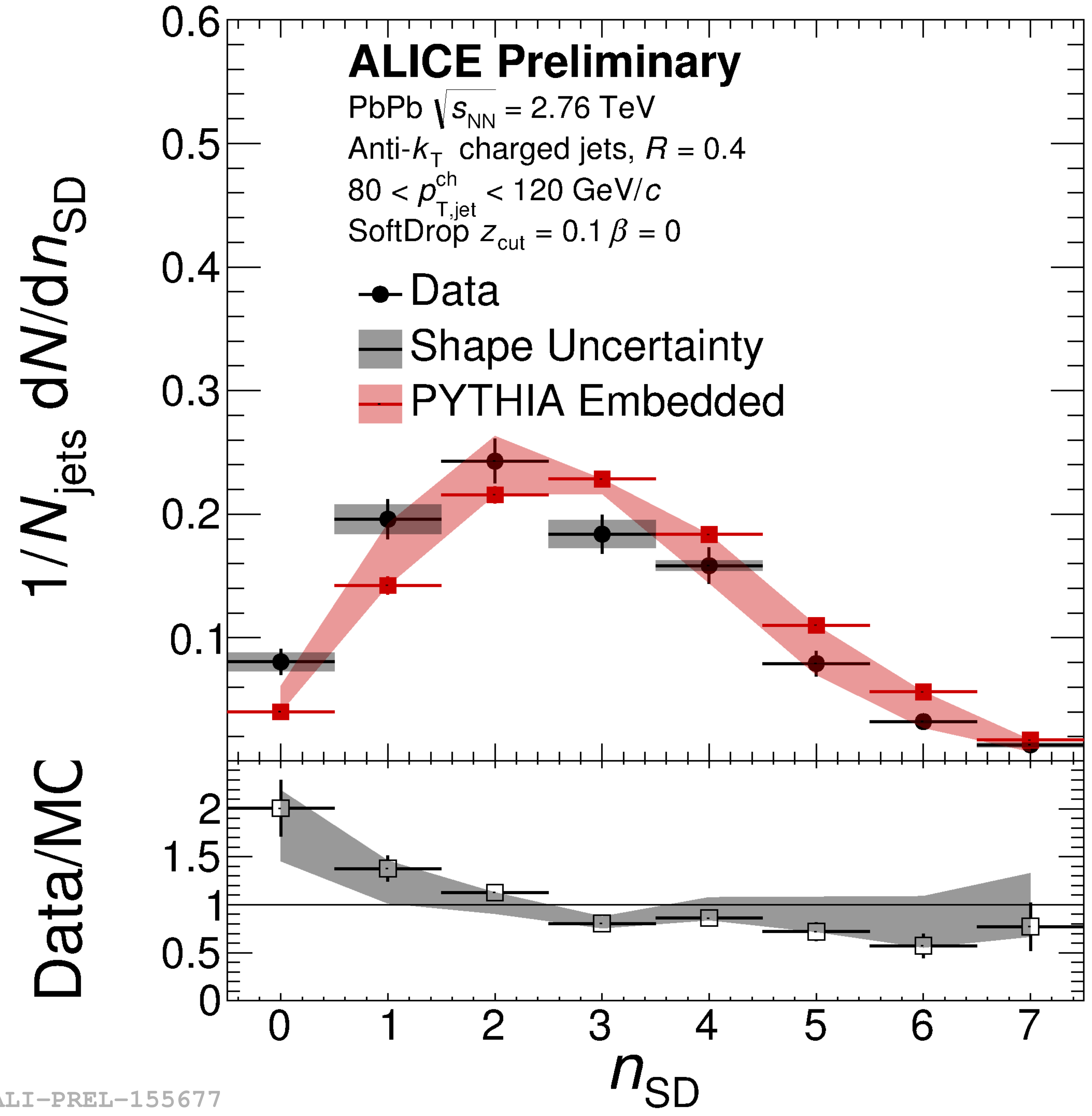


no significant mass modification observed in PbPb within the uncertainties

soft drop: recluster the jet with Cambridge-Aachen then go through the constituents and exclude the softer leg unless

$$z_{\mathrm{g}} = \frac{\min(p_{\mathrm{T},i}, p_{\mathrm{T},j})}{p_{\mathrm{T},i} + p_{\mathrm{T},j}} > z_{\mathrm{cut}} \left(\frac{\Delta R_{ij}}{R_0} \right)^{\beta}$$

Larkoski et al. 1402.2657



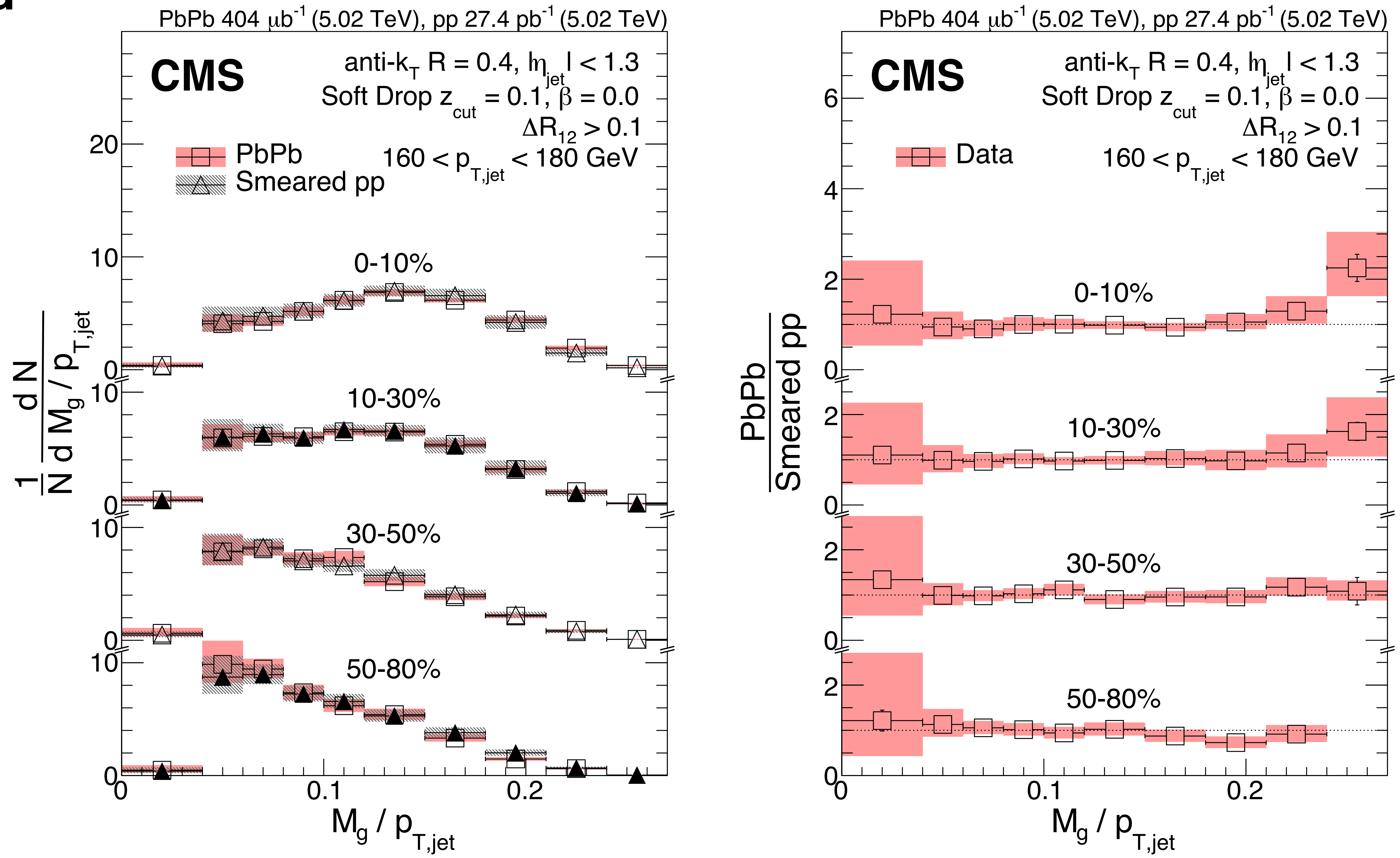
n_{SD}: number of splittings which satisfy the soft drop condition

Harry Andrews, Tuesday

soft drop: recluster the jet with Cambridge-Aachen then go through the constituents a exclude the softer leg unless

$$z_g = \frac{\min(p_{T,i}, p_{T,j})}{p_{T,i} + p_{T,j}} > z_{cut} \left(\frac{\Delta R_{ij}}{R_0} \right)^{\beta}$$

Larkoski et al. 1402.2657



exclude jet if final 2 subjets are at $\Delta R_{12} < 0.1$ (30%)

calculate mass from these two subjets

1805.05145

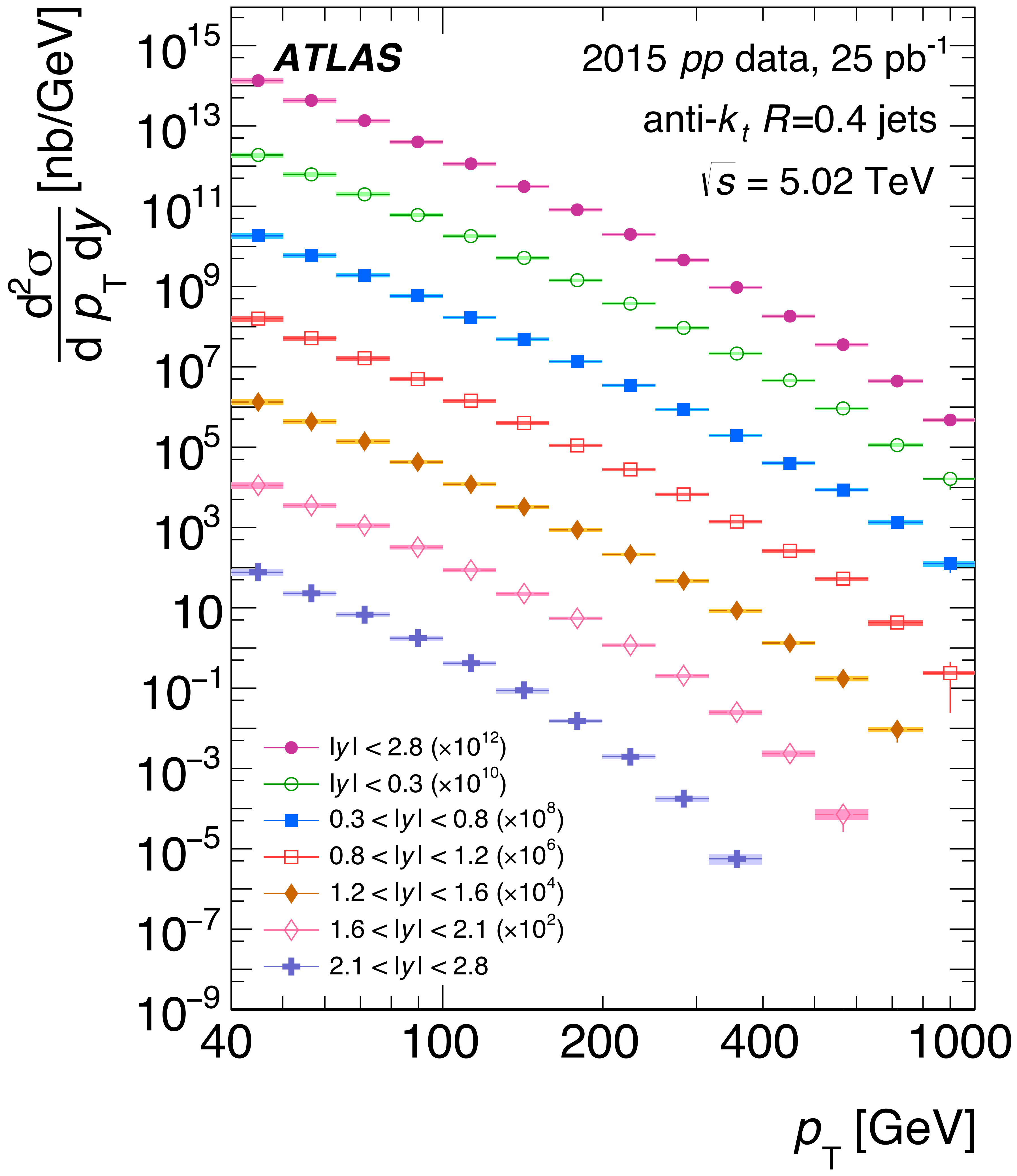
Yi Chen, Wendnesday

the role of jet parton flavor

y dependence of inclusive jets and fragmentation functions

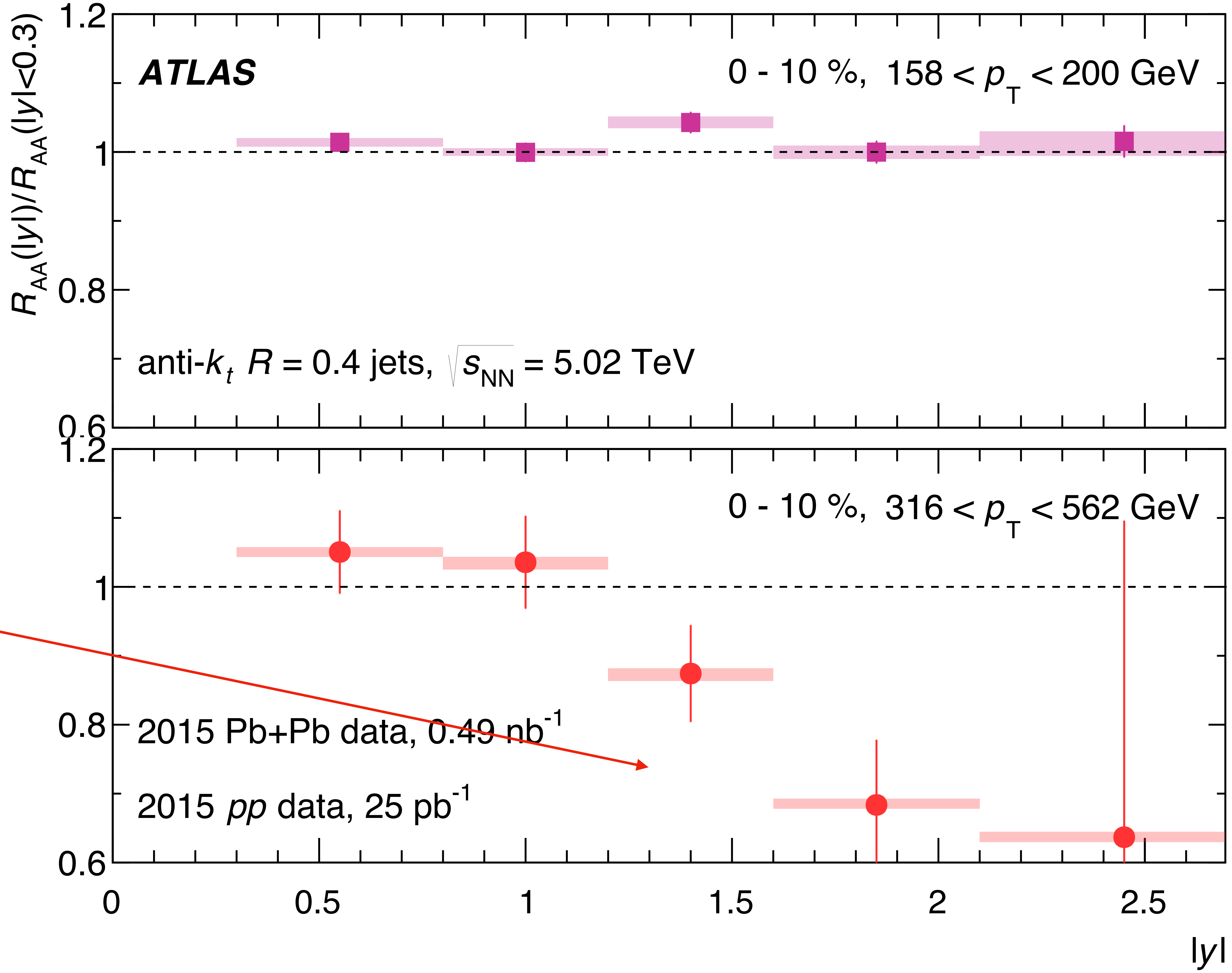
- why rapidity?
  - fraction of quark jets increases with |y| at fixed jet p_T
  - jet p_T spectra become steeper with increasing |y|

rapidity selected spectra in pp collisions

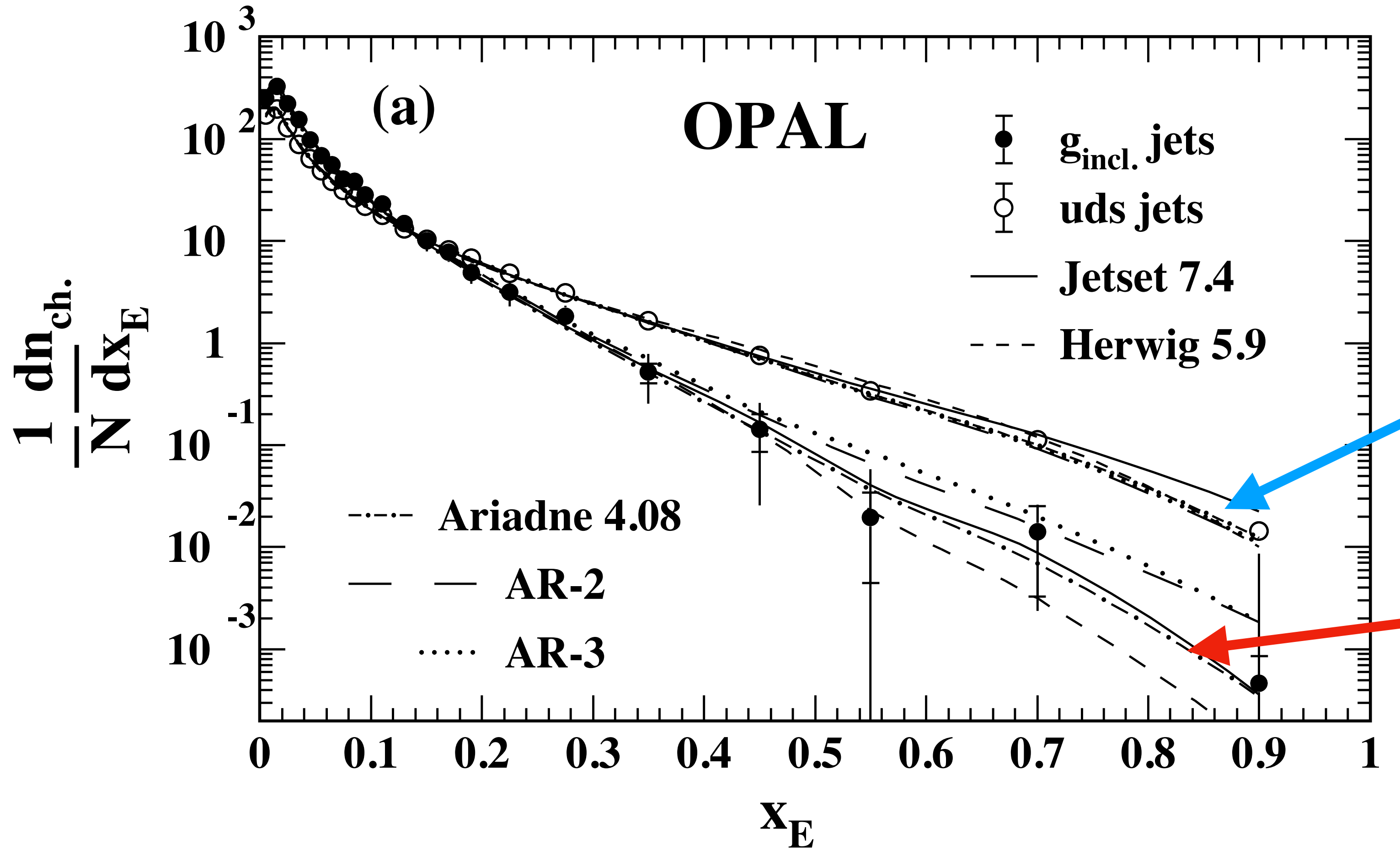


y dependence of inclusive jets and fragmentation functions

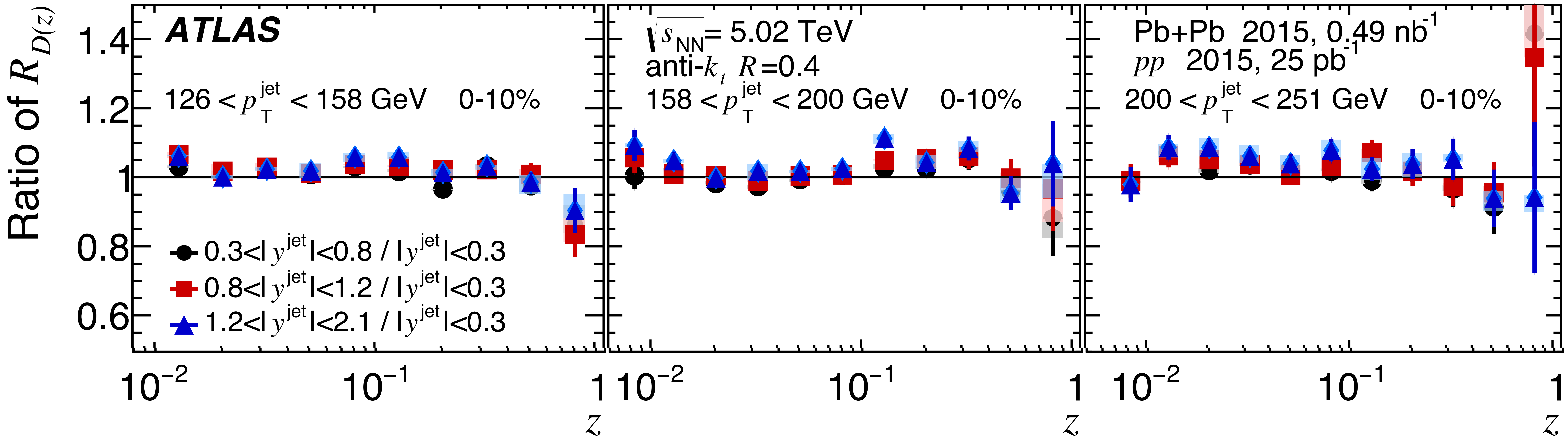
- why rapidity?
  - fraction of quark jets increases with |y| at fixed jet p_T
  - jet p_T spectra become steeper with increasing |y|
    - **decrease RAA with |y|**
  - quarks jets should lose less energy than gluon jets
    - **increase RAA with |y|**



and fragmentation functions?



quark jets have more high z particles than **gluon** jets



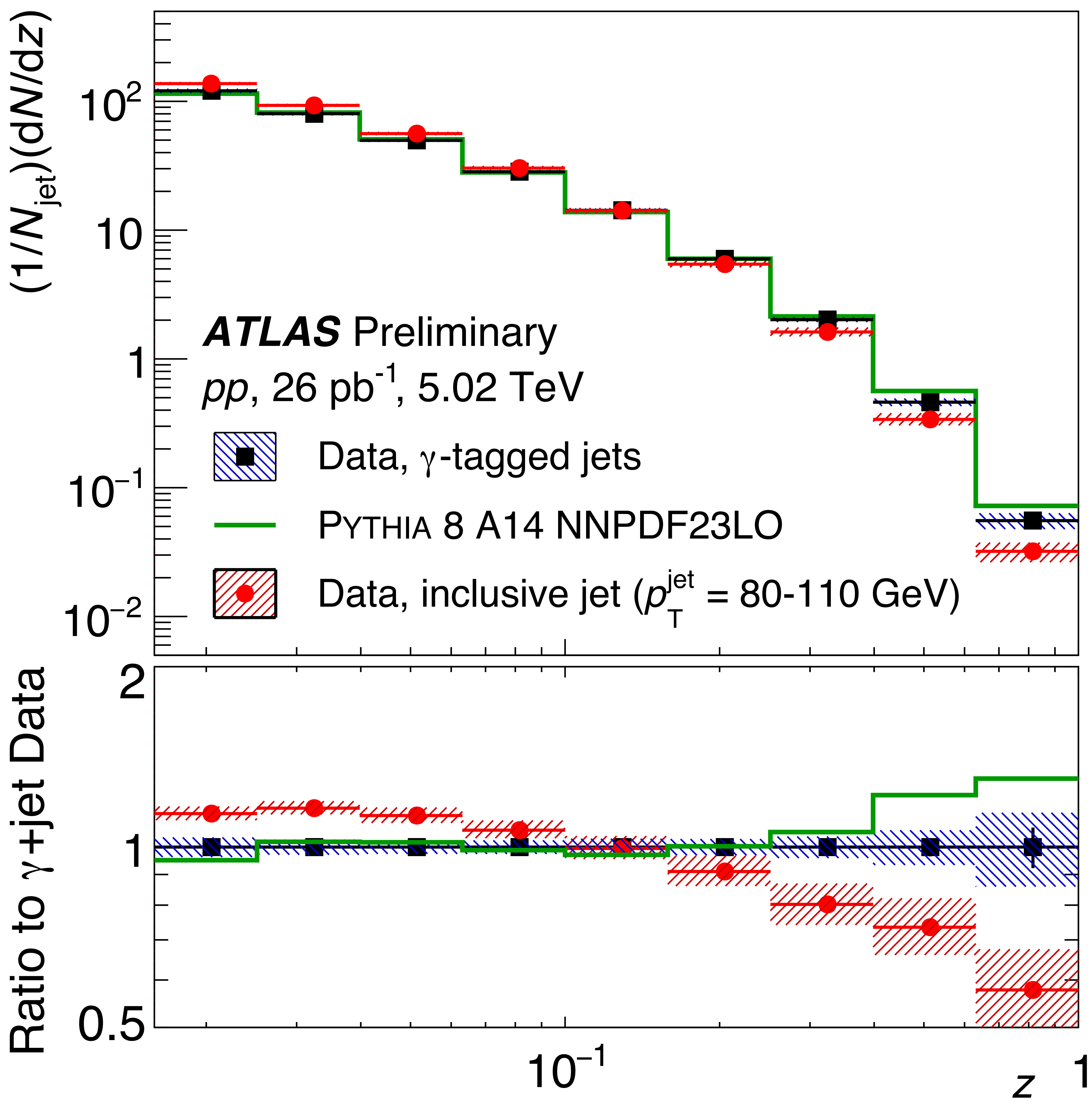
M. Rybar, Wed
1805.05424

no significant rapidity dependence to modification of fragmentation functions

quark vs gluon differences

- photon-jet events dominated by $q + g \rightarrow q + \gamma$ process
  - changes the flavor mix with respect to inclusive jets
  - significant difference between **inclusive** and **γ-tagged** fragmentation functions

ATLAS-CONF-2017-074



photon p_T: 79.6-125 GeV
jet p_T: 63.1-144 GeV

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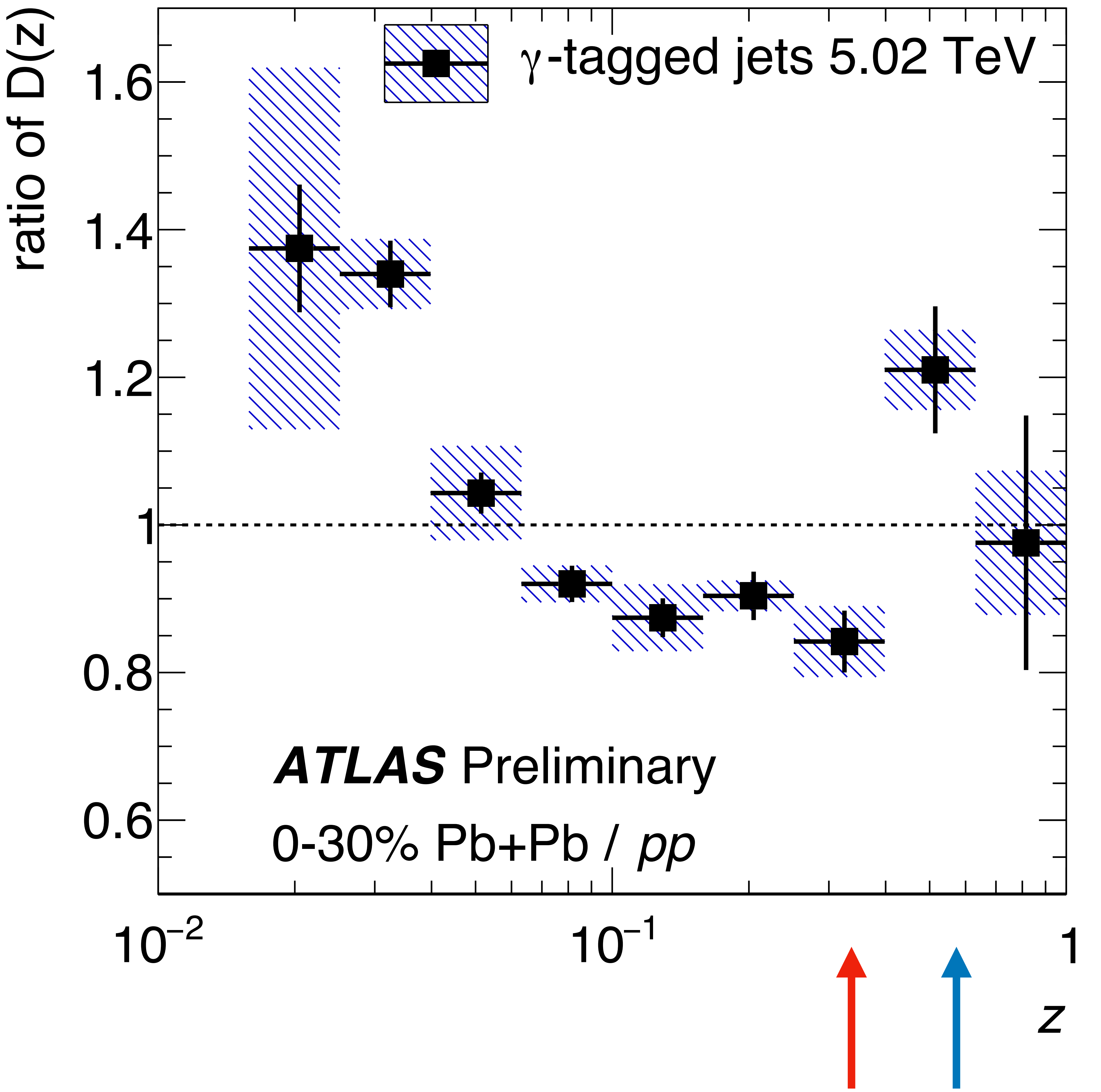
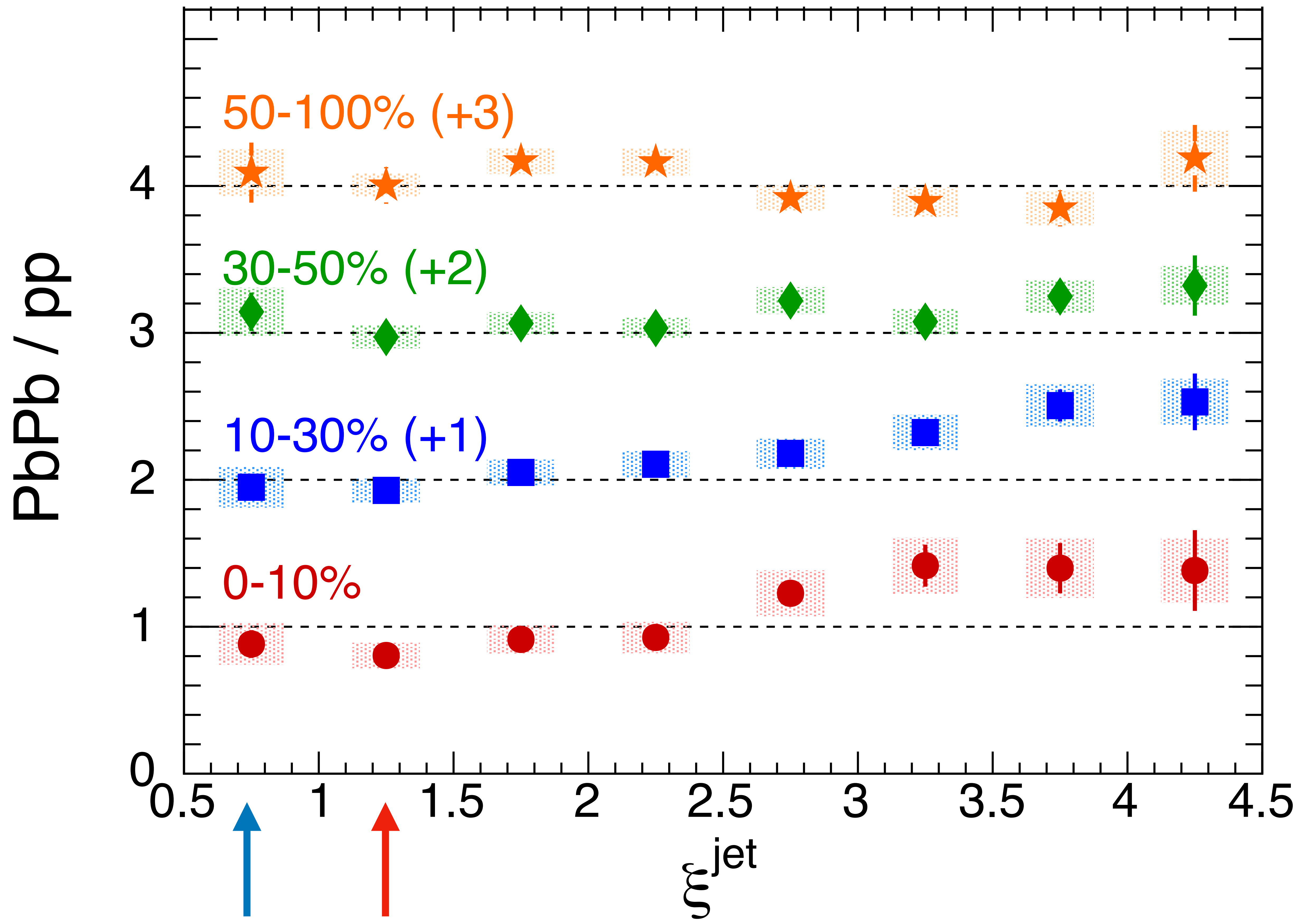


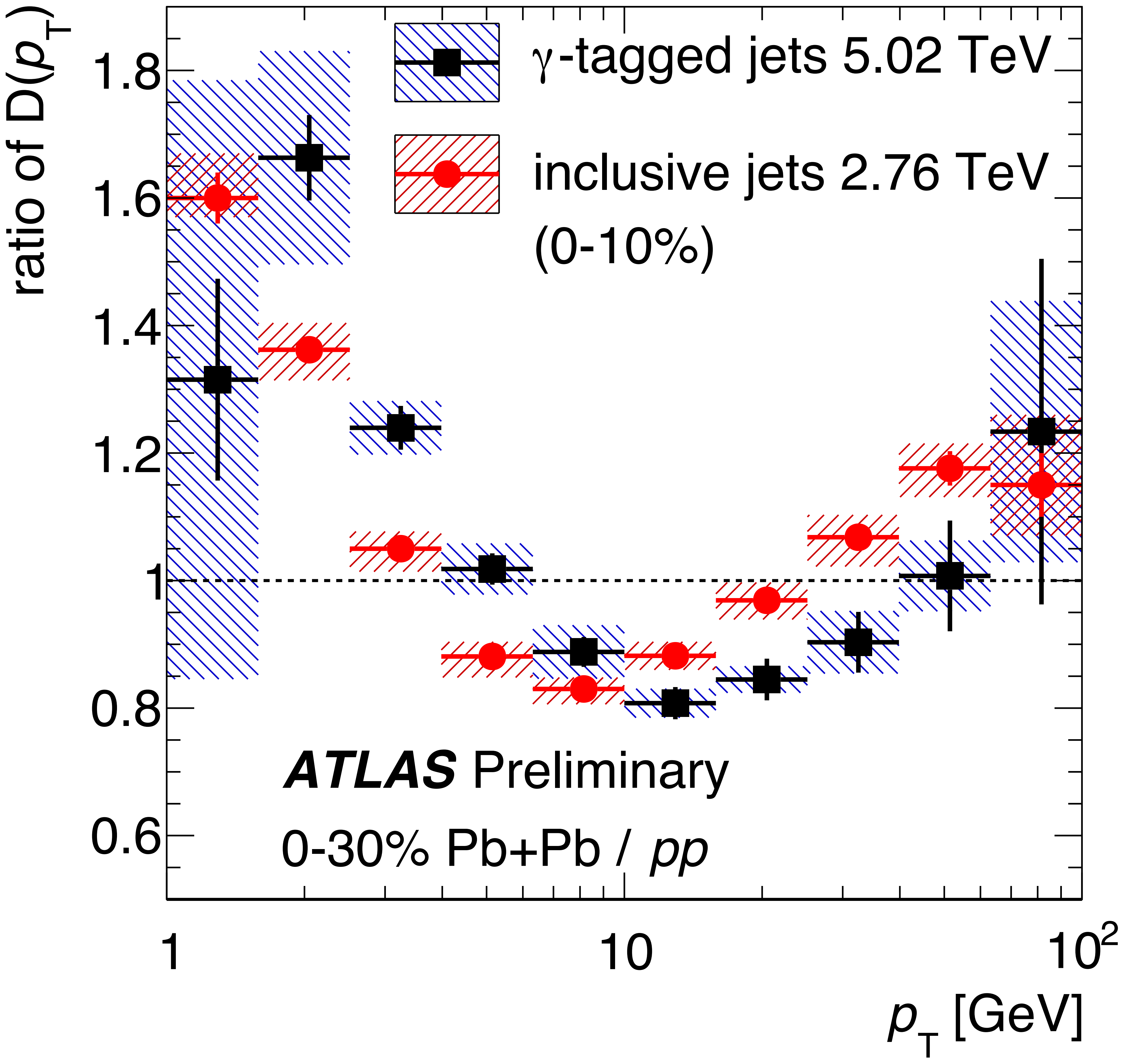
$\xi^{jet} = \ln(1/z)$

photon p_T: > 60 GeV
jet p_T: > 30 GeV



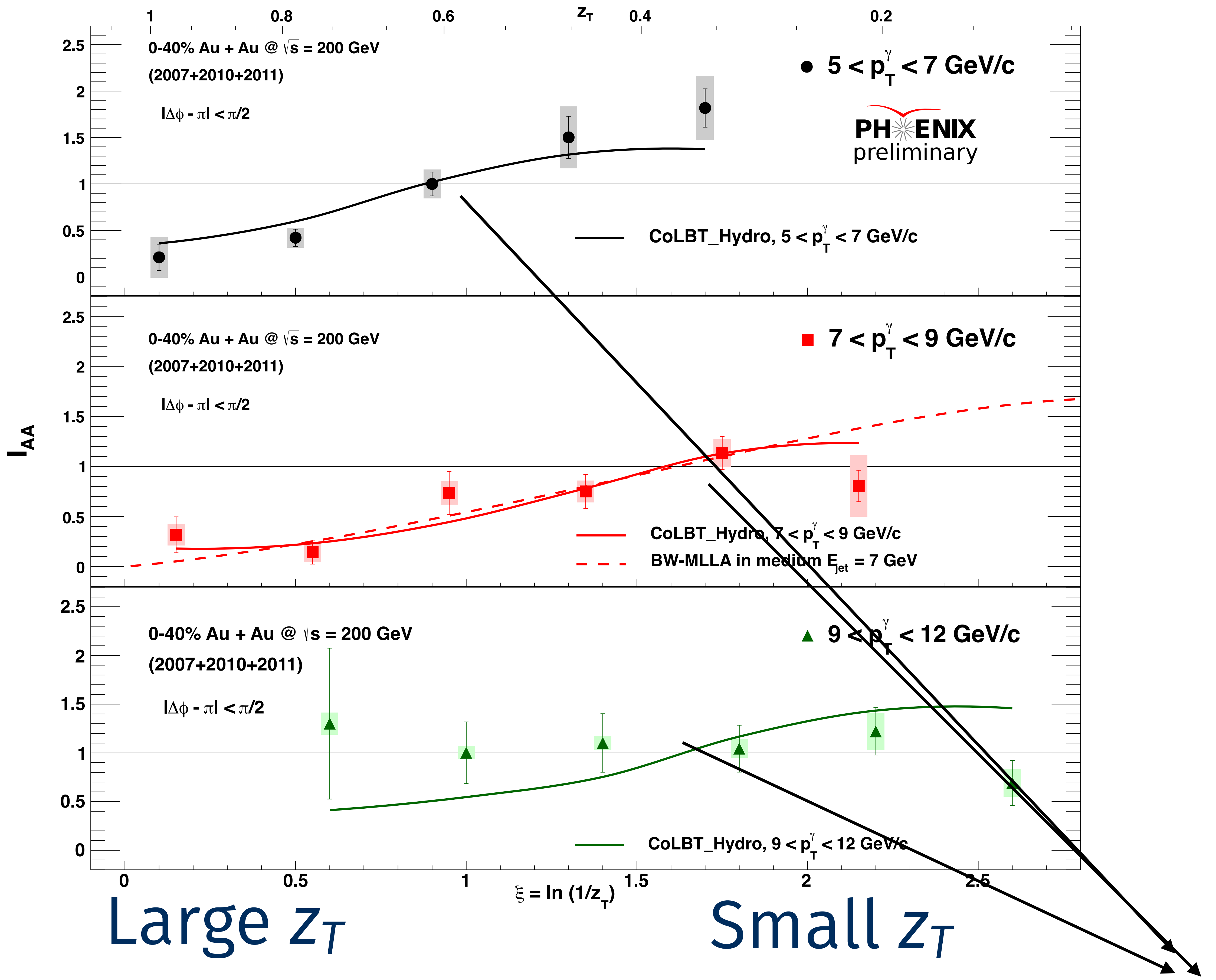
photon-tagged fragmentation functions

photon p_T: 79.6-125 GeV
jet p_T: 63.1-144 GeV



γ-hadron correlations at 200 GeV AuAu collisions

Joe Osborn, Wednesday



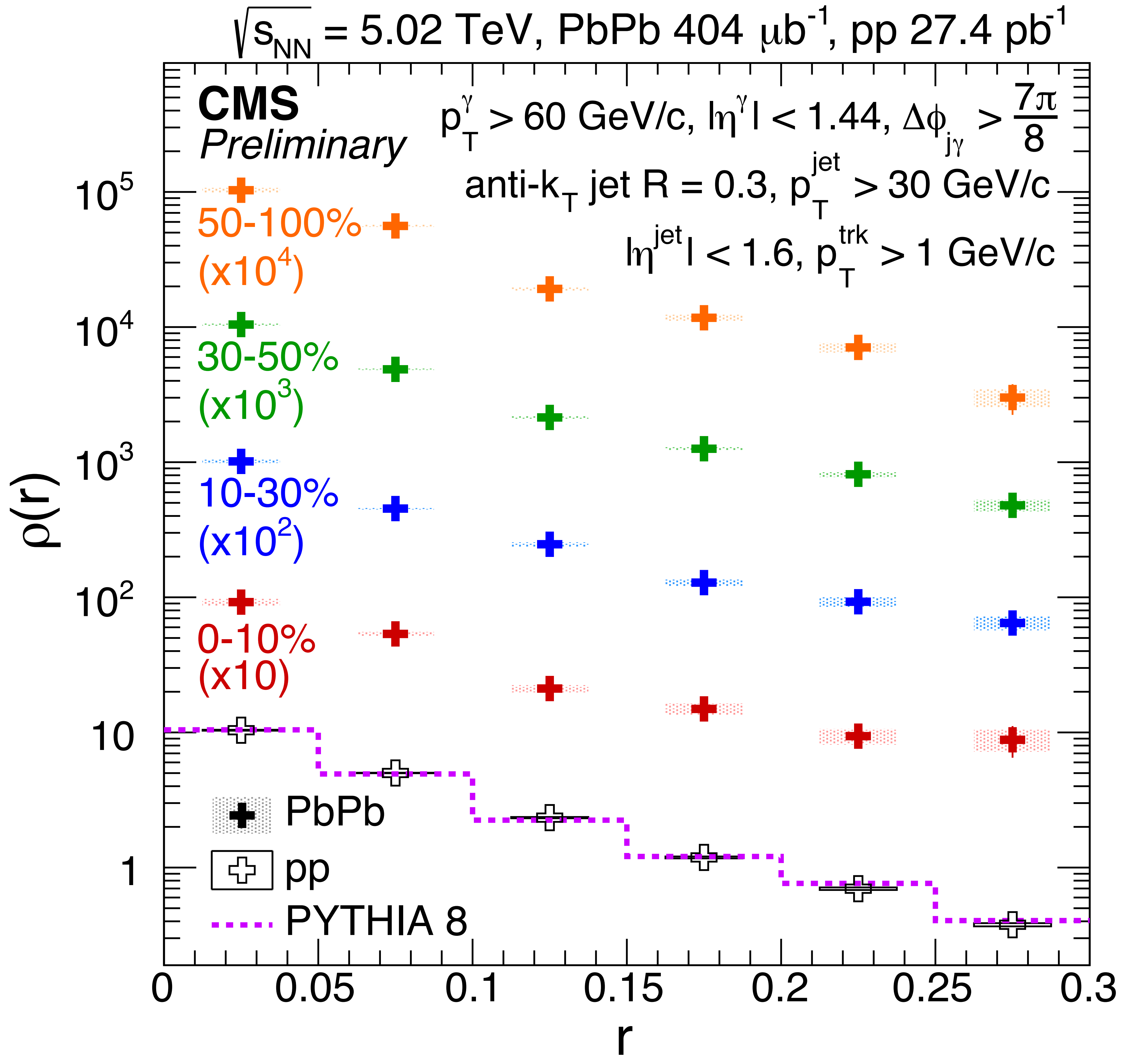
low p_T enhancement begins at a similar p_T to inclusive jets and at a similar p_T between LHC and RHIC

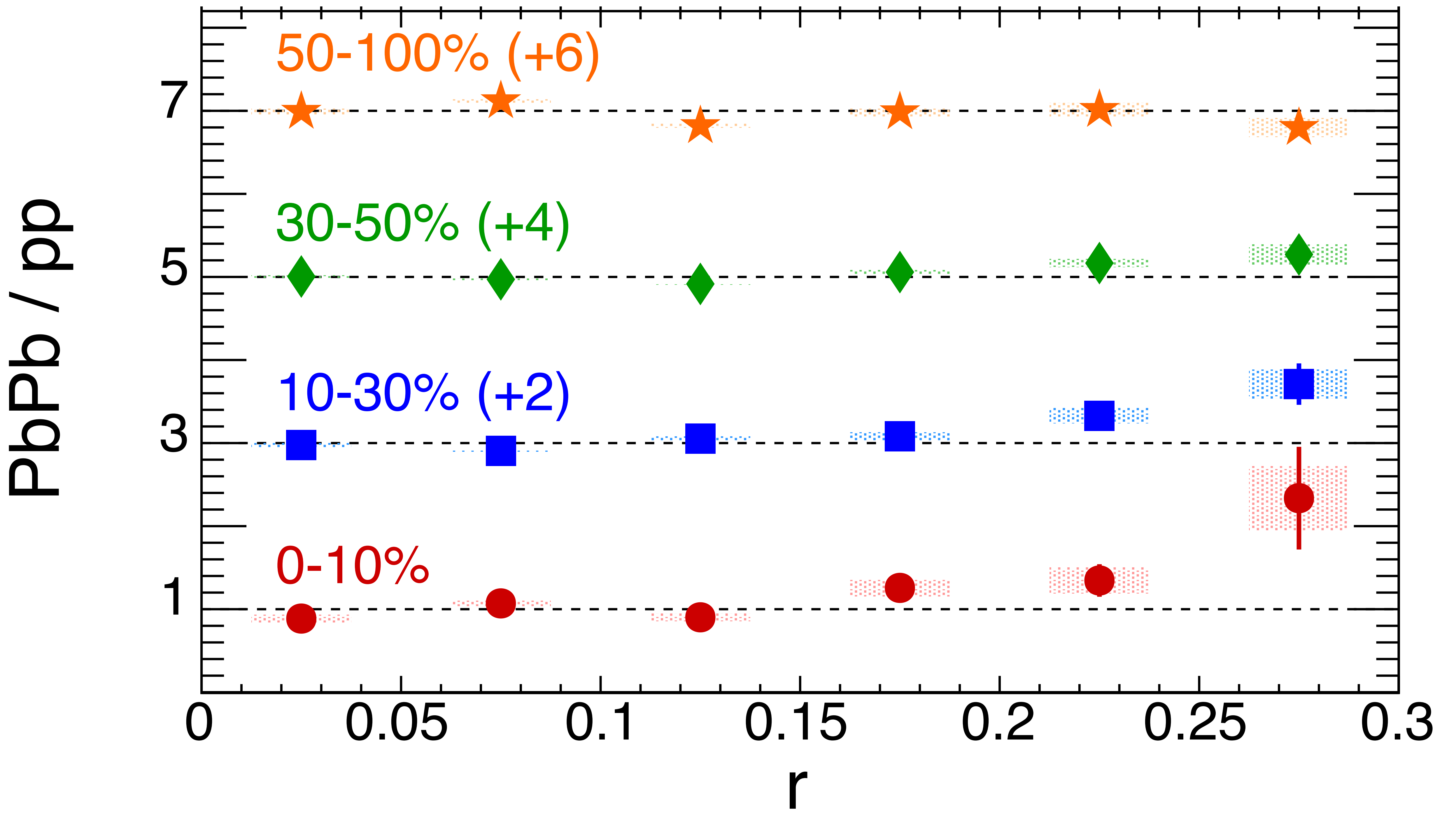
looking forward to precision measurements with reconstructed jets at sPHENIX!

shape measurements of jets opposite a photon

radial distribution of tracks in a jet opposite the photon

photon p_T: > 60 GeV
jet p_T: > 30 GeV



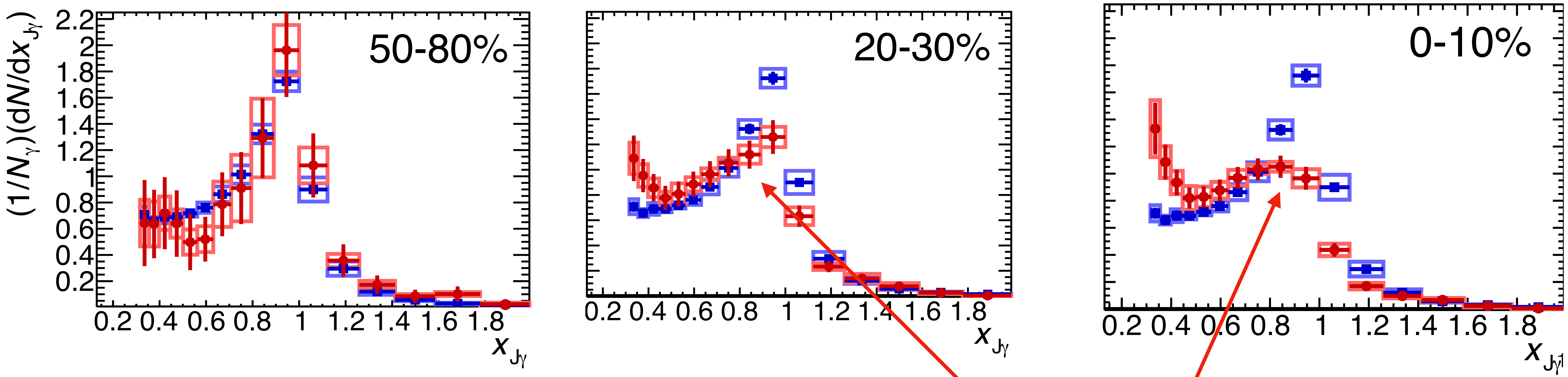


photon p_T: 100-158 GeV

ATLAS Preliminary
pp 5.02 TeV, 25 pb^{-1}
Pb+Pb, 0.49 nb^{-1}

p_T^{γ} = 100-158 GeV
pp (same each panel)
Pb+Pb

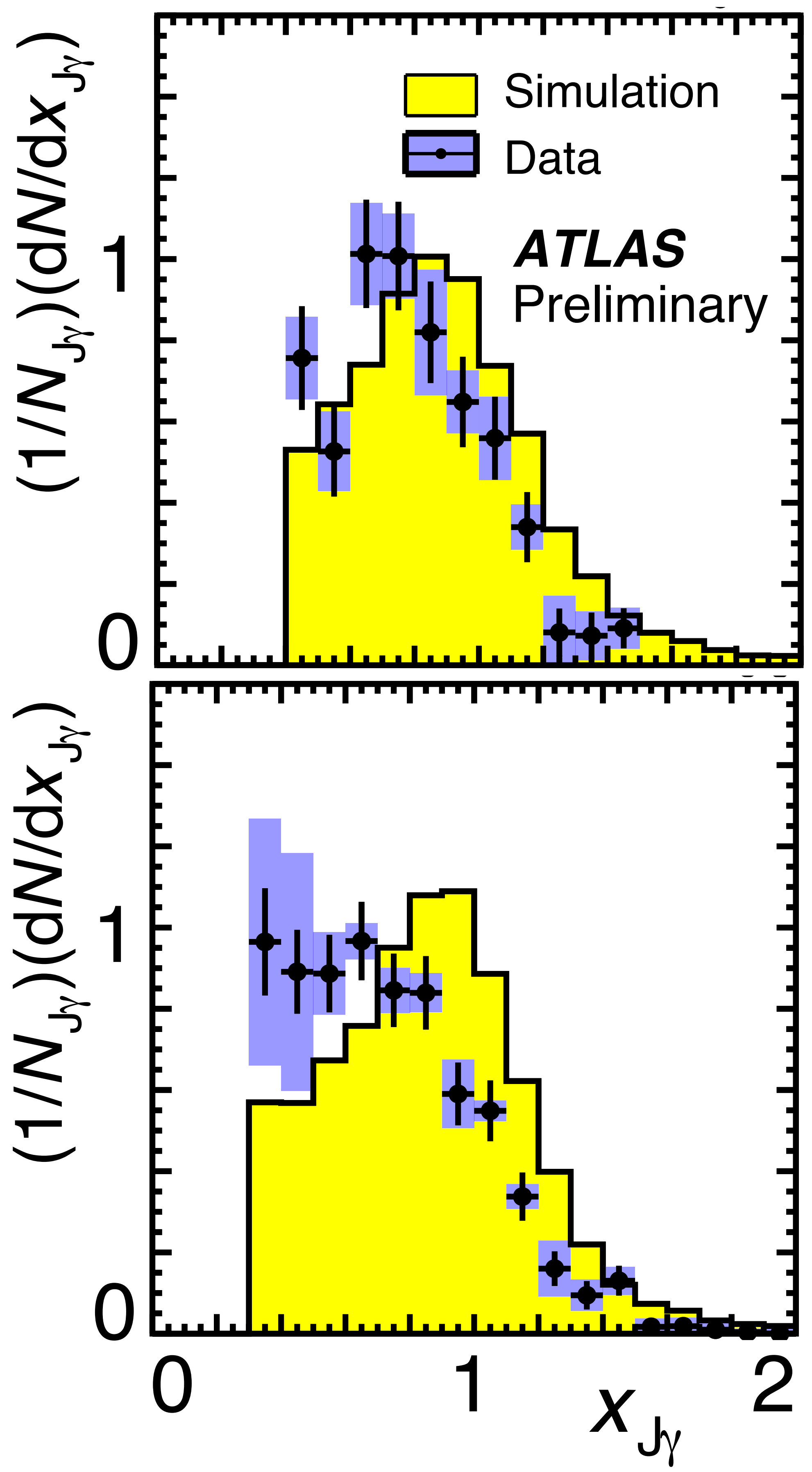
increasing centrality → increasing shift to low $x_{J\gamma}$



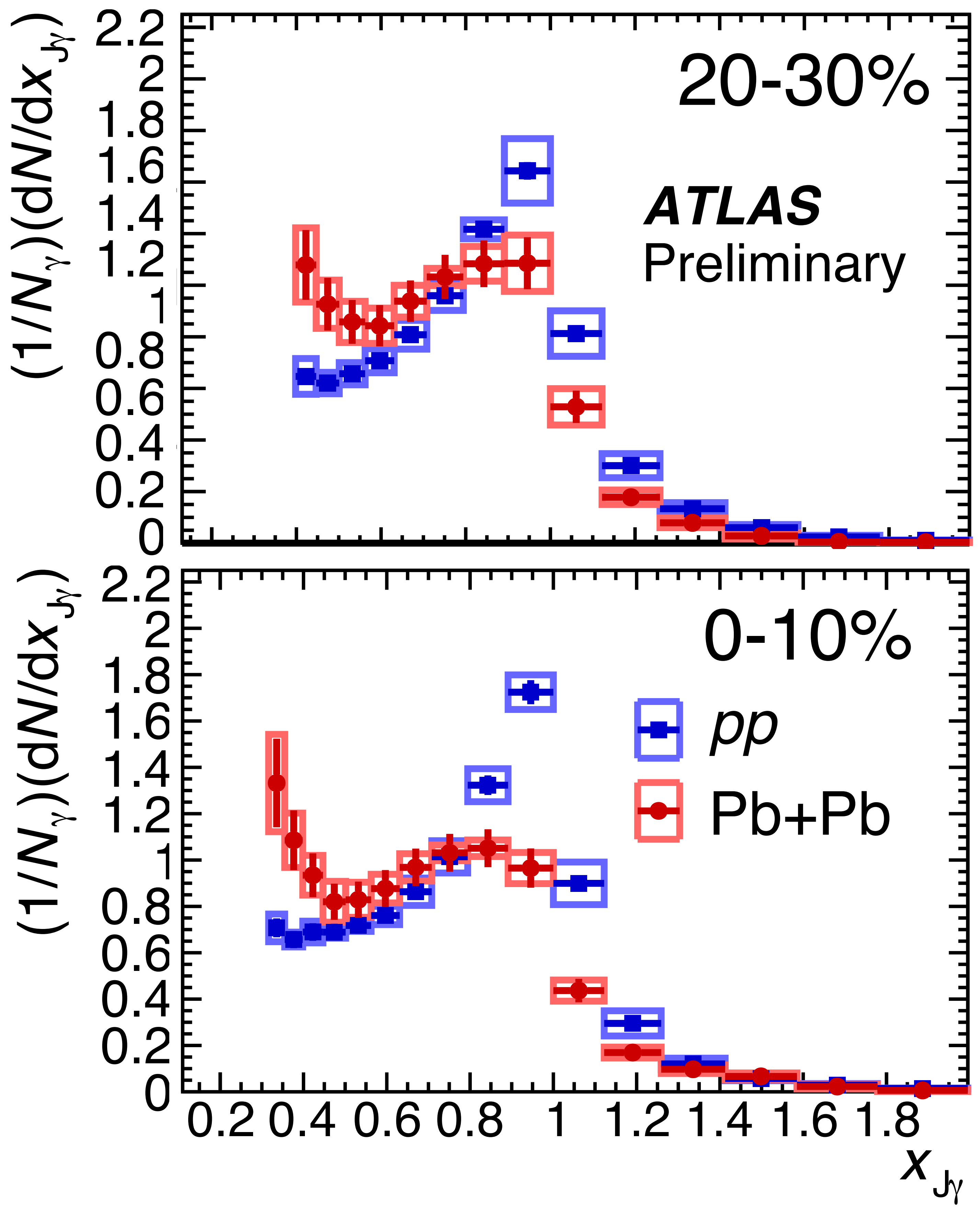
peak for nearly balanced pairs

20-30% Pb+Pb
p_T^γ = 79.6-100 GeV

0-10% Pb+Pb
p_T^γ = 100-158 GeV



Unfolding



QM '17

*uncorrected **Pb+Pb data** to **smeared Pythia** : bulk shift…*

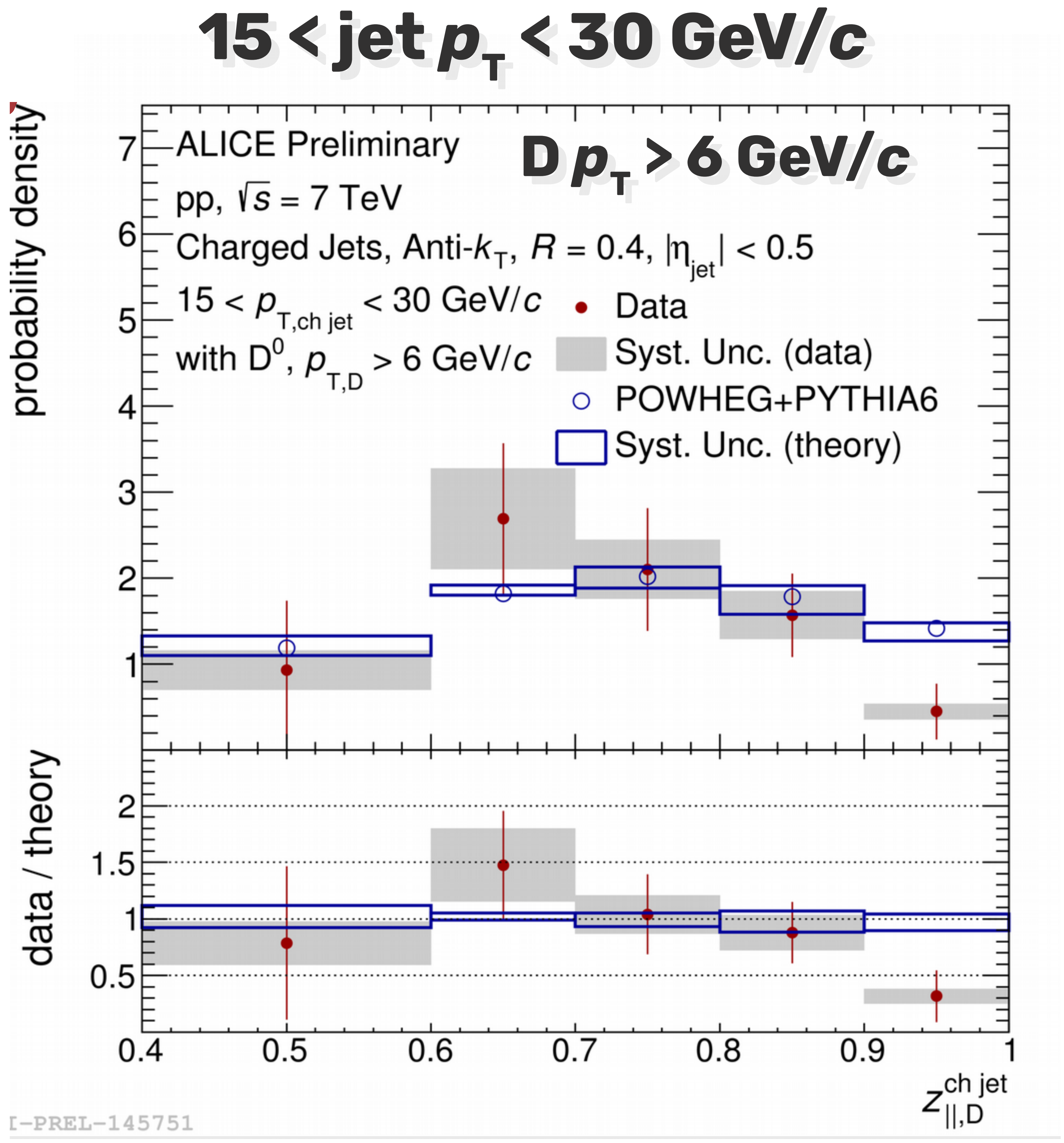
QM '18

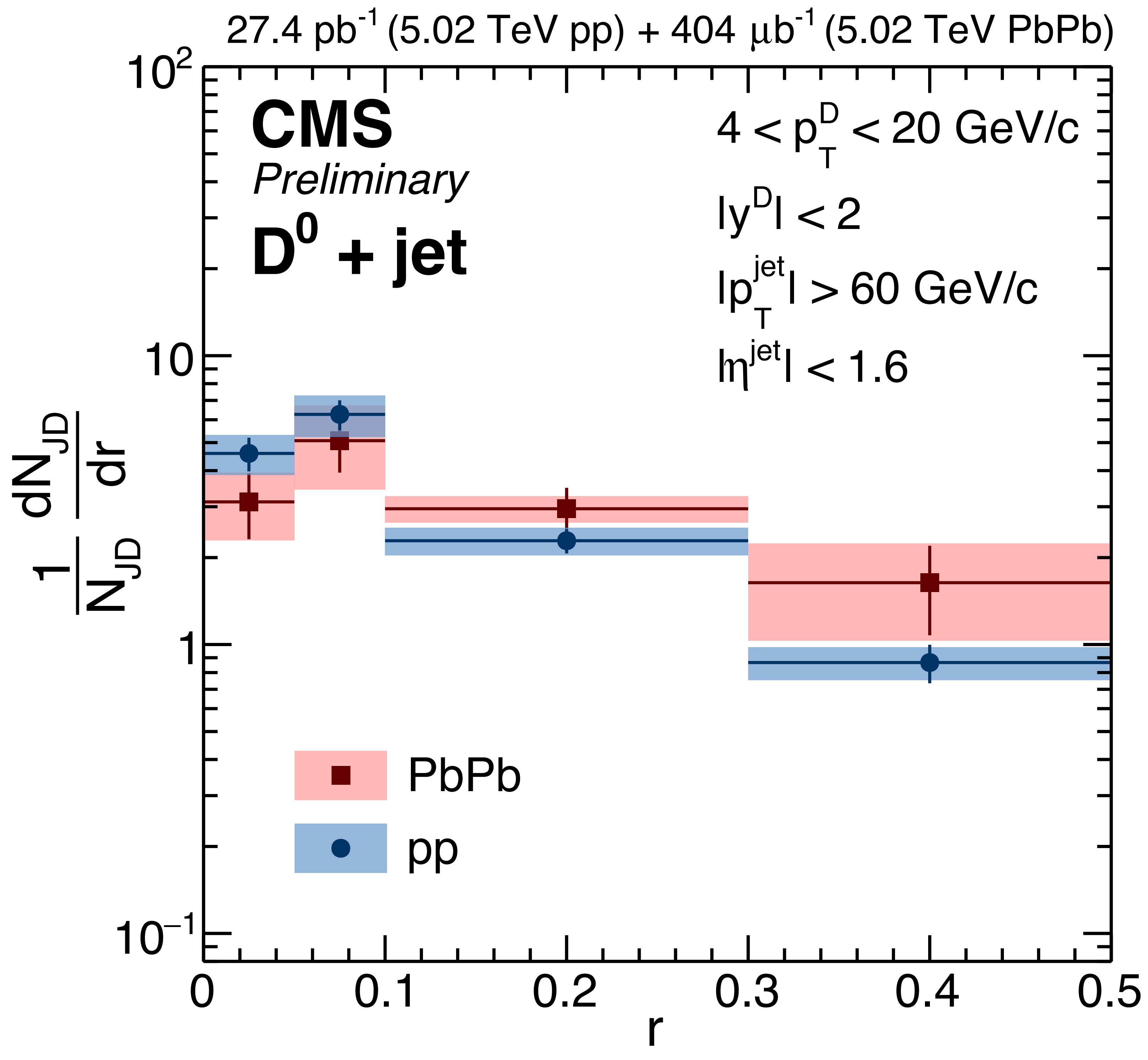
*unfolded **Pb+Pb**-**pp** comparison: jets lose small/ large amounts of energy!*

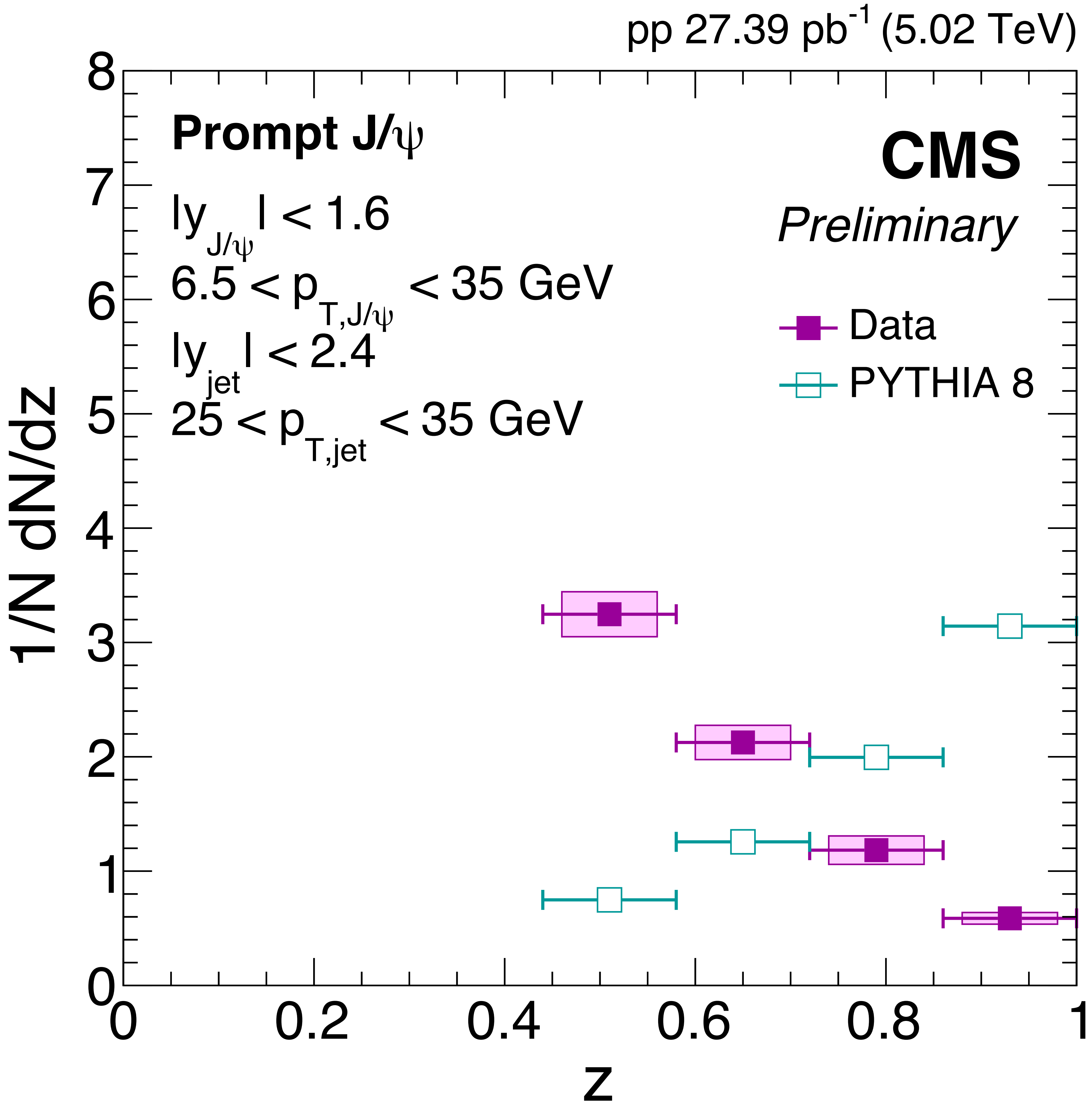
18

Dennis Perepelitsa, Wednesday morning

D⁰s reconstructed in jets

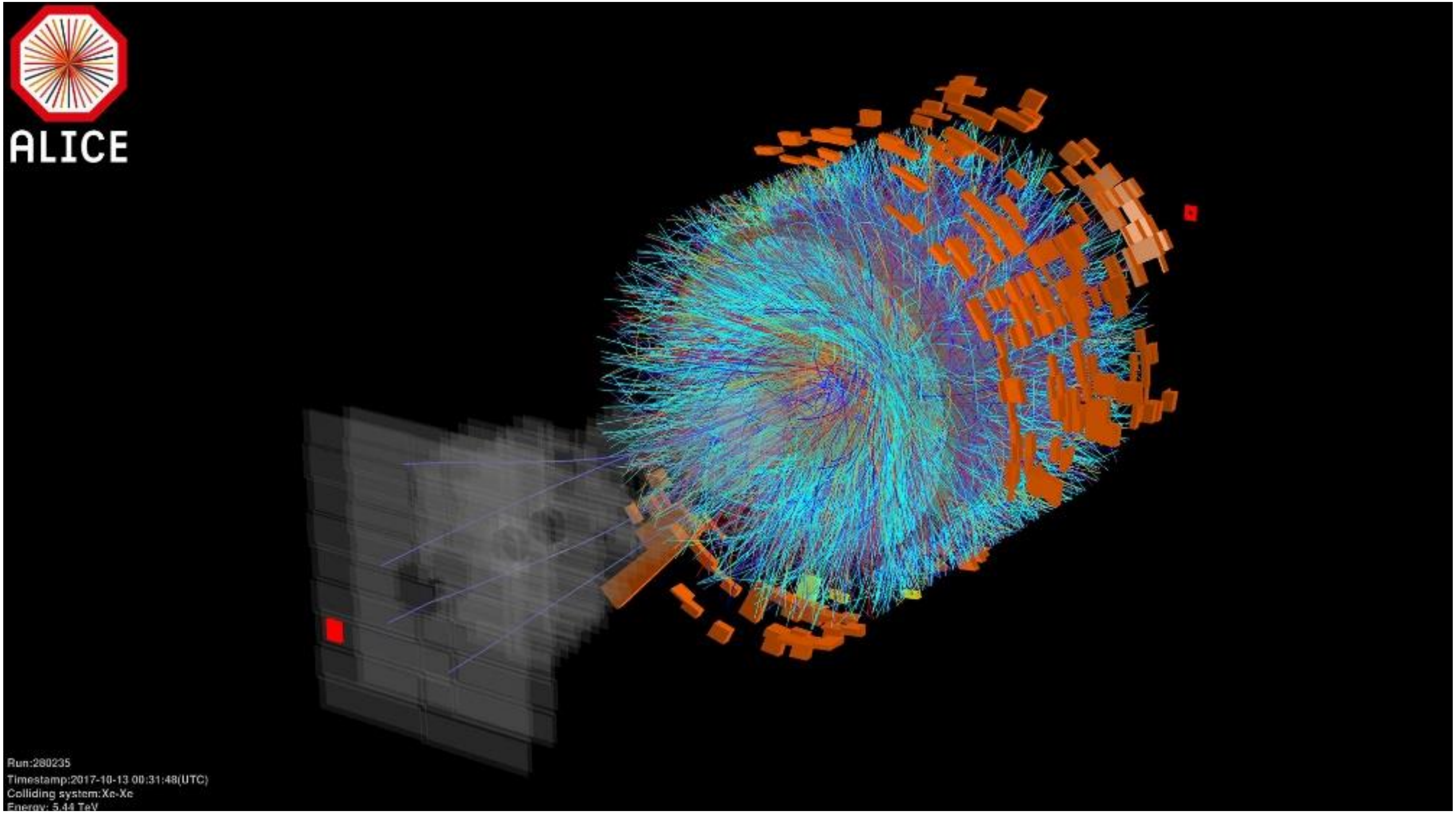




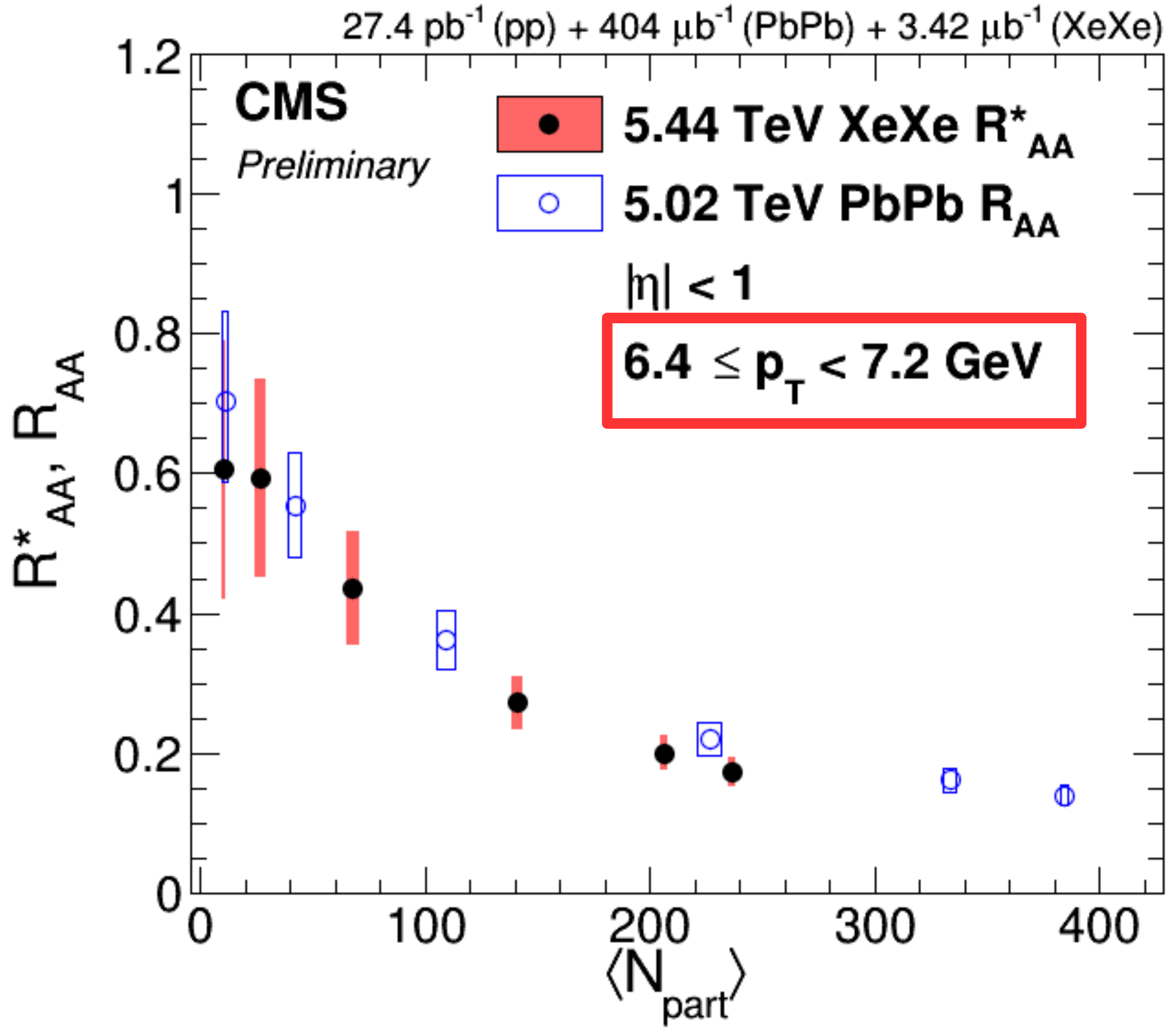


looking forward D to measurements with higher luminosity and the ALICE upgrades

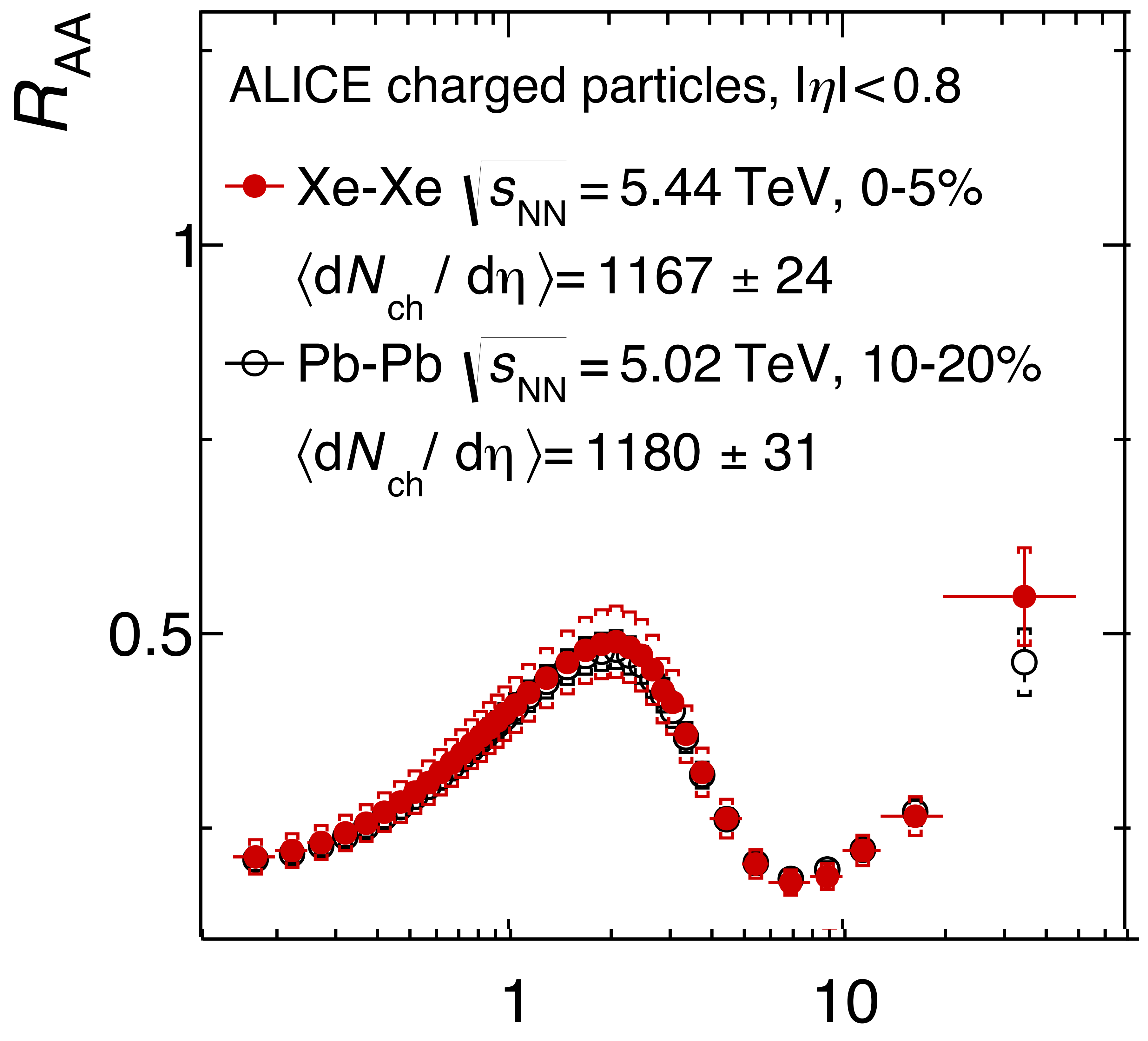
XeXe


ALICE
Run:280235
Timestamp:2017-10-13 00:31:48(UTC)
Colliding system:Xe-Xe
Energy: 5.44 TeV

ALICE, ATLAS & CMS successfully took data for the very short XeXe run



Daiki Sekihata, Tuesday 1805.04399

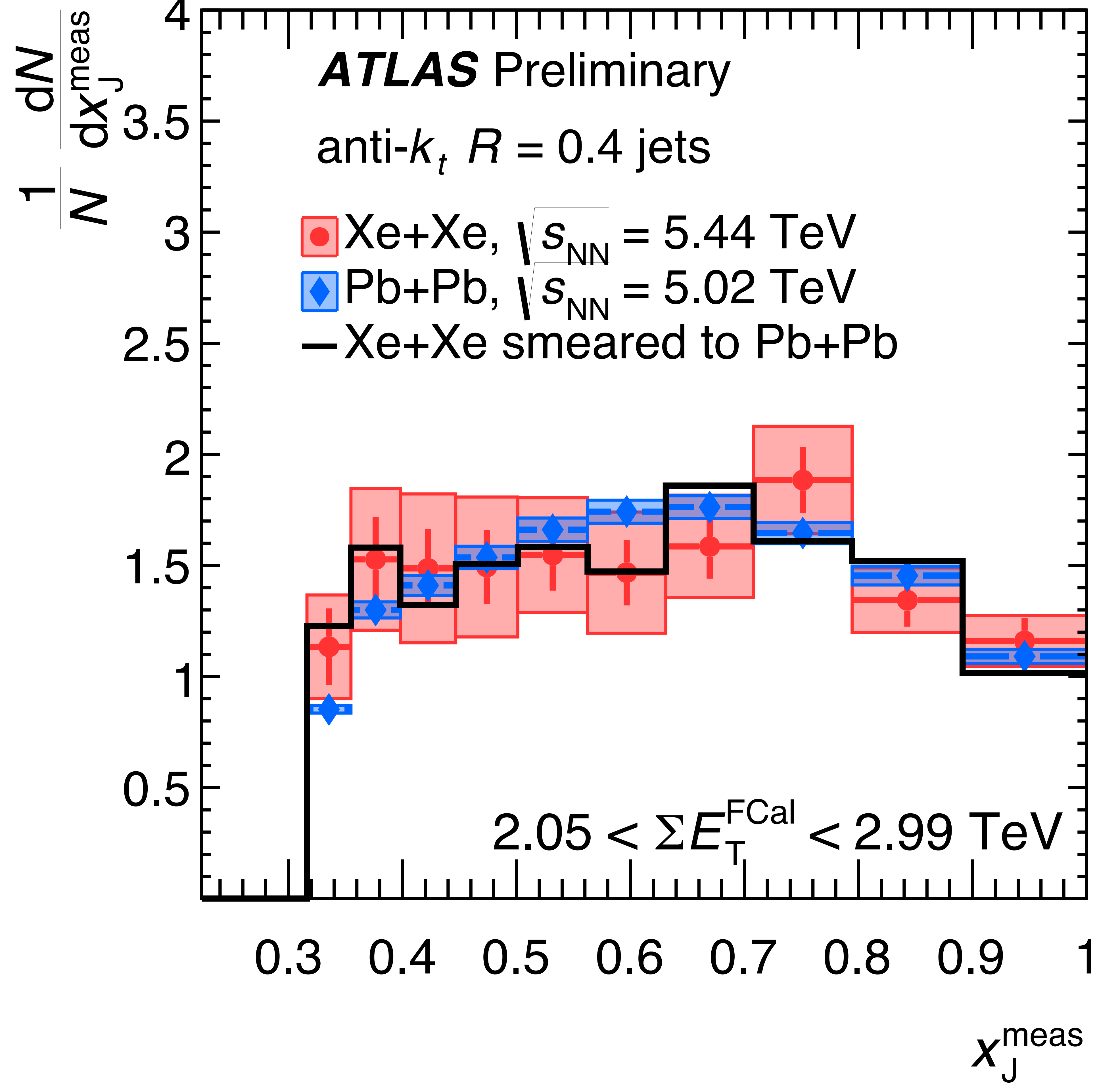


jets and high pt charged particles in XeXe quenched according to ~Npart/multiplicity informs discussion of light ions in the future

Austin Baty, Tuesday

dijet balance XeXe, PbPb, AuAu

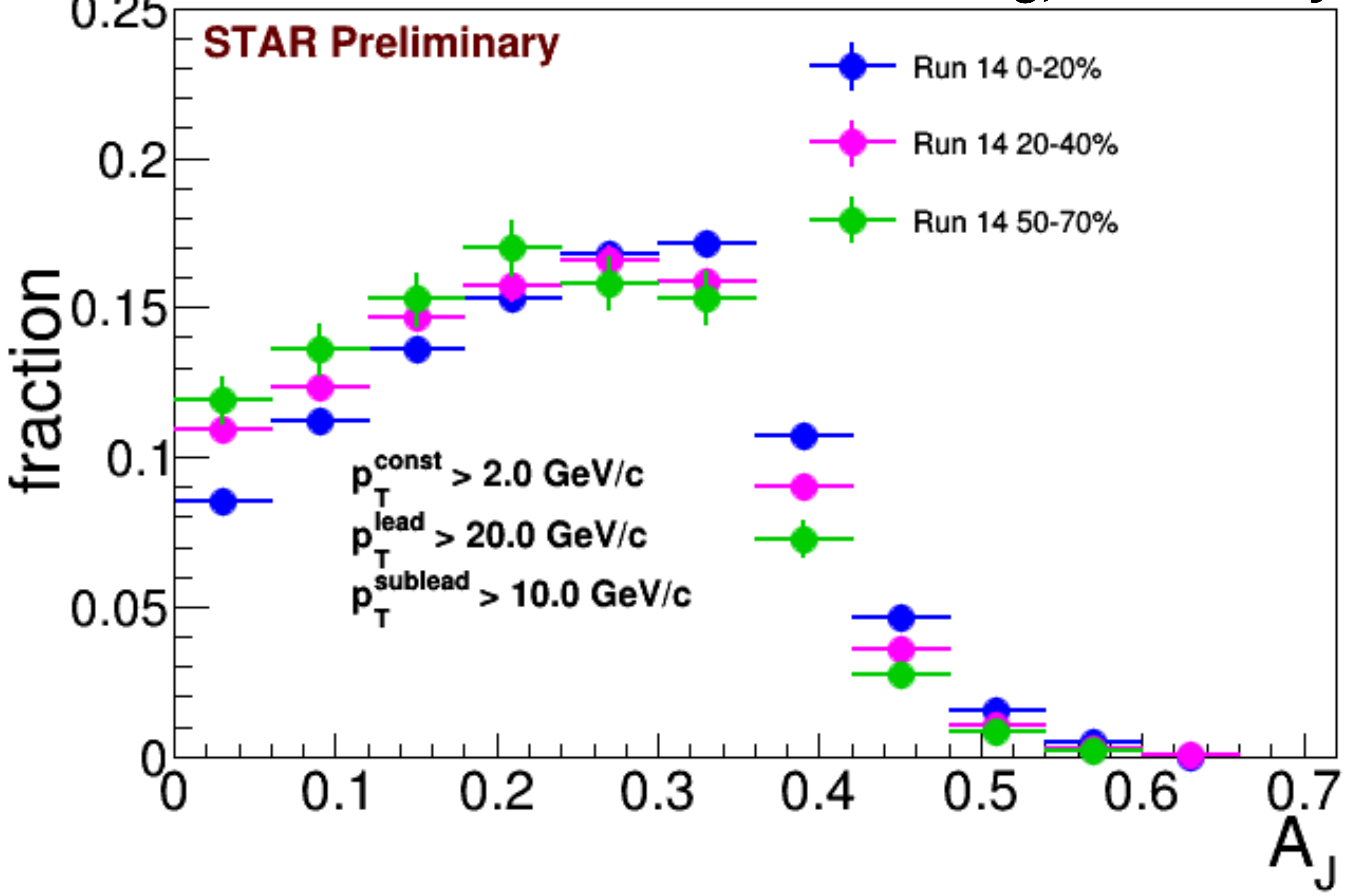
$$x_J = \frac{p_{T_2}}{p_{T_1}}$$



ATLAS-CONF-2018-007, Spousta Wednesday

$A_J = (p_T^{lead} - p_T^{sublead}) / (p_T^{lead} + p_T^{sublead})$

Kun Jiang, Wednesday



looking forward to doing this comparison over a wider kinematic range at RHIC with sPHENIX!

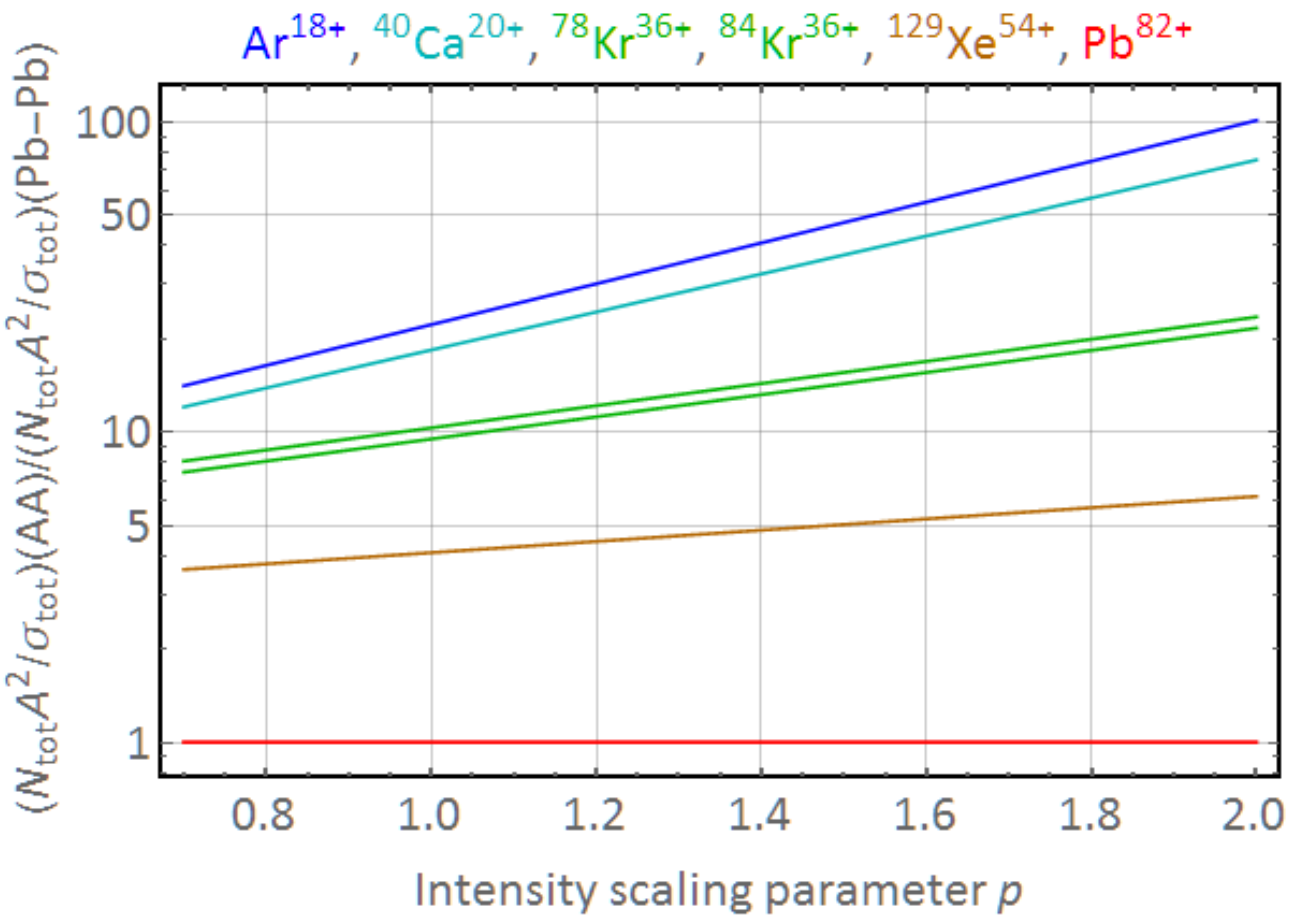
lighter ions could provide more jets at the LHC

Gains in ULTIMATE integrated nucleon-nucleon luminosity PER FILL wrt Pb-Pb

This would be on the assumption that a fill would be kept forever until one beam was exhausted (and other loss mechanisms are neglected). Real gain/fill will be less.

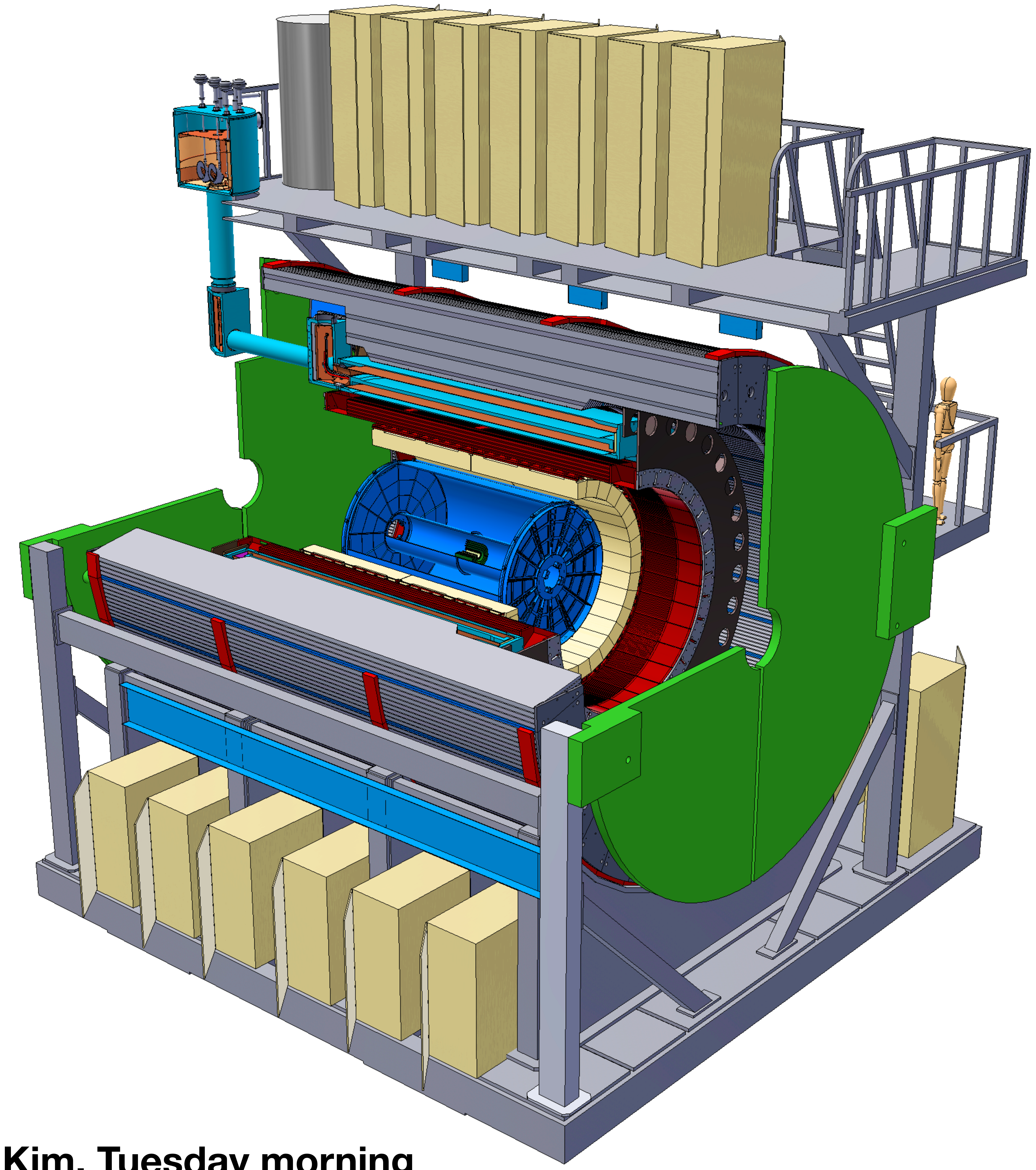
In reality, one also gains from longer luminosity lifetime and less time spent refilling the machine.

We will try to quantify this better in future.



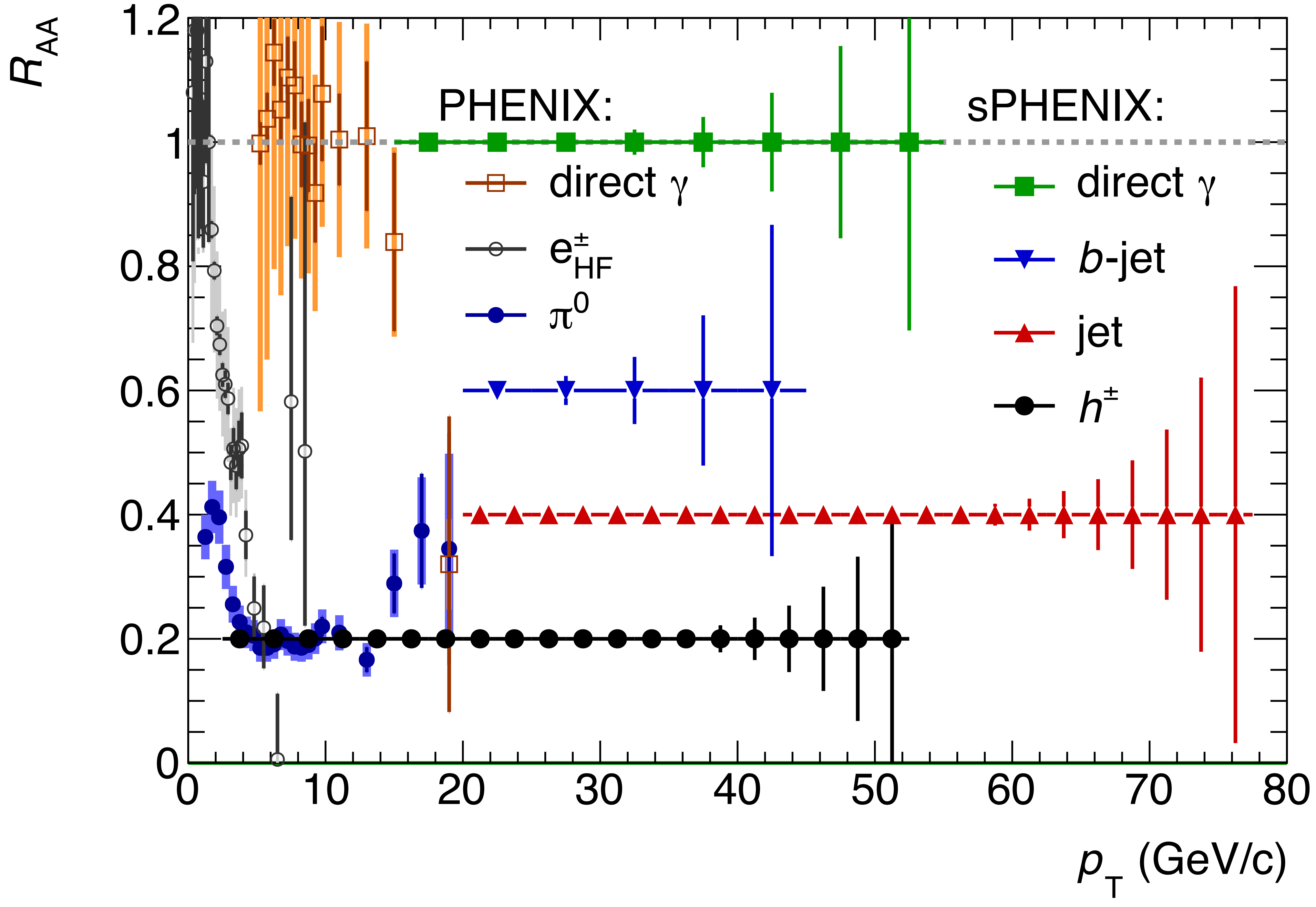
J.M. Jowett, Quark Matter 2018, Venice, 15/5/2018. 29

John Jowett, Tuesday morning



looking forward to sPHENIX in 2023

measurements we are making now will help us understand sPHENIX data when it comes



Yongsun Kim, Tuesday morning

looking forward

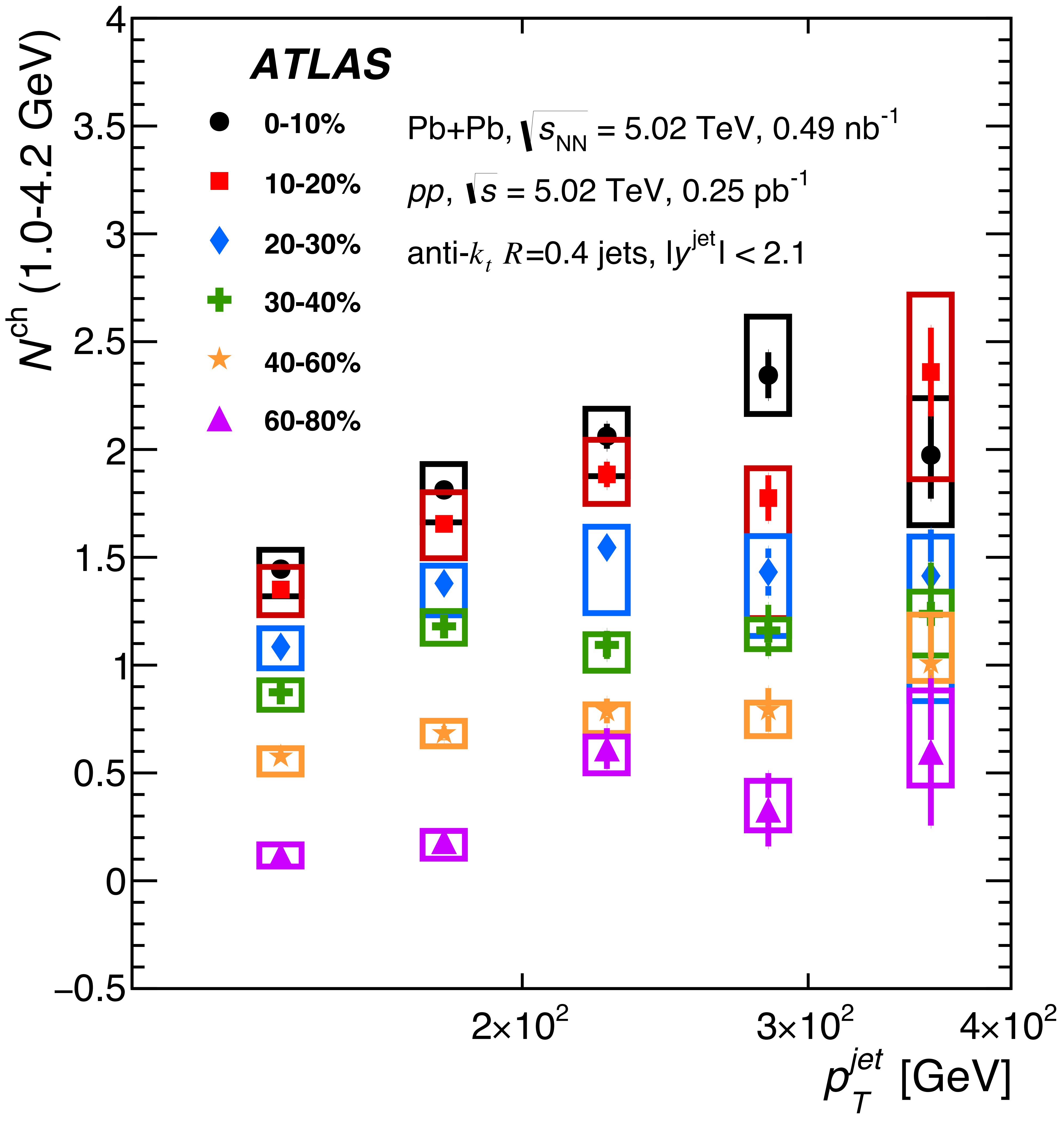
- as a community, much experience with modified jets in AA collisions
- at this conference: many innovate & systematic measurements
- what we need going forward:
  - consistent theory calculations over a wide range of observables and an understanding of what we learn from them
    - great to see the **wealth of theory comparisons** in talks/papers/notes and the **release of JETSCAPE**
  - focus on high quality measurements that are comparable between experiments (now and in the future) and with theory

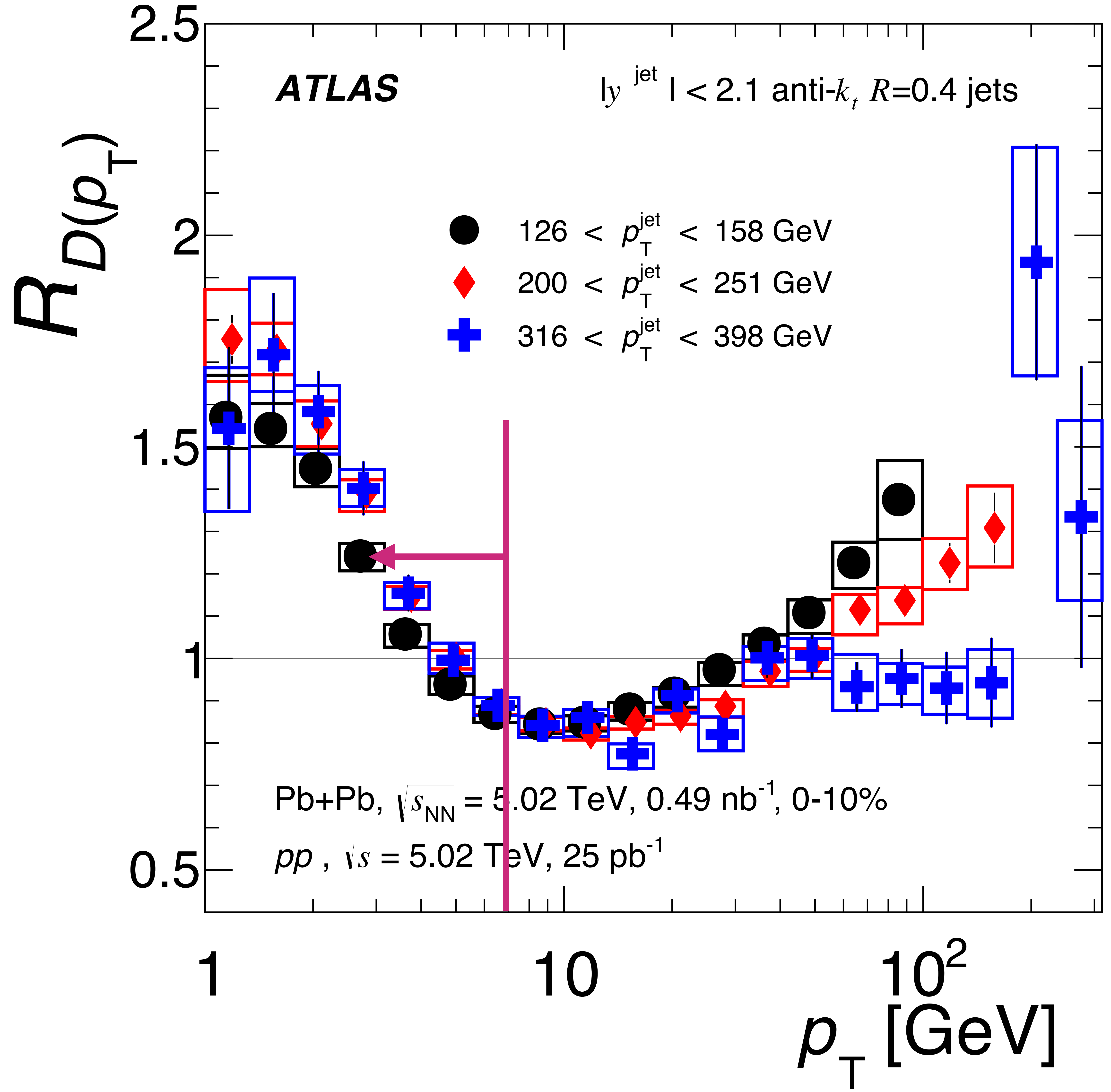
both of these are necessary to make sure that we get the full benefit of the tremendous resources (time and money) that we are putting into heavy ion running over the next decade

backup

ratios of fragmentation functions in PbPb / pp

excess 1-4 GeV particles in PbPb compared to pp





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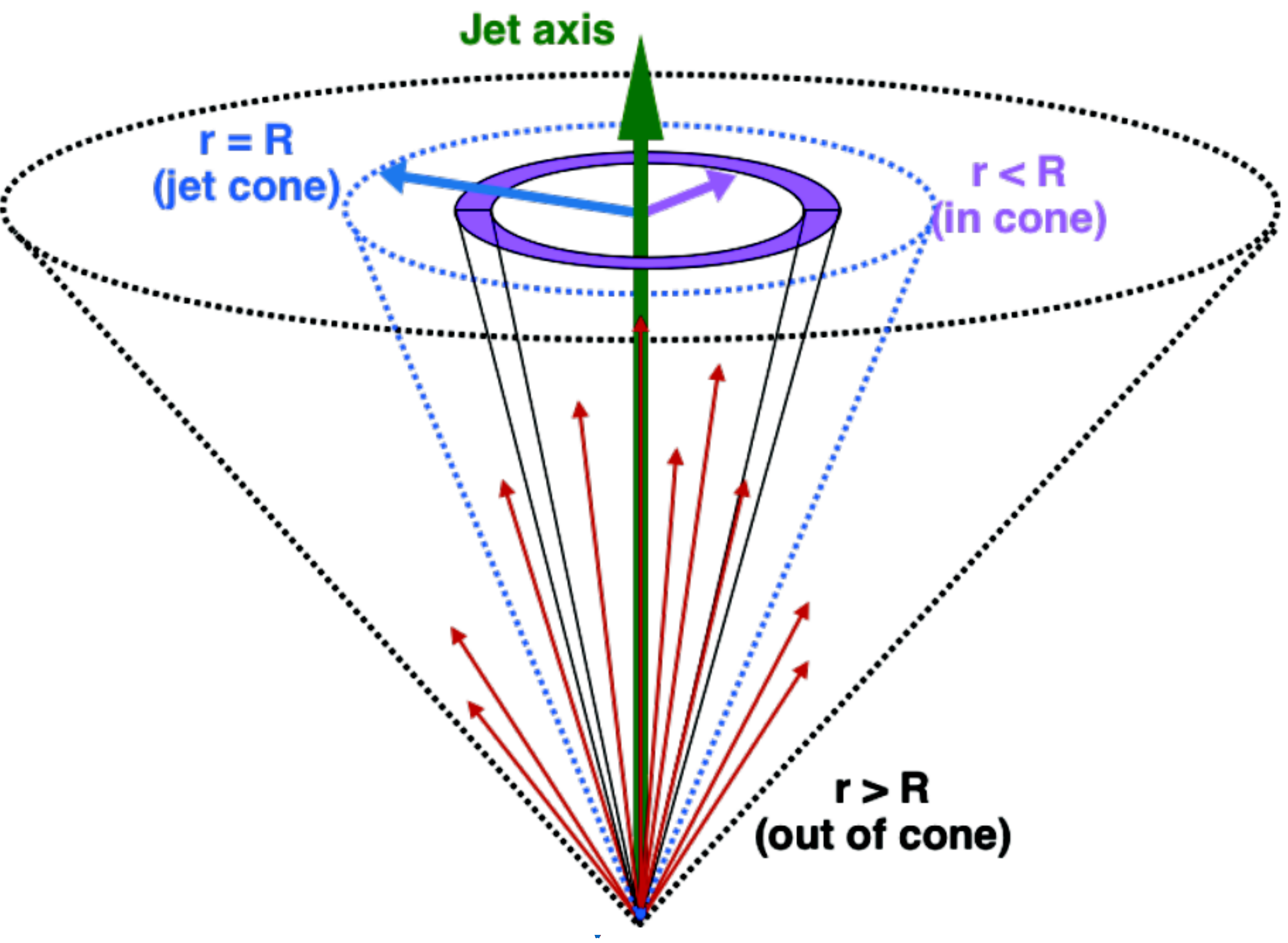

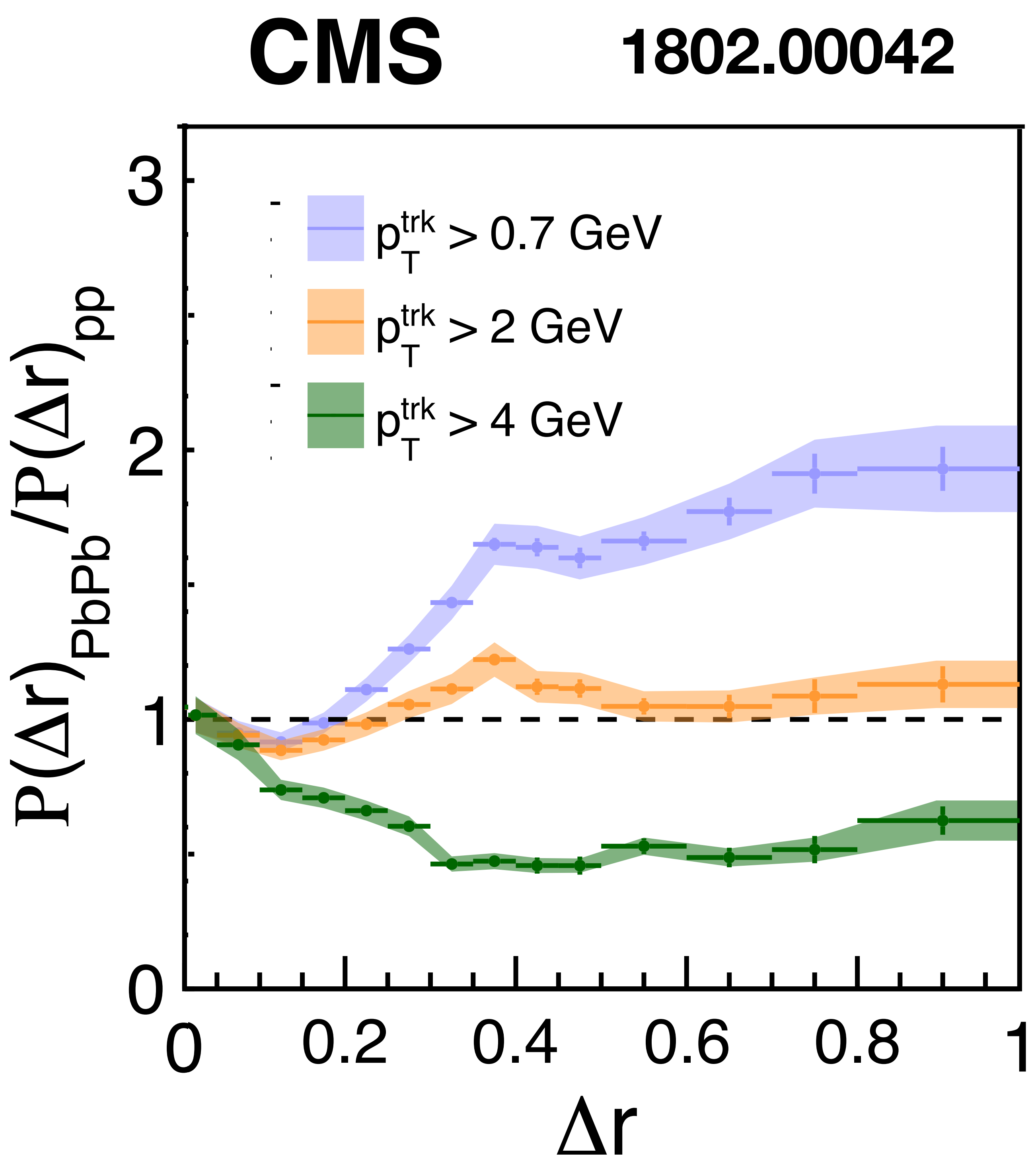

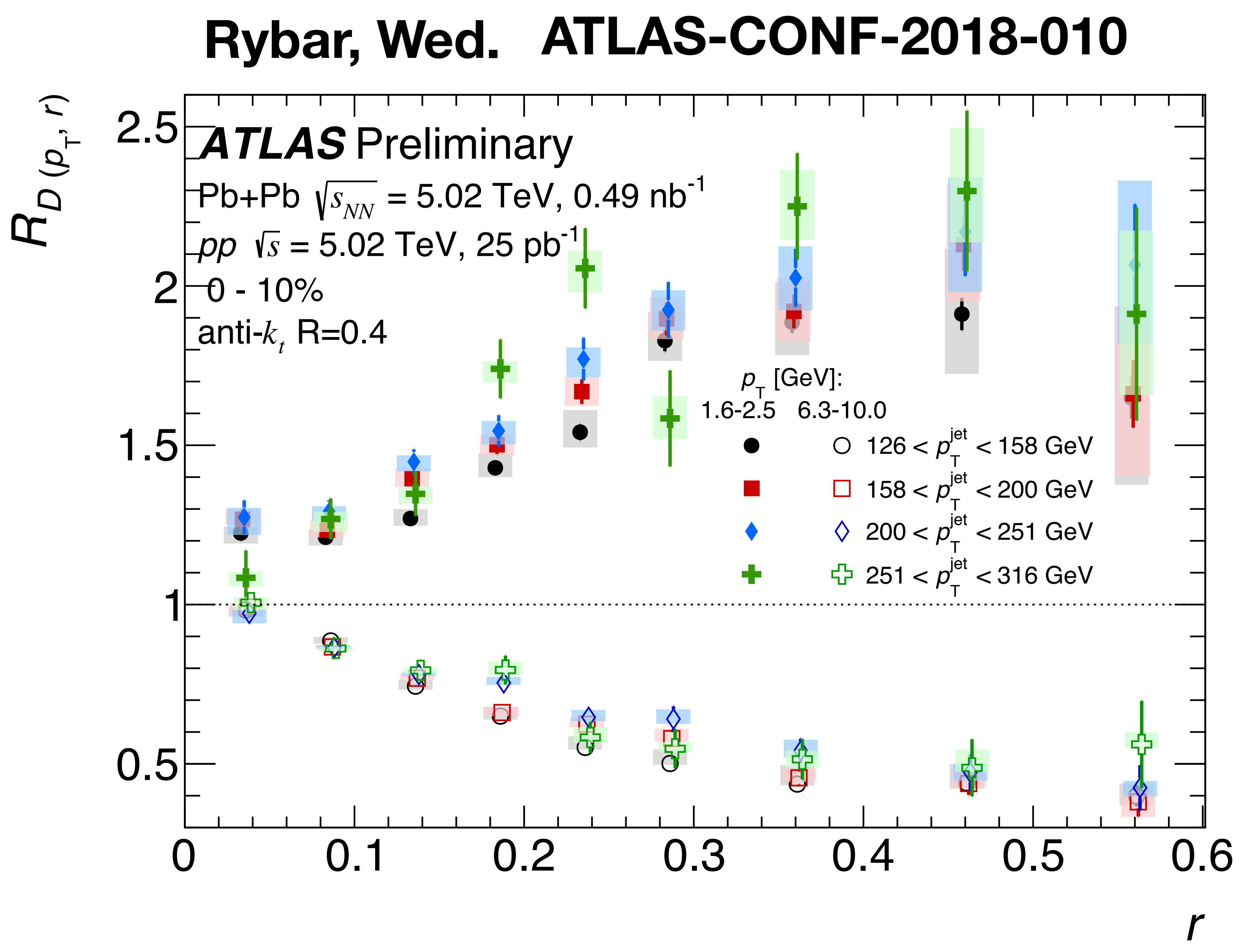

low momentum particles: broad angular distribution which extends far outside the jet