Radius dependent jet quenching measurements from ATLAS

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HION-2024-03/

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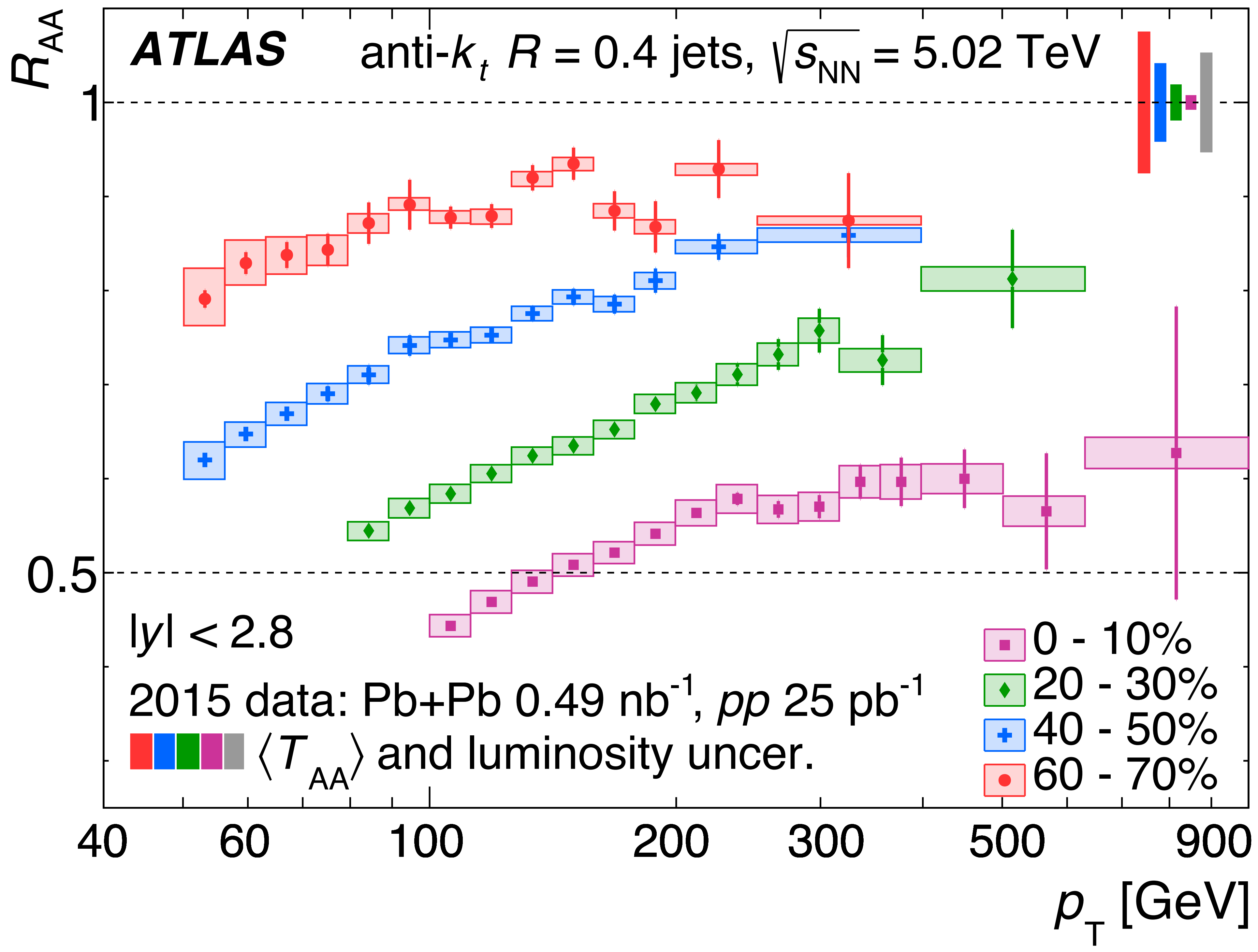
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

PLB 790 (2019) 108



existing, precise, measurements of jet R_{AA} in PbPb collisions

how do we understand the observed suppression in terms of geometry & jet properties?

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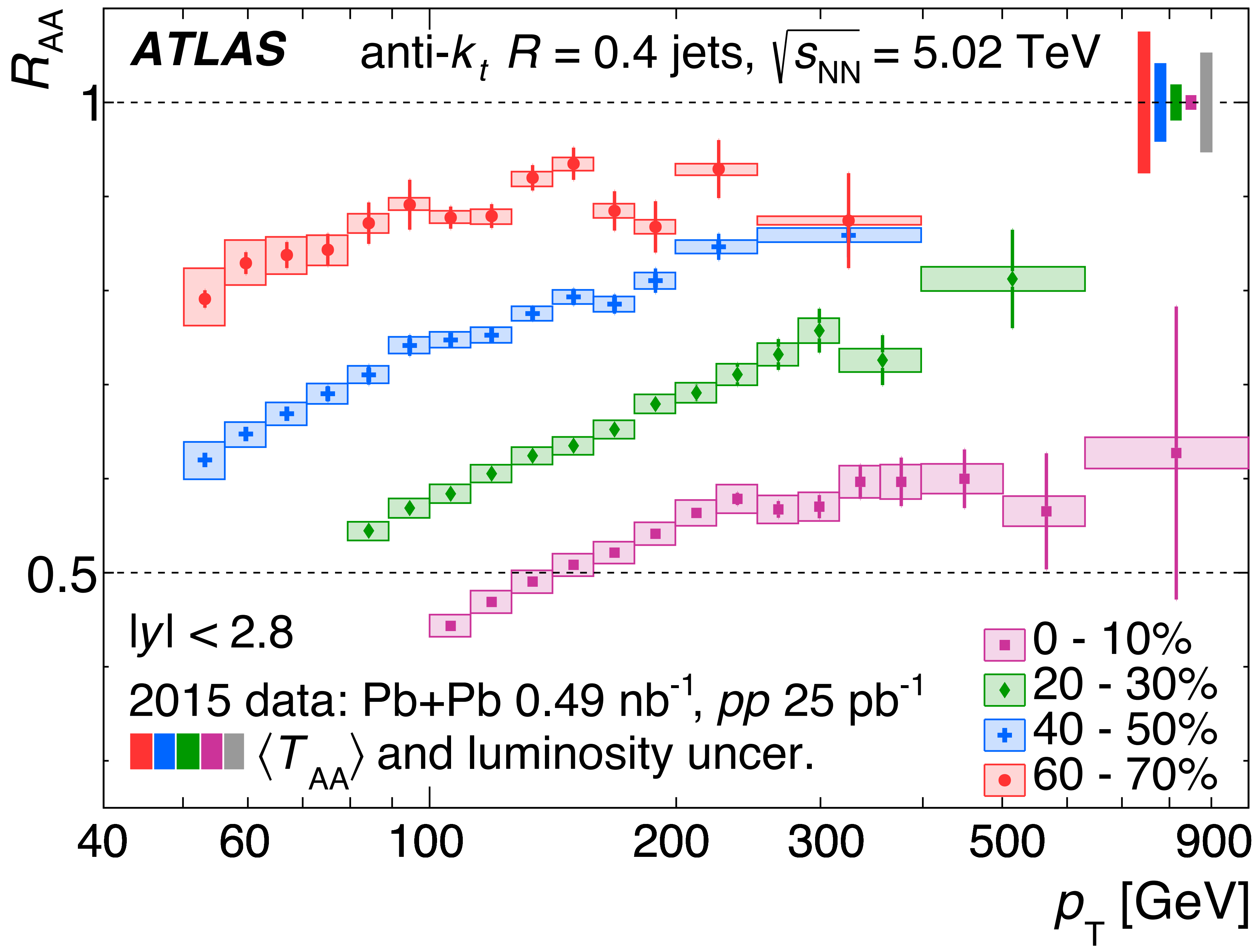

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mass/substructure dependent R_{AA}

M. Rybar (the next talk)

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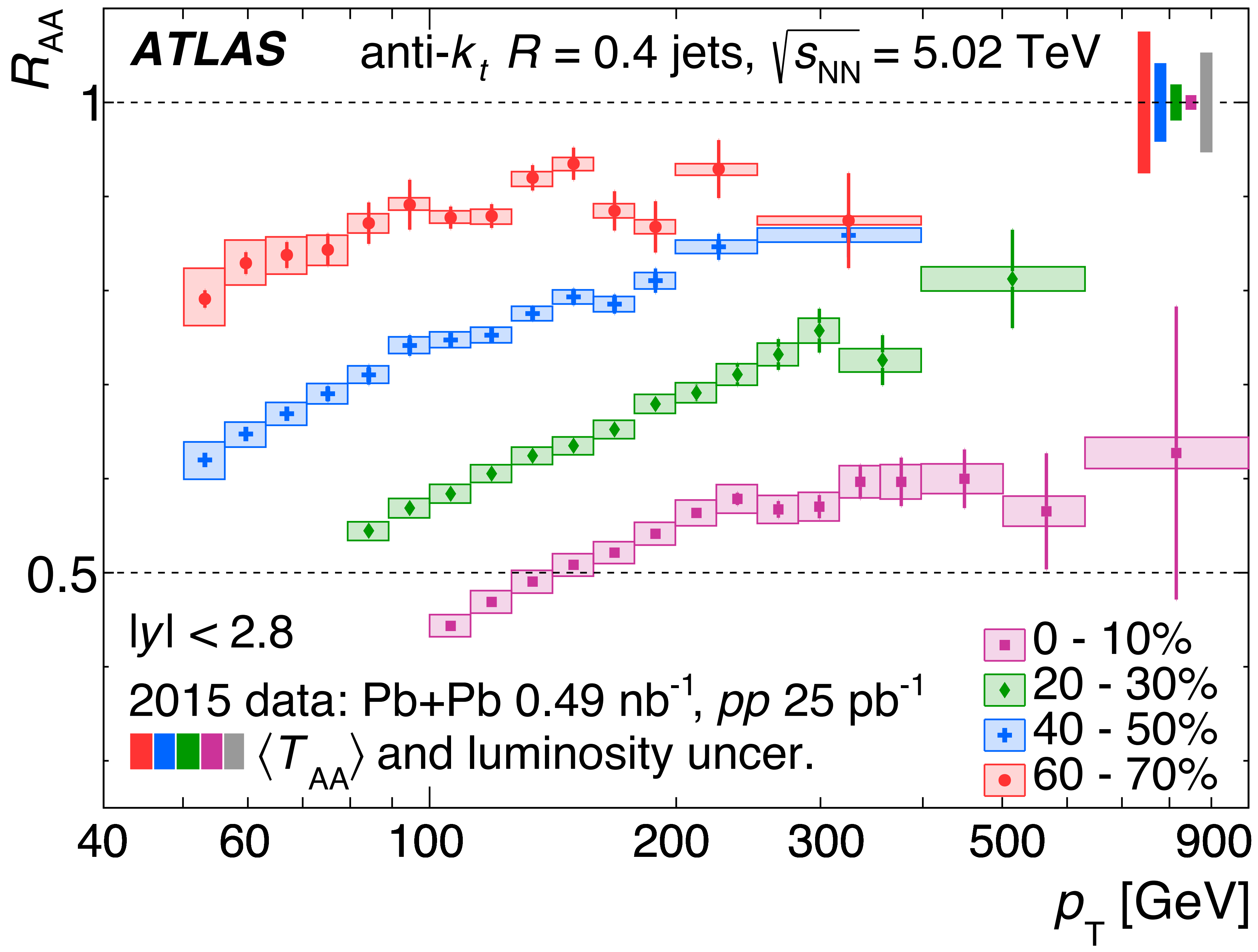


existing, precise, measurements of jet R_{AA} in PbPb collisions

how do we understand the observed suppression in terms of geometry & jet properties?

dijets & jet v_n

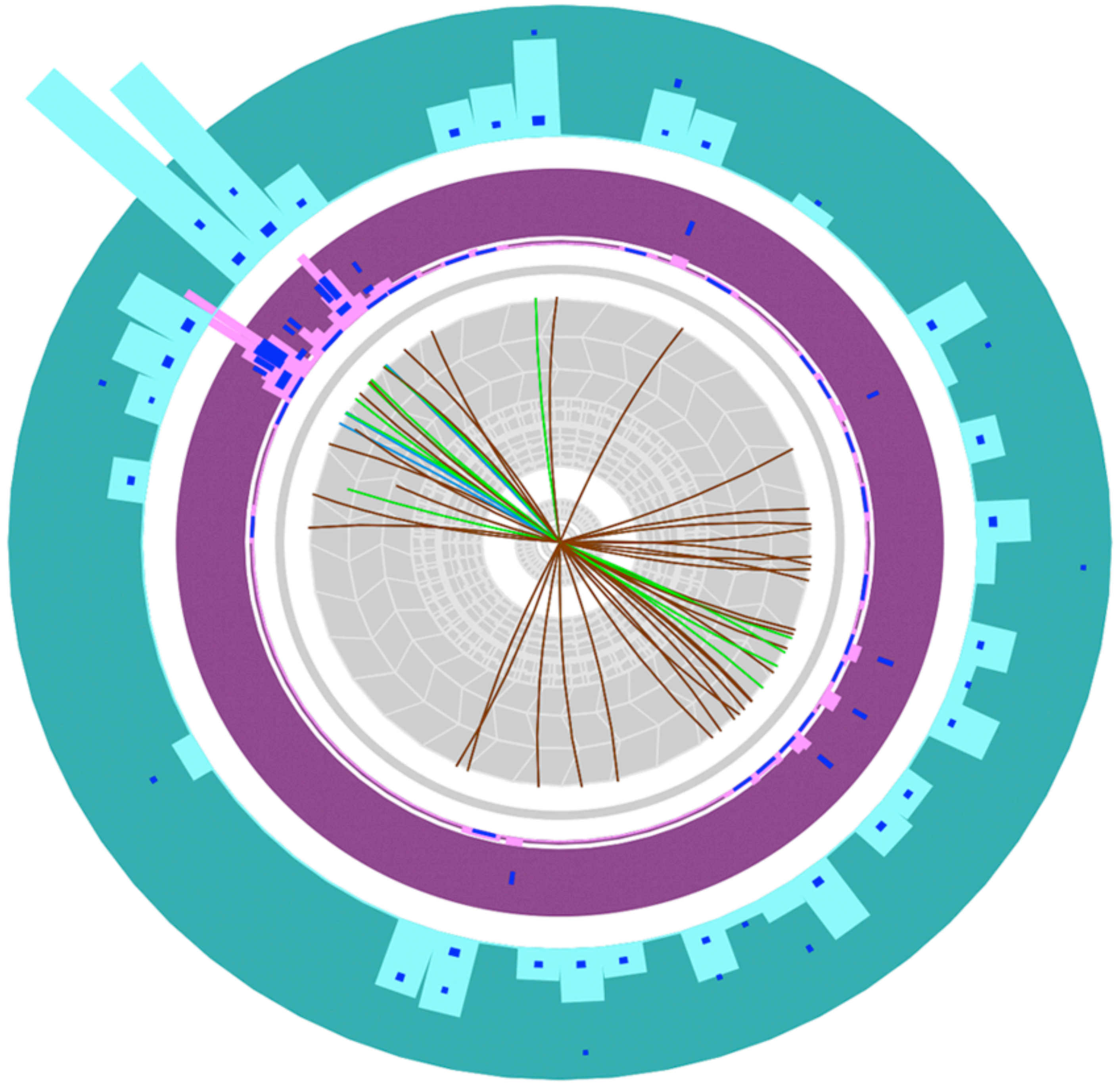
this talk, X. Wang (17:10 Monday), poster A. Romero

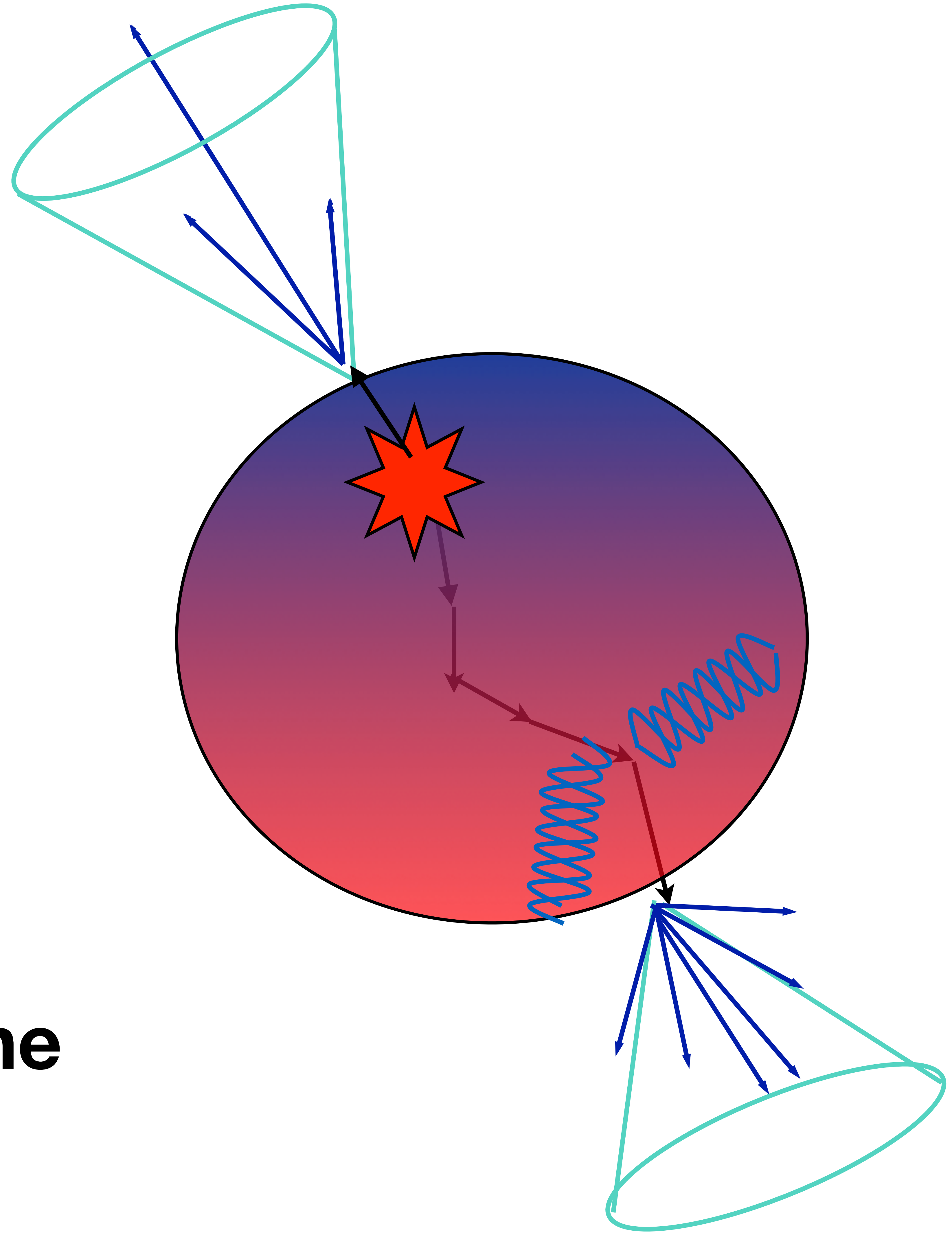
mass/substructure dependent R_{AA}

M. Rybar (the next talk)

dijets

leading jet: very short path length thourgh the QGP, nearly no energy loss

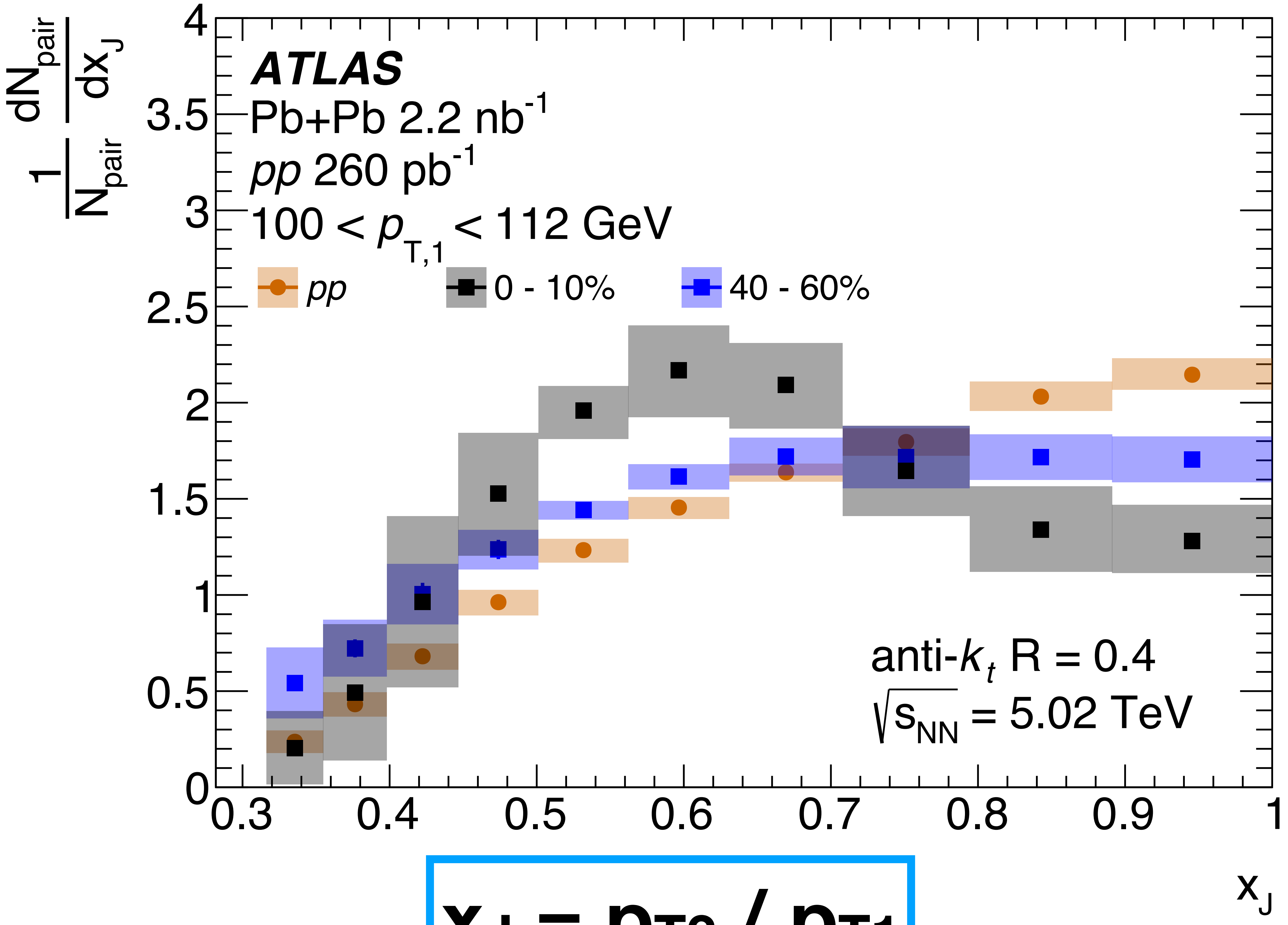




subleading jet: lots of interactions through the QGP, stronger quenching of the jet

new method for studying x_J

$$\frac{1}{N_{\text{pair}}}\frac{dN_{\text{pair}}}{dx_J}.$$ **area normalization**



$x_J = p_{T2} / p_{T1}$

2205.00682

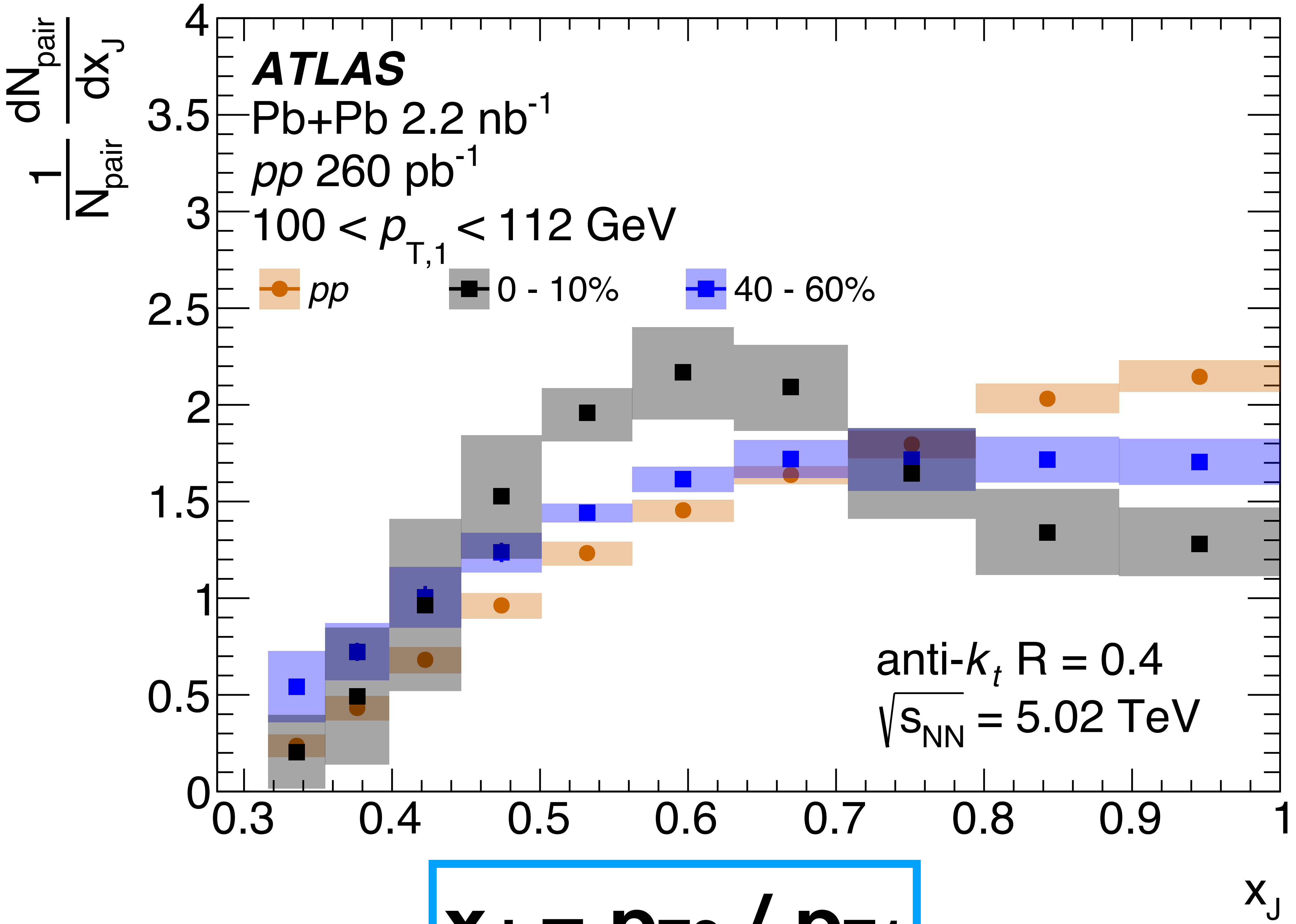
new method for studying x_J

$$\frac{1}{N_{\text{pair}}}\frac{dN_{\text{pair}}}{dx_J}$$

area normalization

$$\frac{1}{\langle T_{AA}\rangle N_{\text{evt}}^{AA}}\frac{dN_{\text{pair}}^{AA}}{dx_J}$$

absolute normalization



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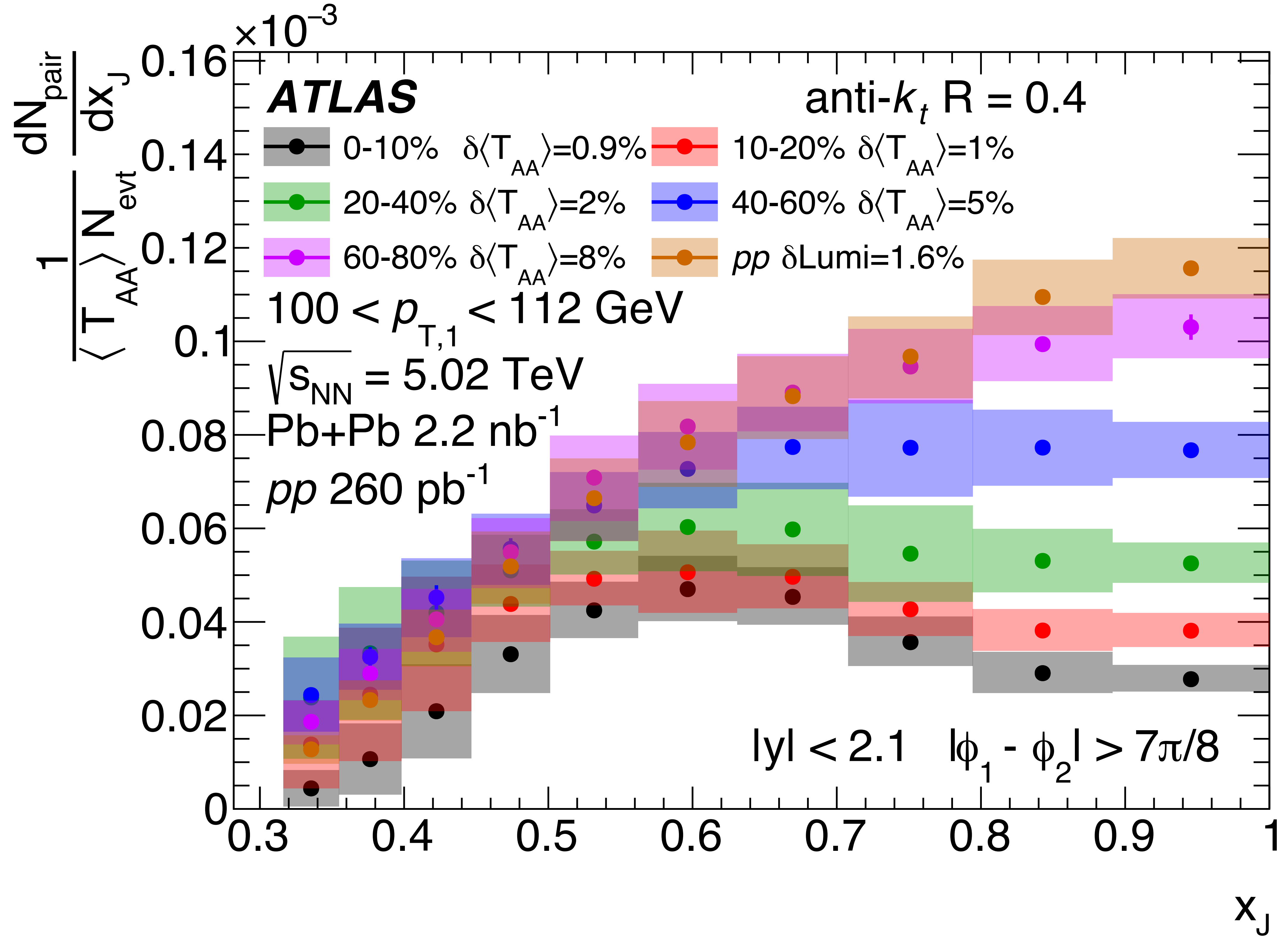

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new method for studying x_J

$\frac{1}{N_{\text{pair}}}\frac{dN_{\text{pair}}}{dx_J}$ **area normalization**

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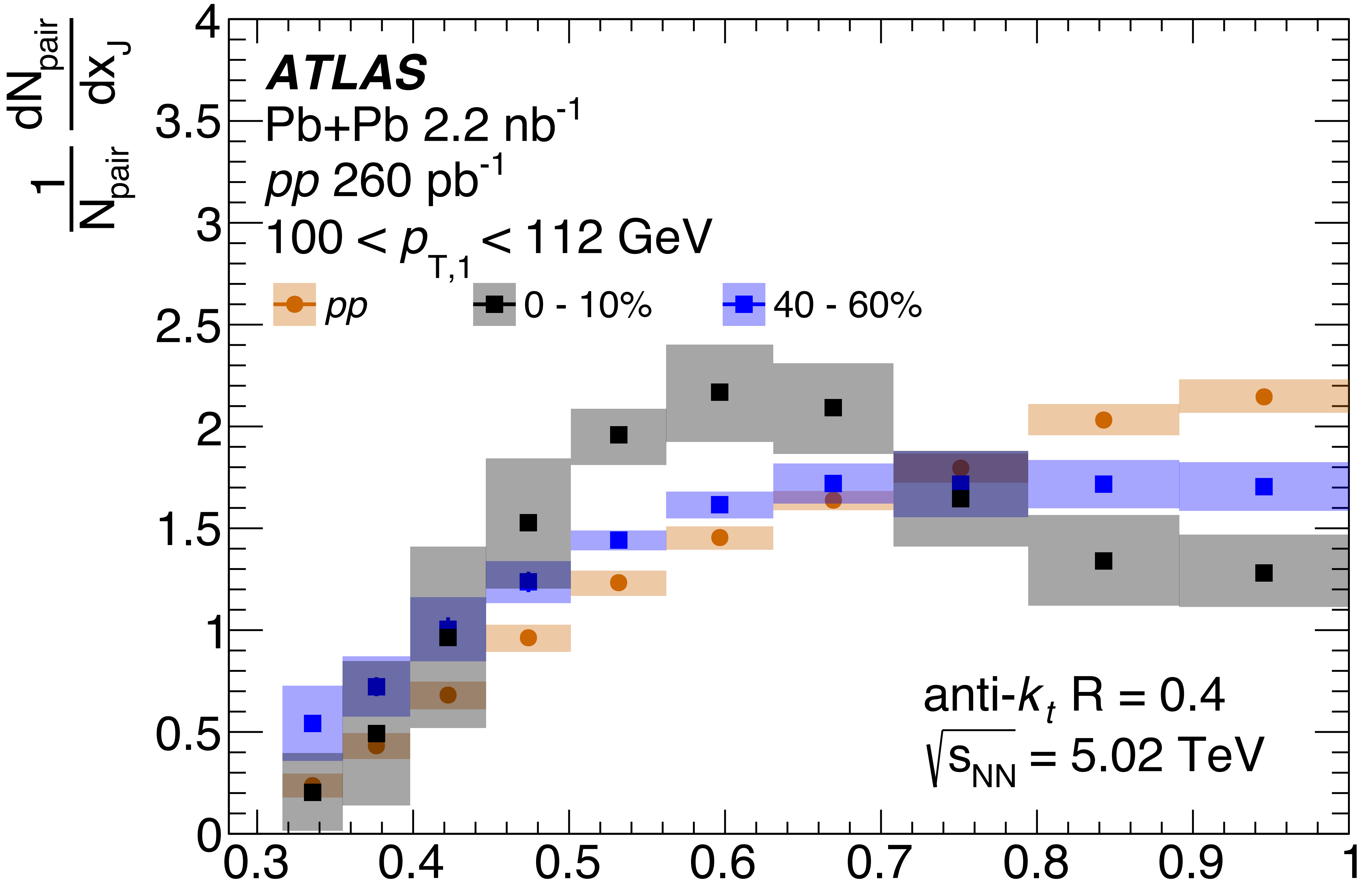

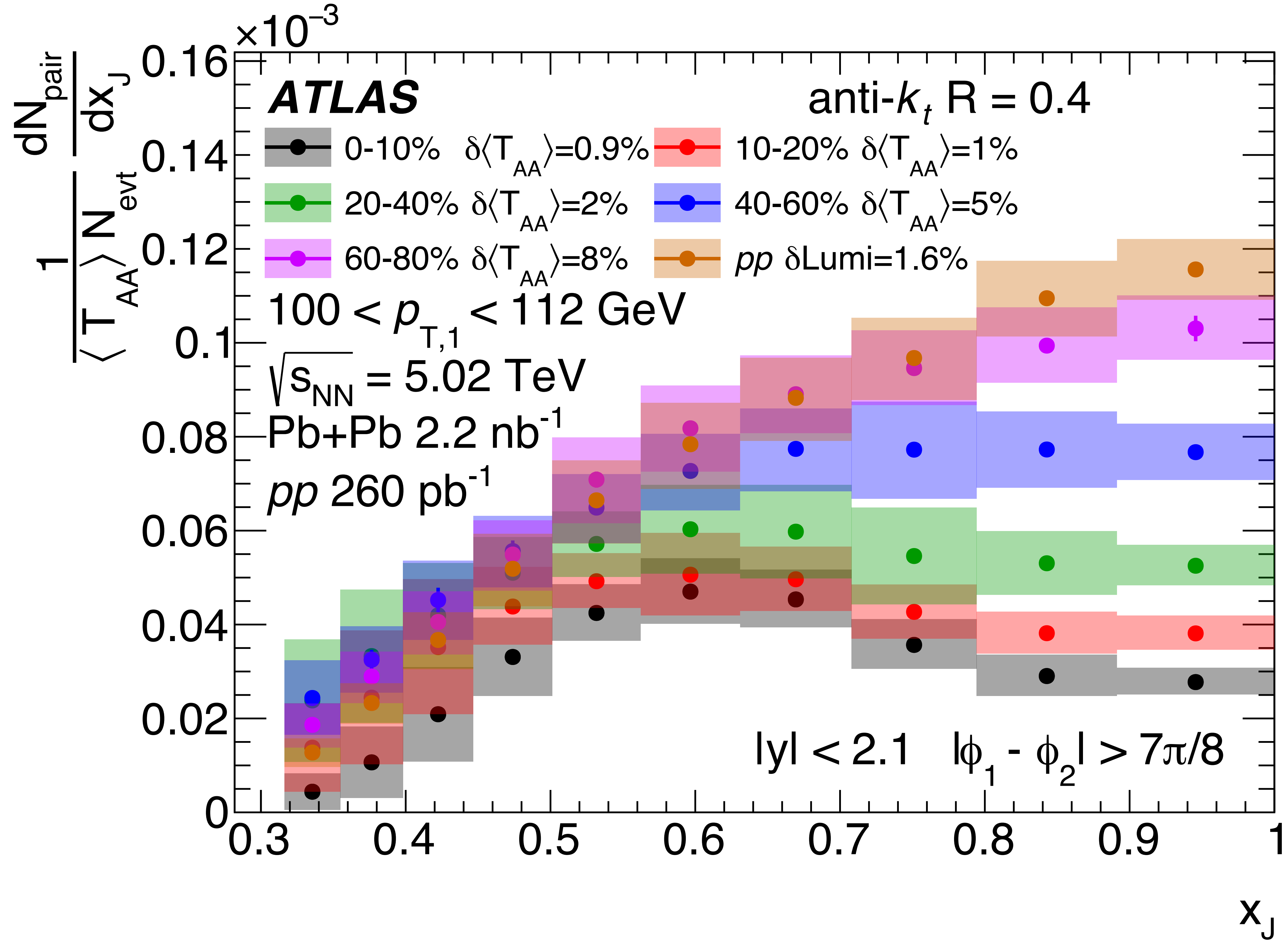

$x_J = p_{T2} / p_{T1}$

absolutely normalized distributions show that *balanced* jets are preferentially suppressed

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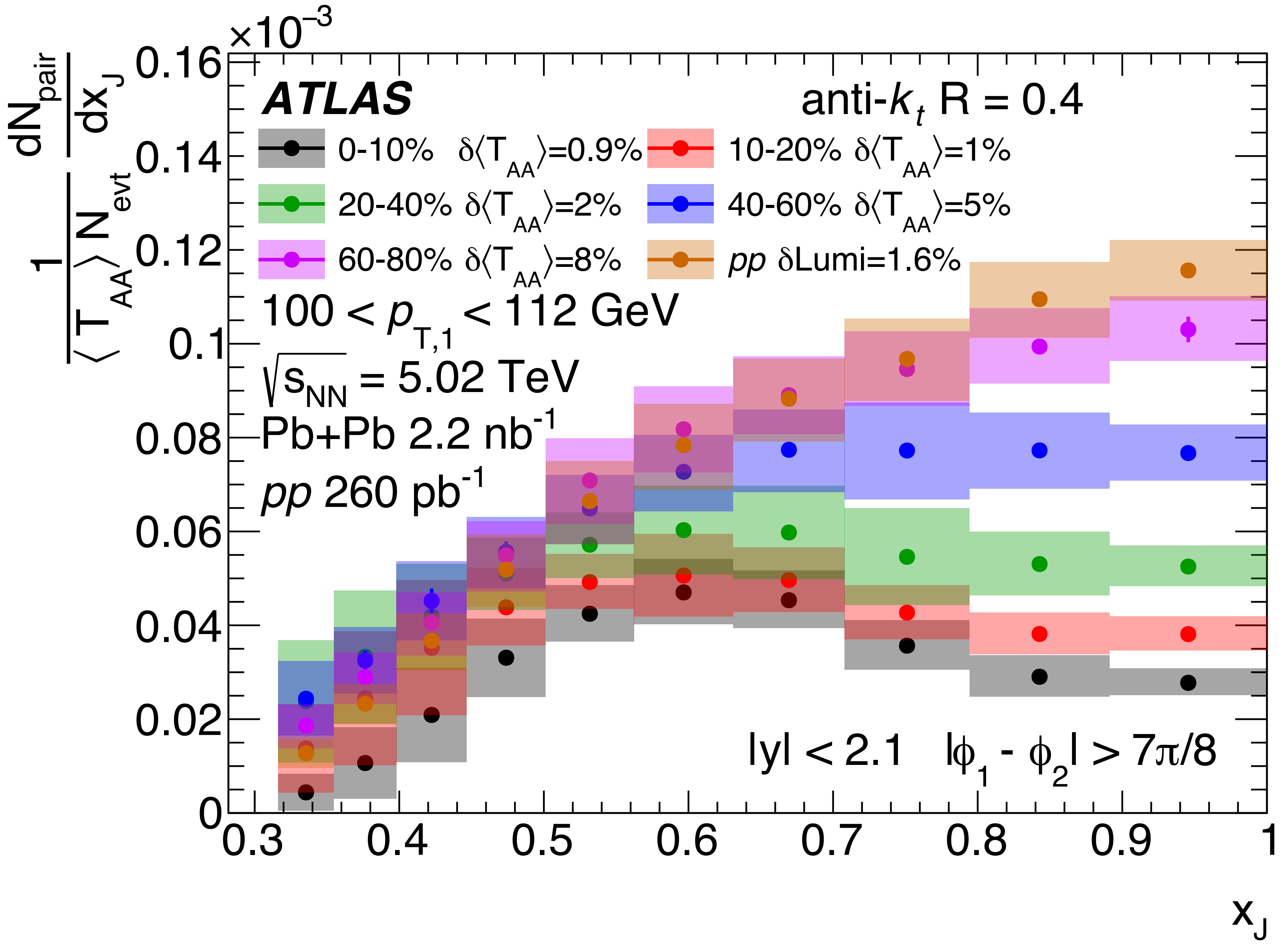
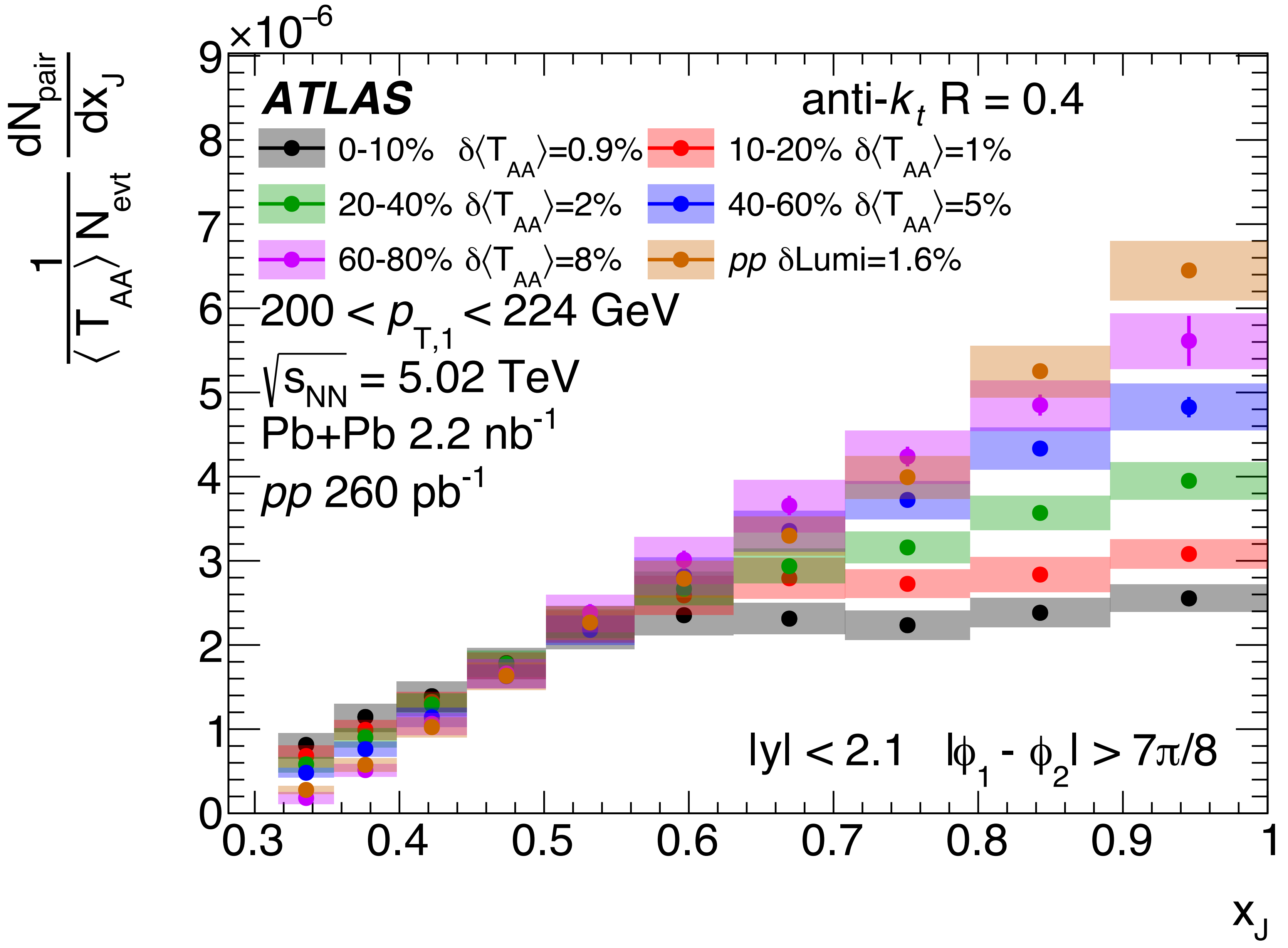
suppression of balanced dijets

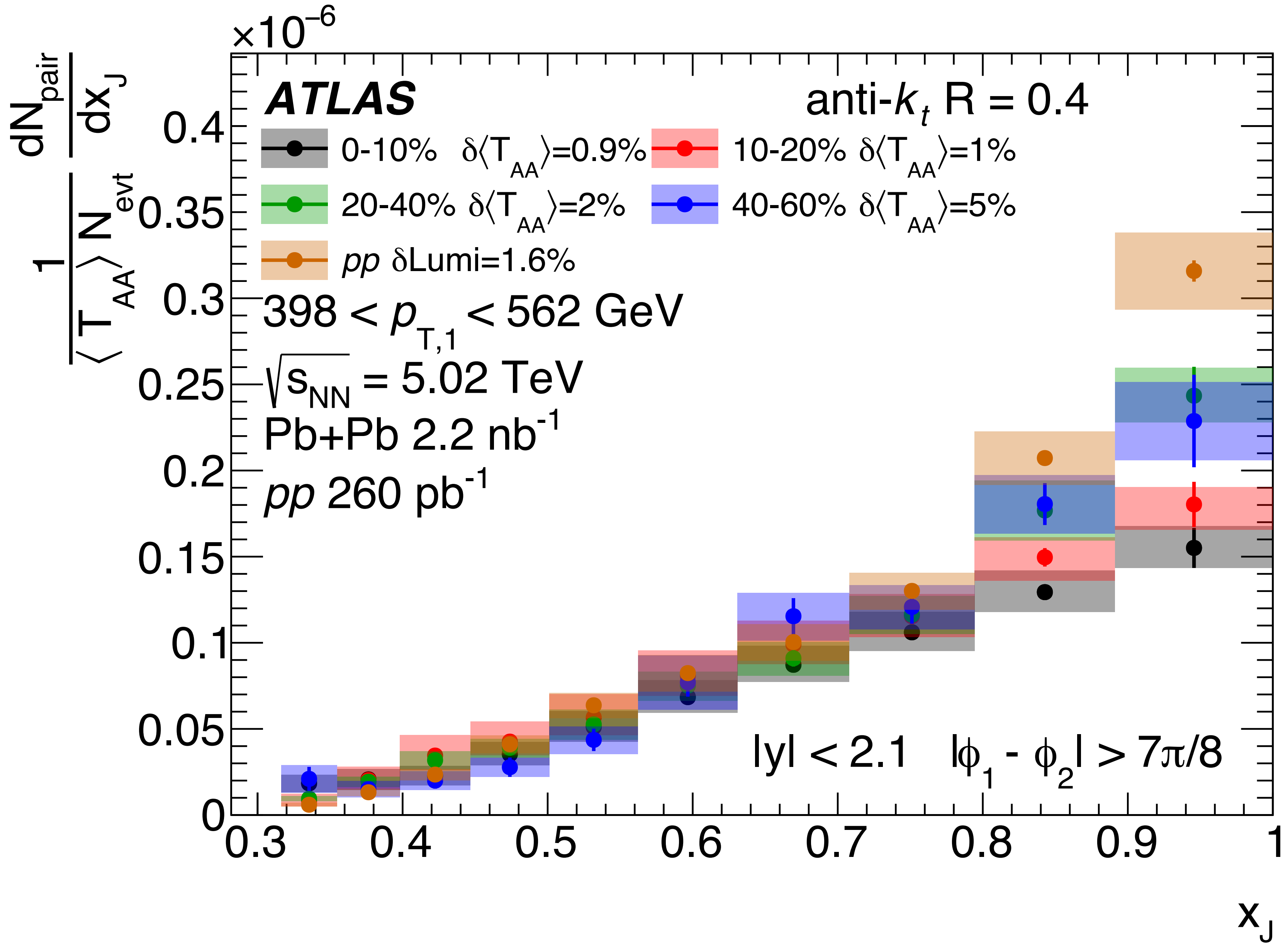
100 < pT1 < 112 GeV



200 < pT1 < 224 GeV



398 < pT1 < 562 GeV



suppression of both jets important!

2205.00682

how do the conclusions about dijets depend on the jet radius?

- do the exact same analysis as for the R = 0.4 jets (2205.00682) for R = 0.2, 0.3, 0.4, 0.5, 0.6 jets
- leading dijets, required to have:
  - $|\Delta\phi| > 7\pi/8$
  - $|y_{jet}| < 2.1$
  - $p_{T2}/p_{T1} > 0.32$
- remember: not all jets at a given p_T are part of a leading dijet
  - jets which are not part of a leading dijet that meets our criteria are excluded from the analysis

arXiv:2407.18796

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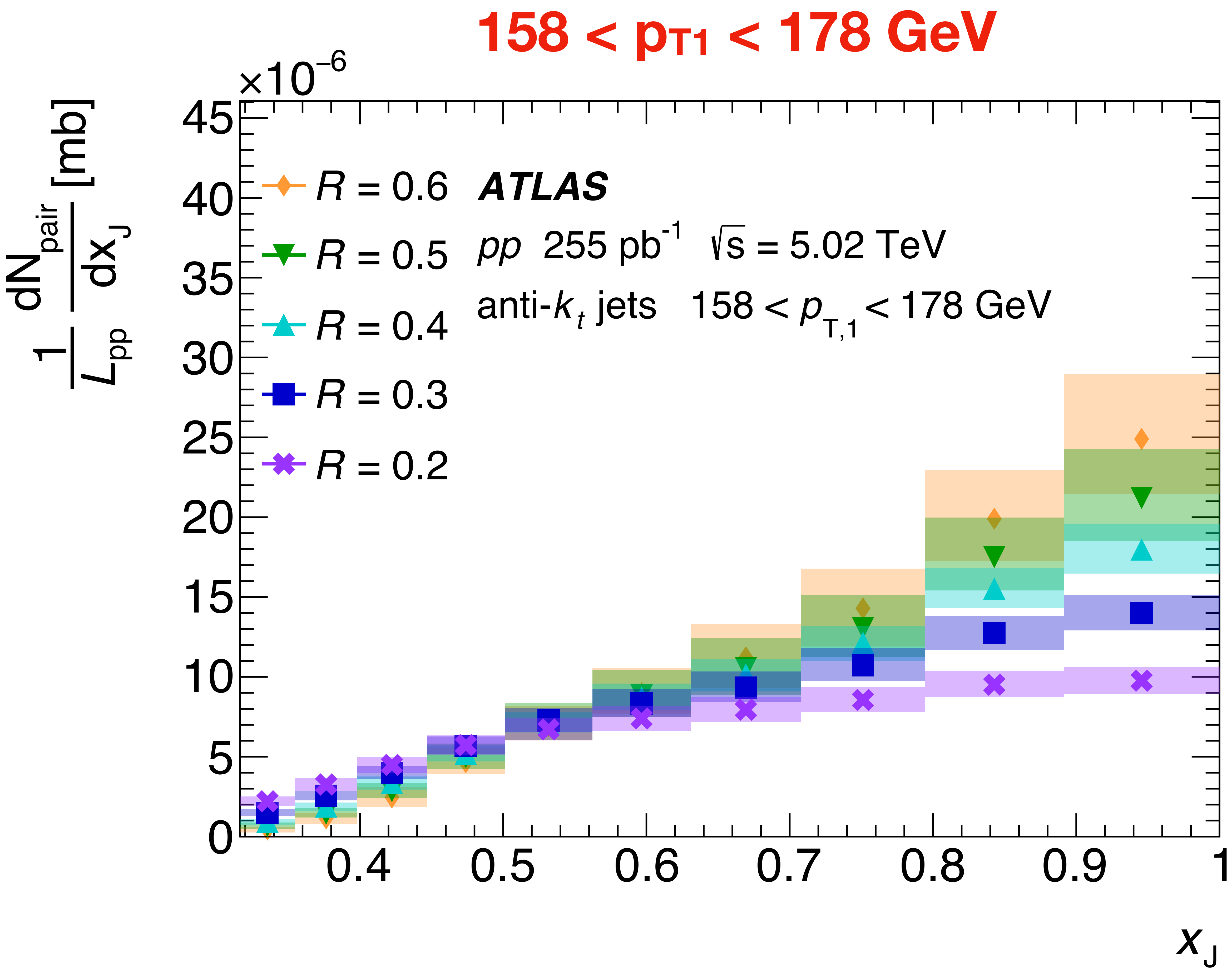
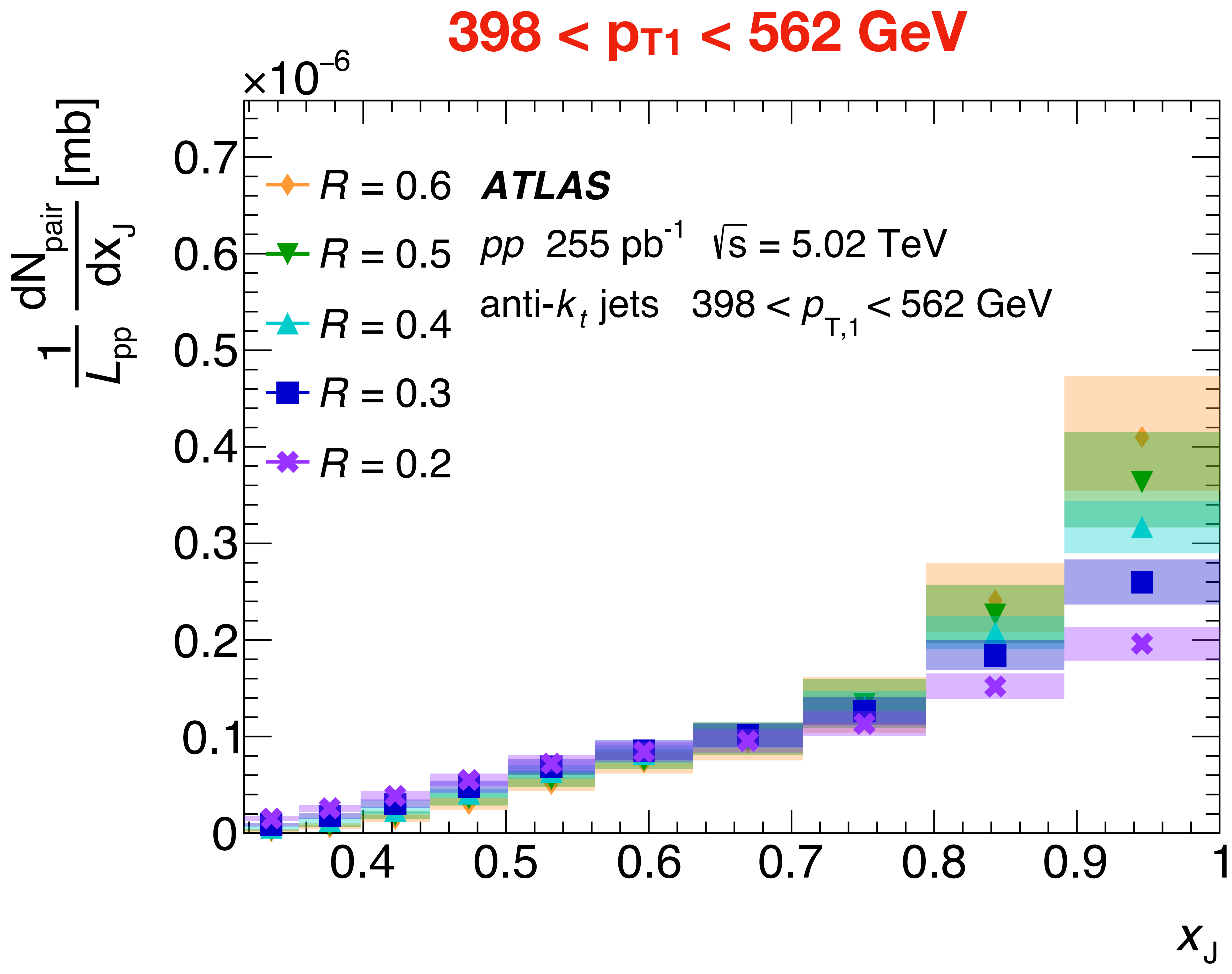
dijets in pp collisions





increasing jet radius leads to increasing fraction of balanced jets (in good agreement with pythia/herwig)

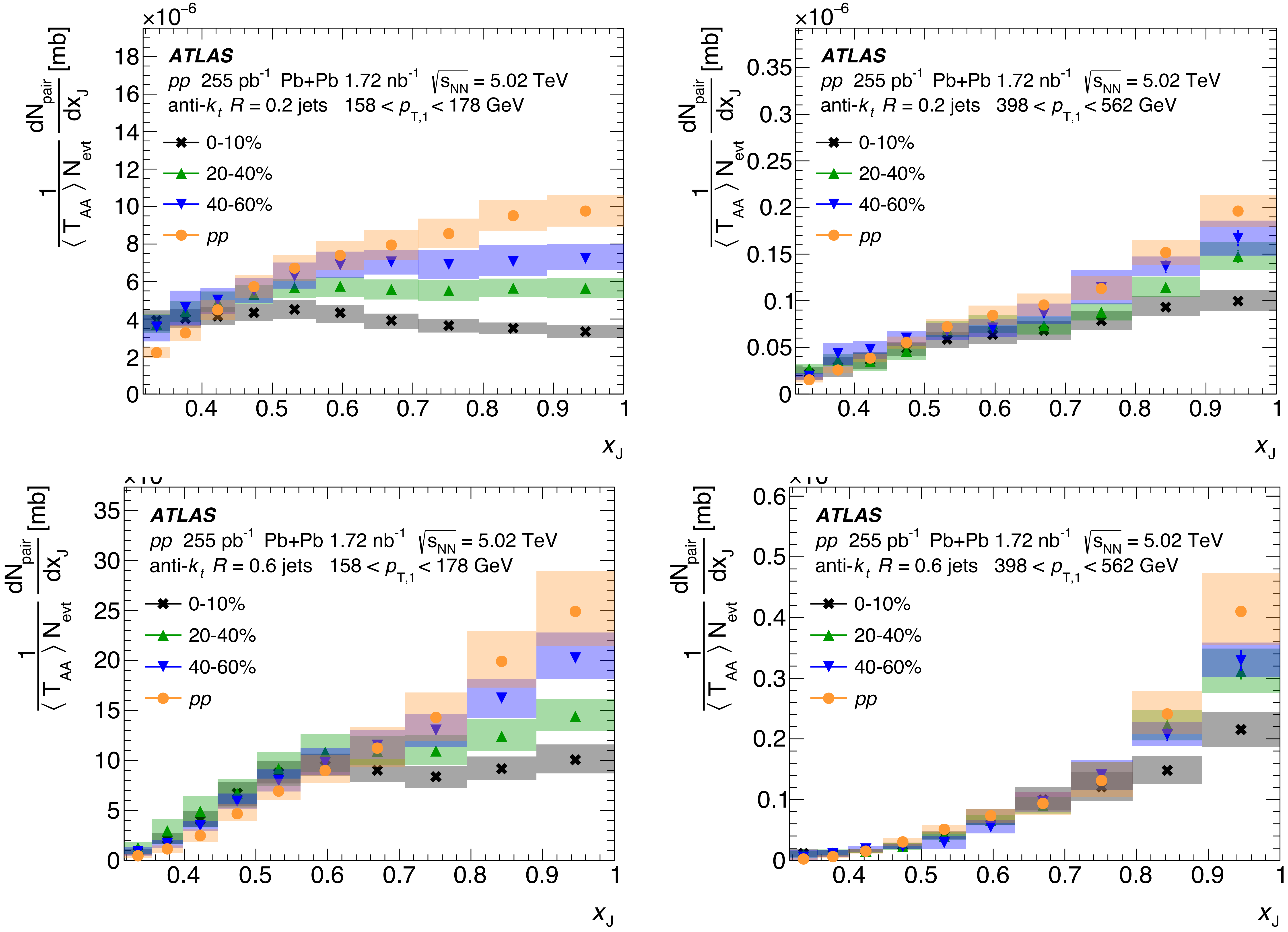
R-dep. of dijet imbalance

$p_{T,1}$: 158 - 178 GeV

$p_{T,1}$: 398 - 562 GeV

R = 0.2

R = 0.6



- balanced dijets are preferentially suppressed for 0.2 < R < 0.6 jets
- much smaller modifications for imbalanced jets

arXiv:2407.18796

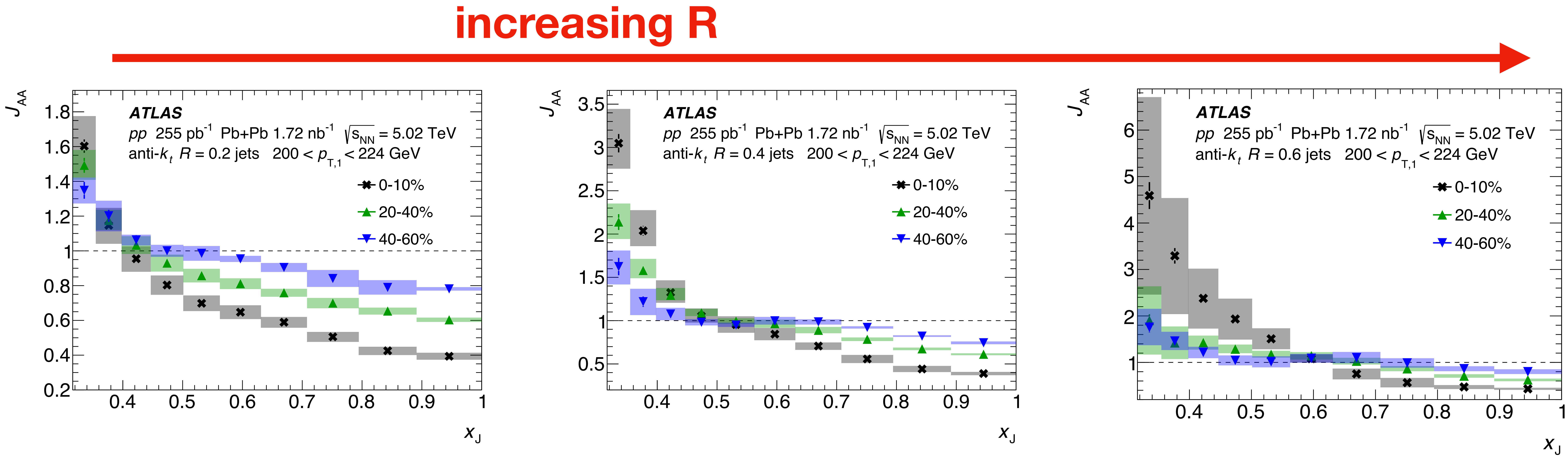
poster: Anabel Romero

how does this suppression change with x_J?

J_{AA}

$$J_{AA} \equiv \frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}} \frac{dN_{pair}^{AA}}{dx_J} \Bigg/ \left(\frac{1}{L_{pp}} \frac{dN_{pair}^{pp}}{dx_J} \right)$$

J_{AA} compares the modification of the absolutely normalized xJ distributions in PbPb collisions



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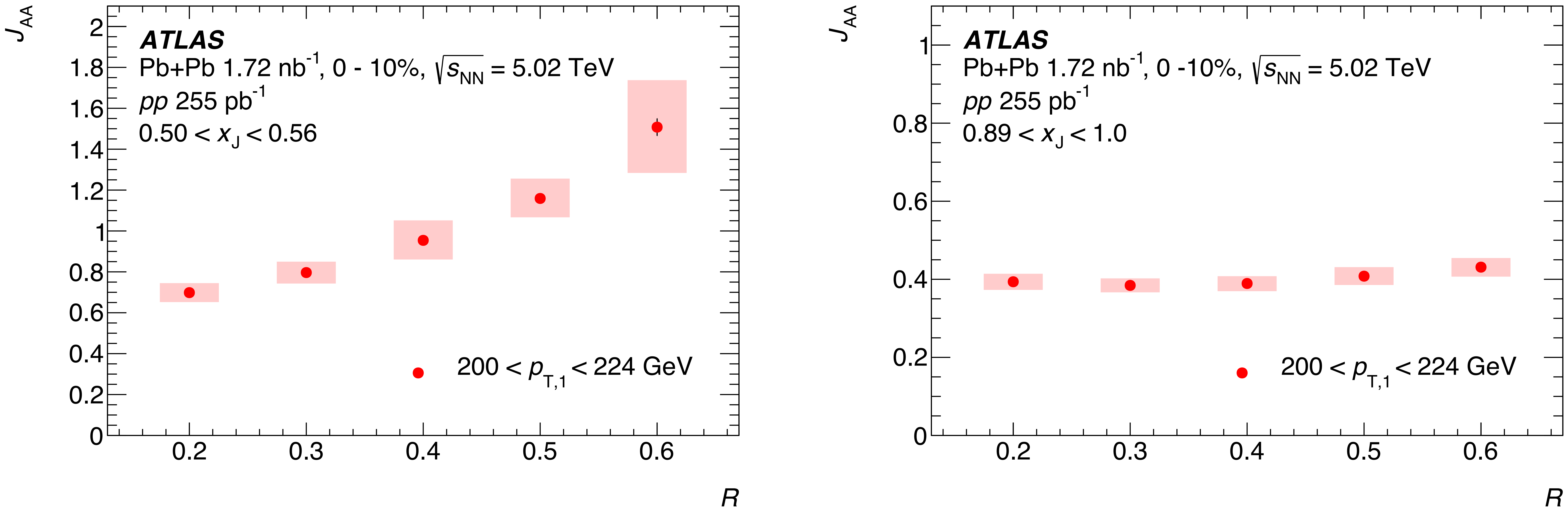
x_J-dependent dijet suppression

$$J_{AA} \equiv \frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}} \frac{dN_{pair}^{AA}}{dx_J} \Bigg/ \left(\frac{1}{L_{pp}} \frac{dN_{pair}^{pp}}{dx_J}\right).$$

R dependent suppression only seen for low-x_J values

balanced jet suppression independent of R



$0.50 < x_J < 0.56$ $0.89 < x_J < 1.0$

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dijet yields integrated over x_J

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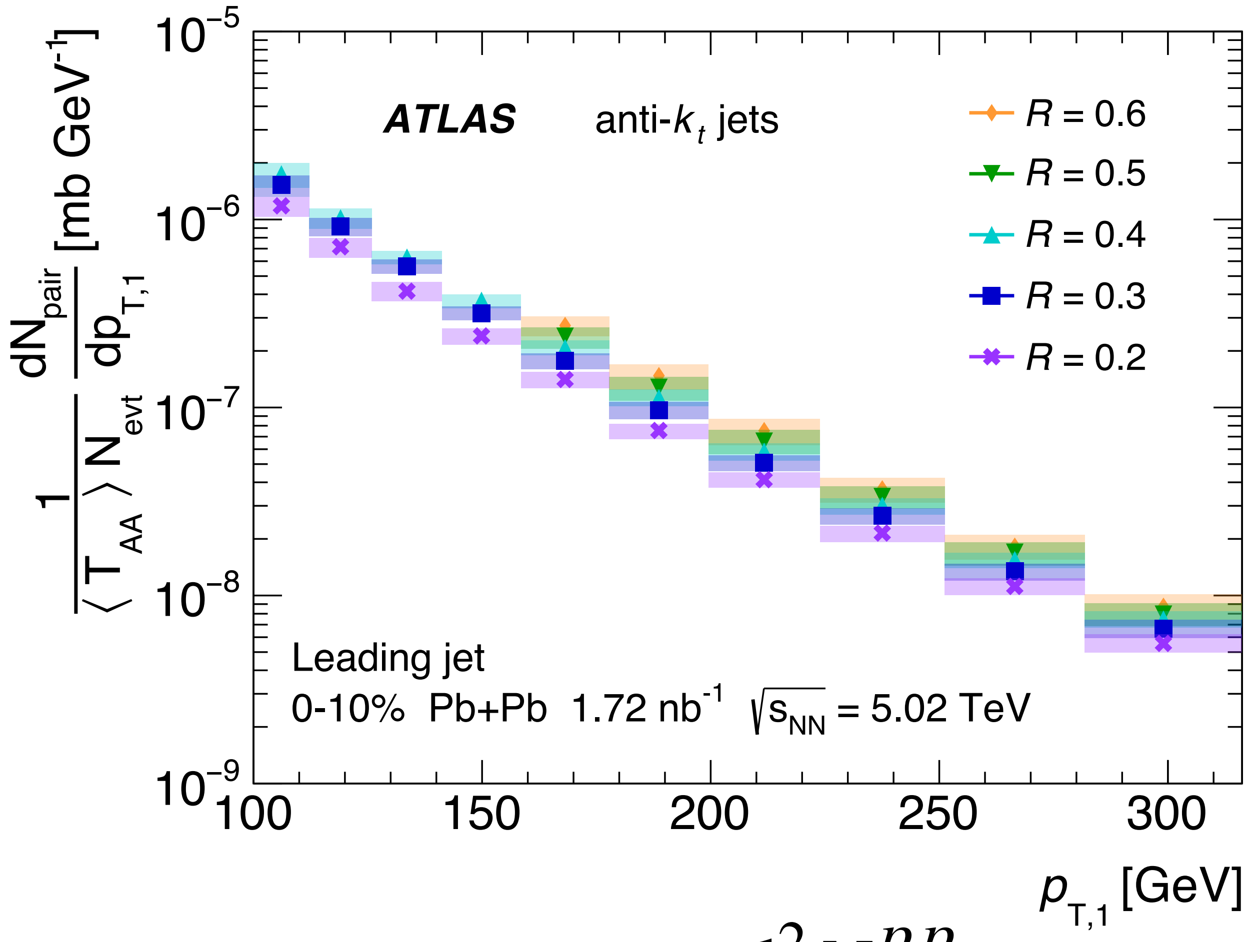
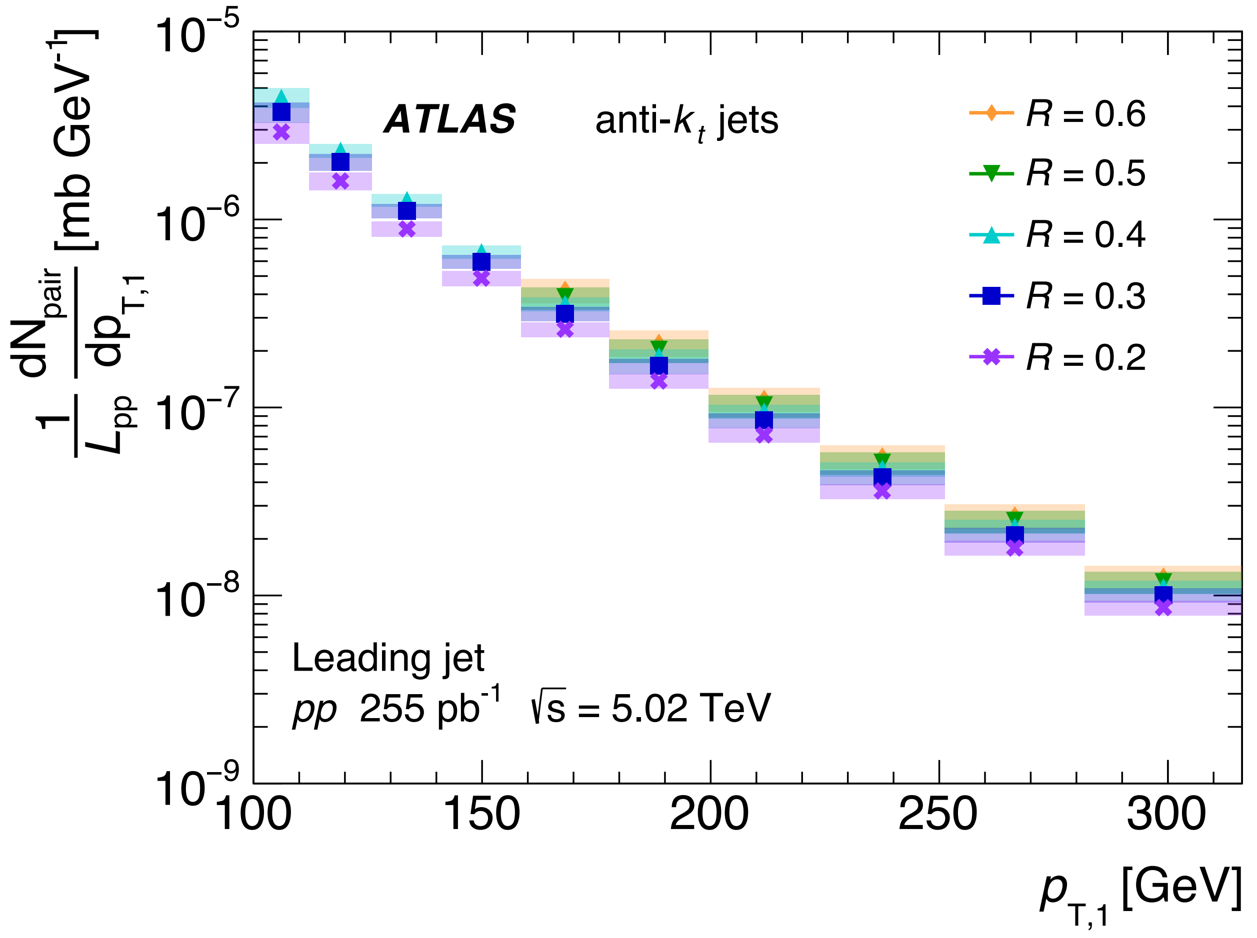
dijet yields

$$\frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}}\int_{0.32\times p_{T,1}}^{p_{T,1}}\frac{d^2N_{pair}^{AA}}{dp_{T,1}dp_{T,2}}dp_{T,2}$$



$$\frac{1}{L_{pp}}\int_{0.32\times p_{T,1}}^{p_{T,1}}\frac{d^2N_{pair}^{pp}}{dp_{T,1}dp_{T,2}}dp_{T,2}$$



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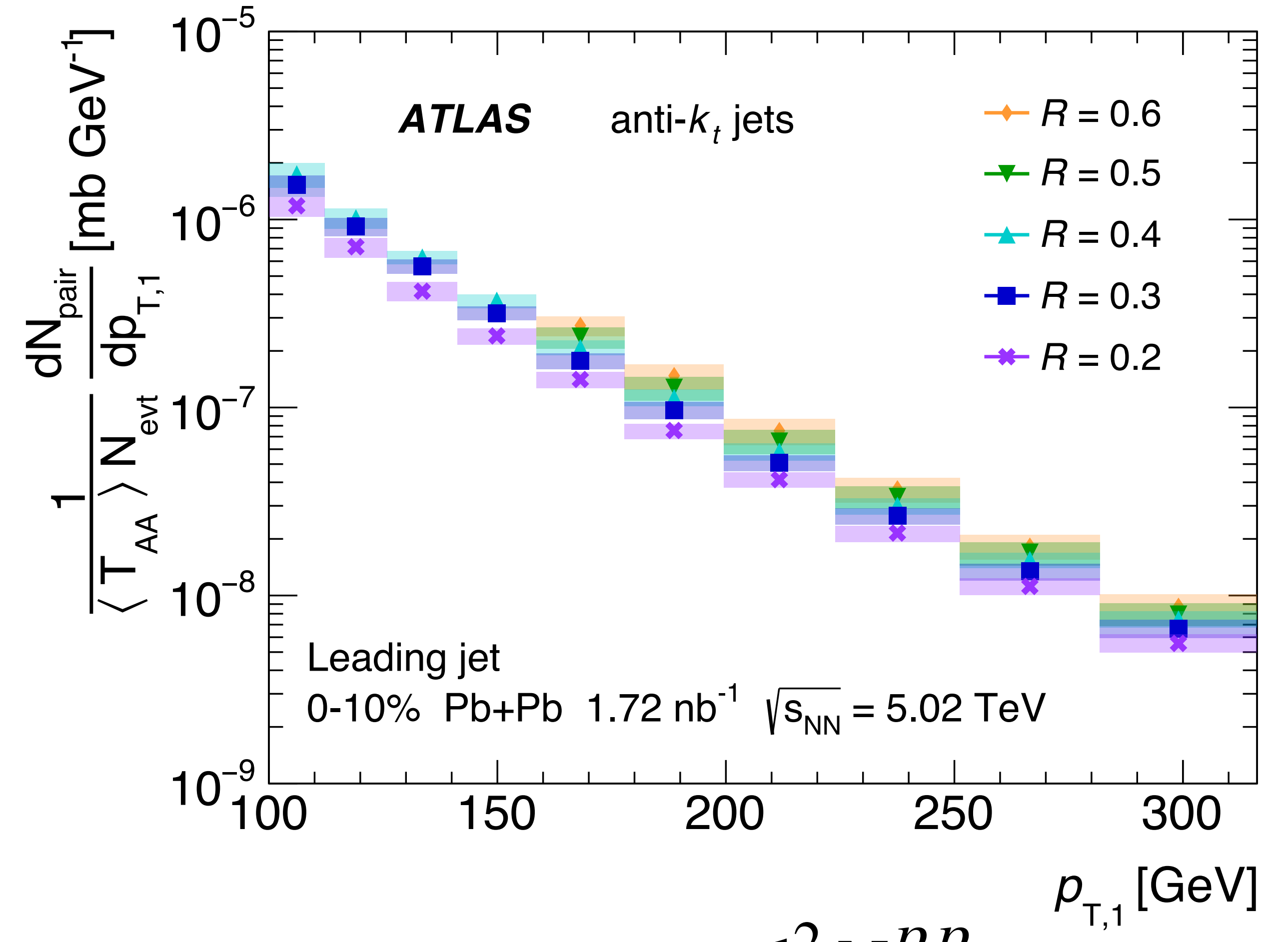

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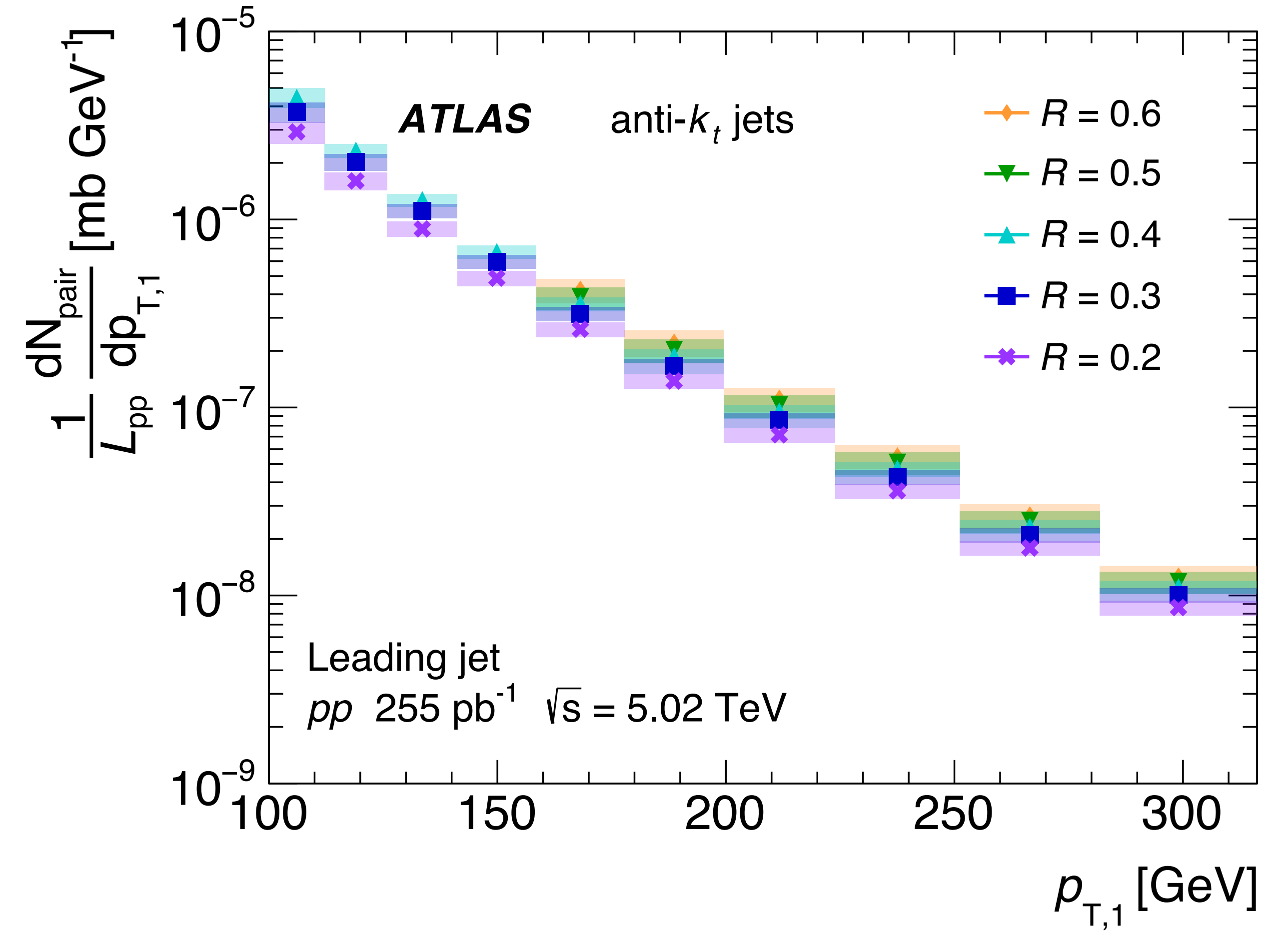

integrate over p_{T2} from $0.32 < x_J < 1.0$ → dijet yields as a function of p_{T1} (swapping indices of course works too)

$$R_{AA}^{pair}(p_{T,1}) = \frac{\frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}} \int_{0.32\times p_{T,1}}^{p_{T,1}} \frac{d^2 N_{pair}^{AA}}{dp_{T,1} dp_{T,2}} dp_{T,2}}{\frac{1}{L_{pp}} \int_{0.32\times p_{T,1}}^{p_{T,1}} \frac{d^2 N_{pair}^{pp}}{dp_{T,1} dp_{T,2}} dp_{T,2}}$$

dijet yields

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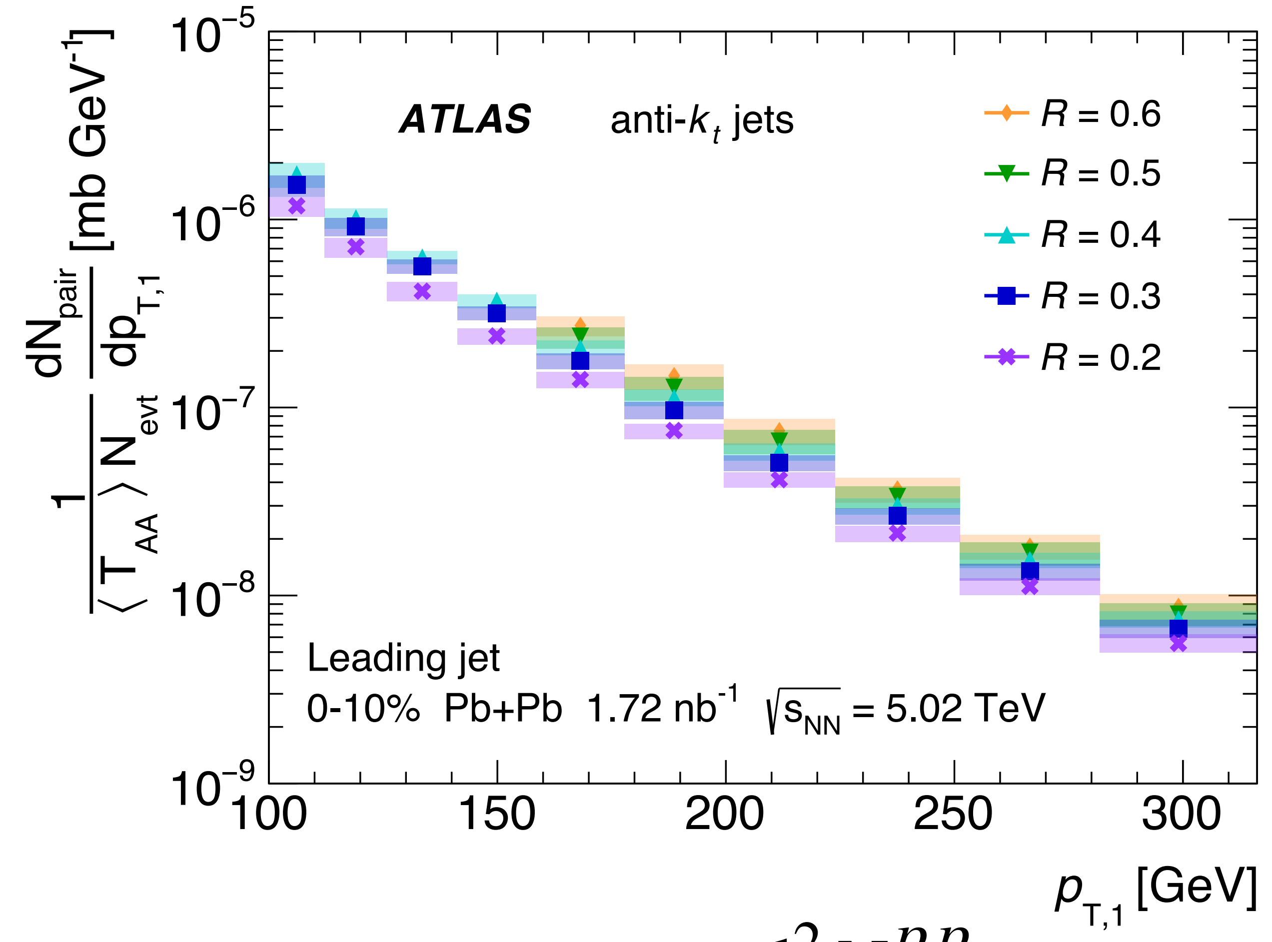

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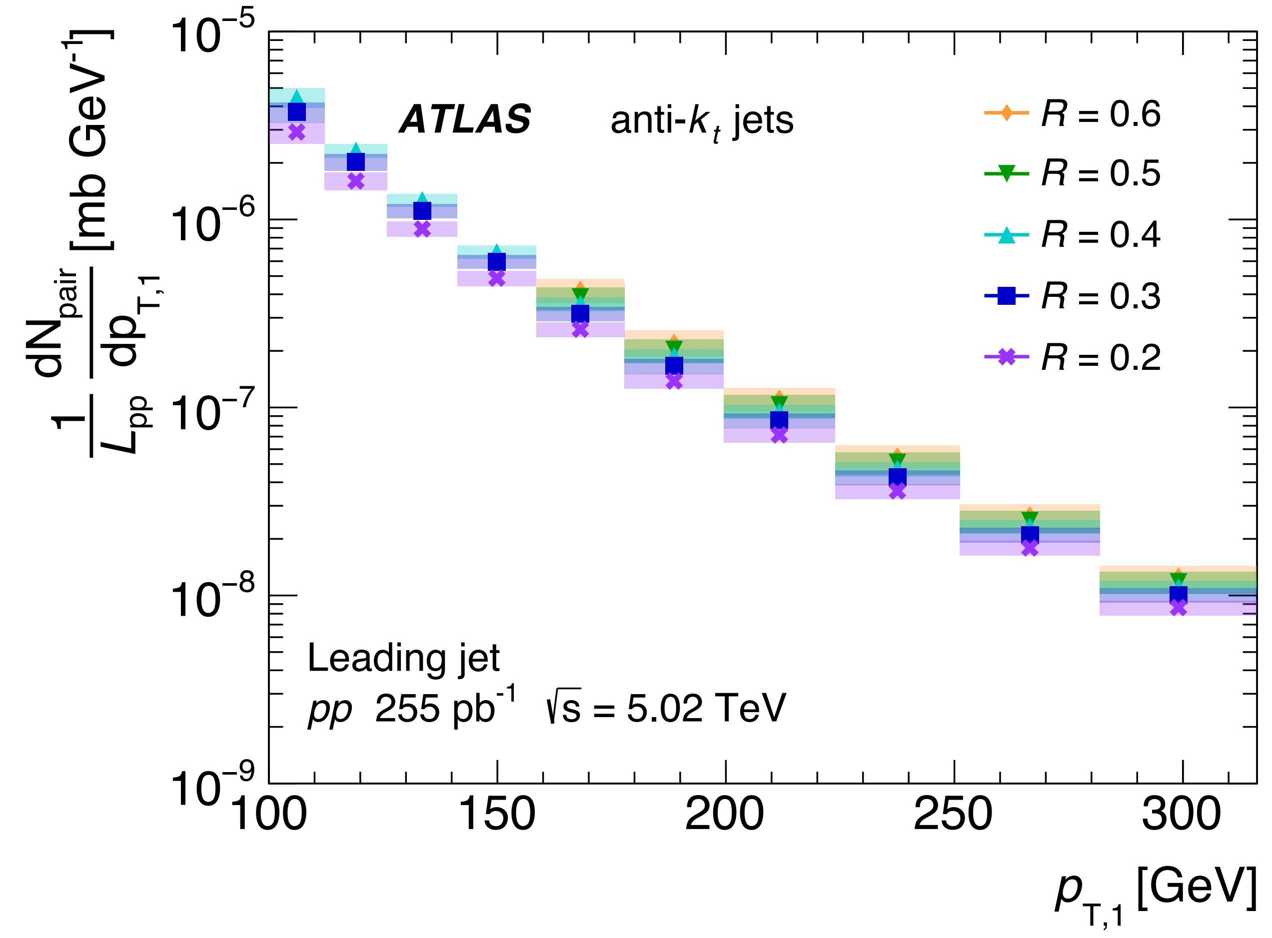

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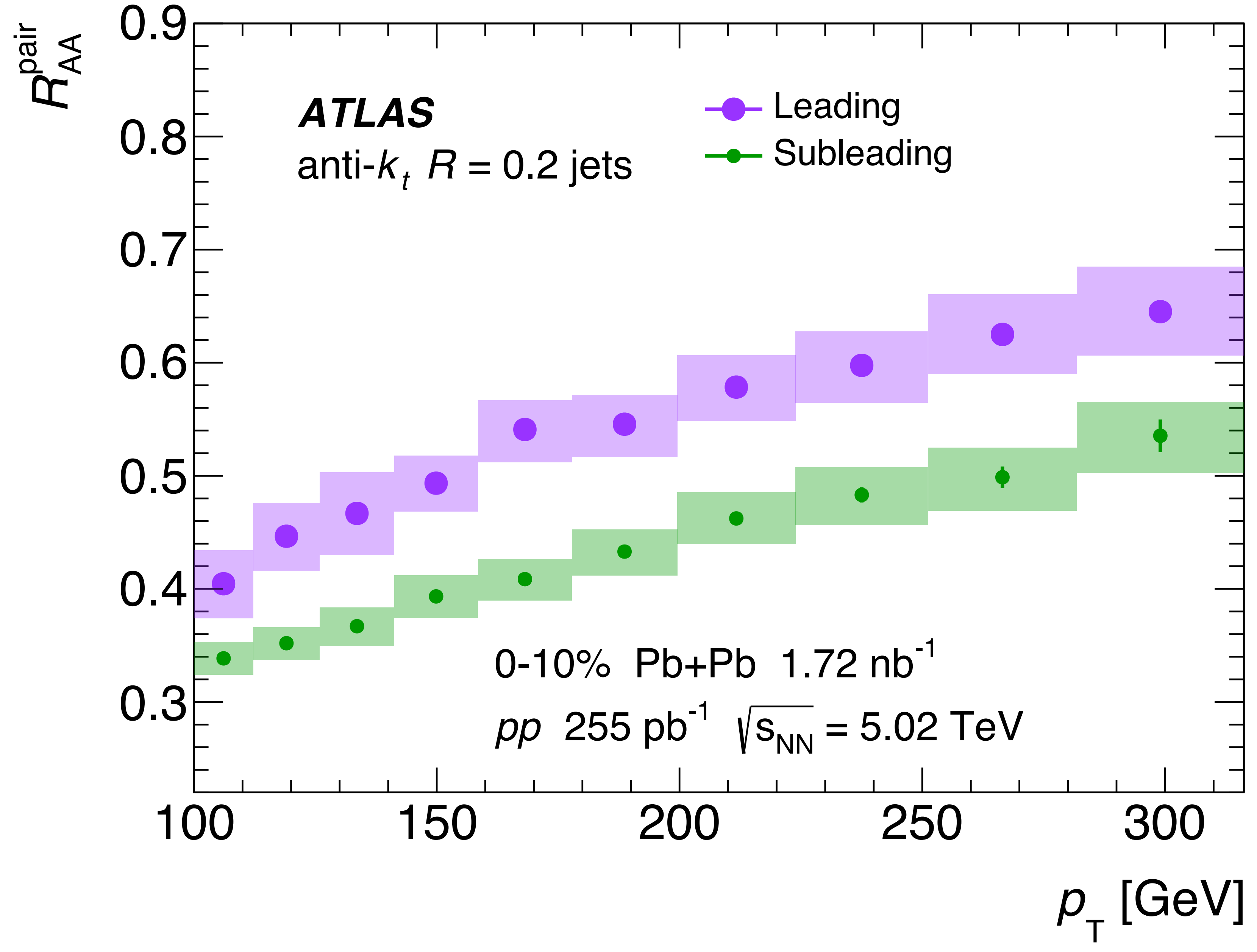
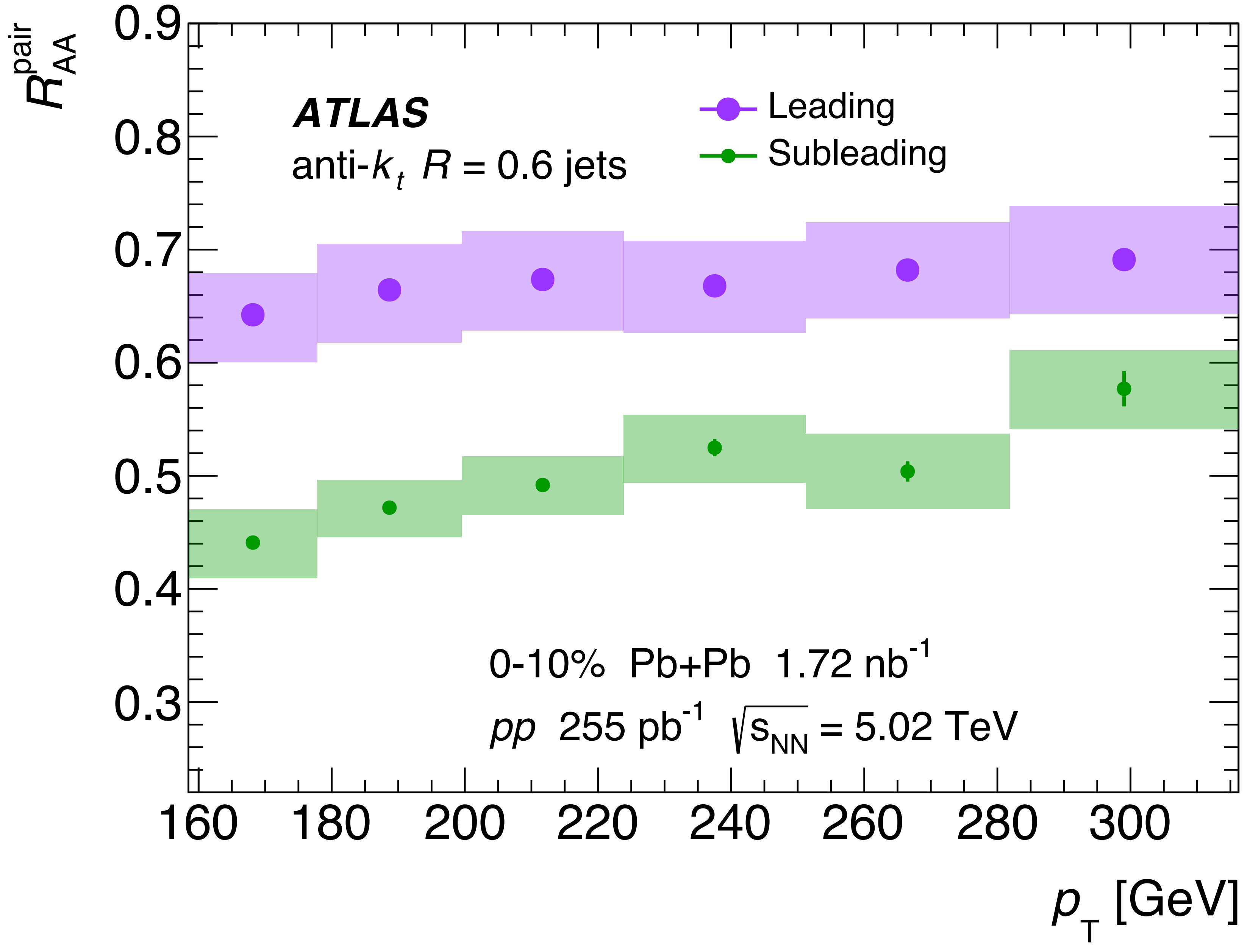
R = 0.2

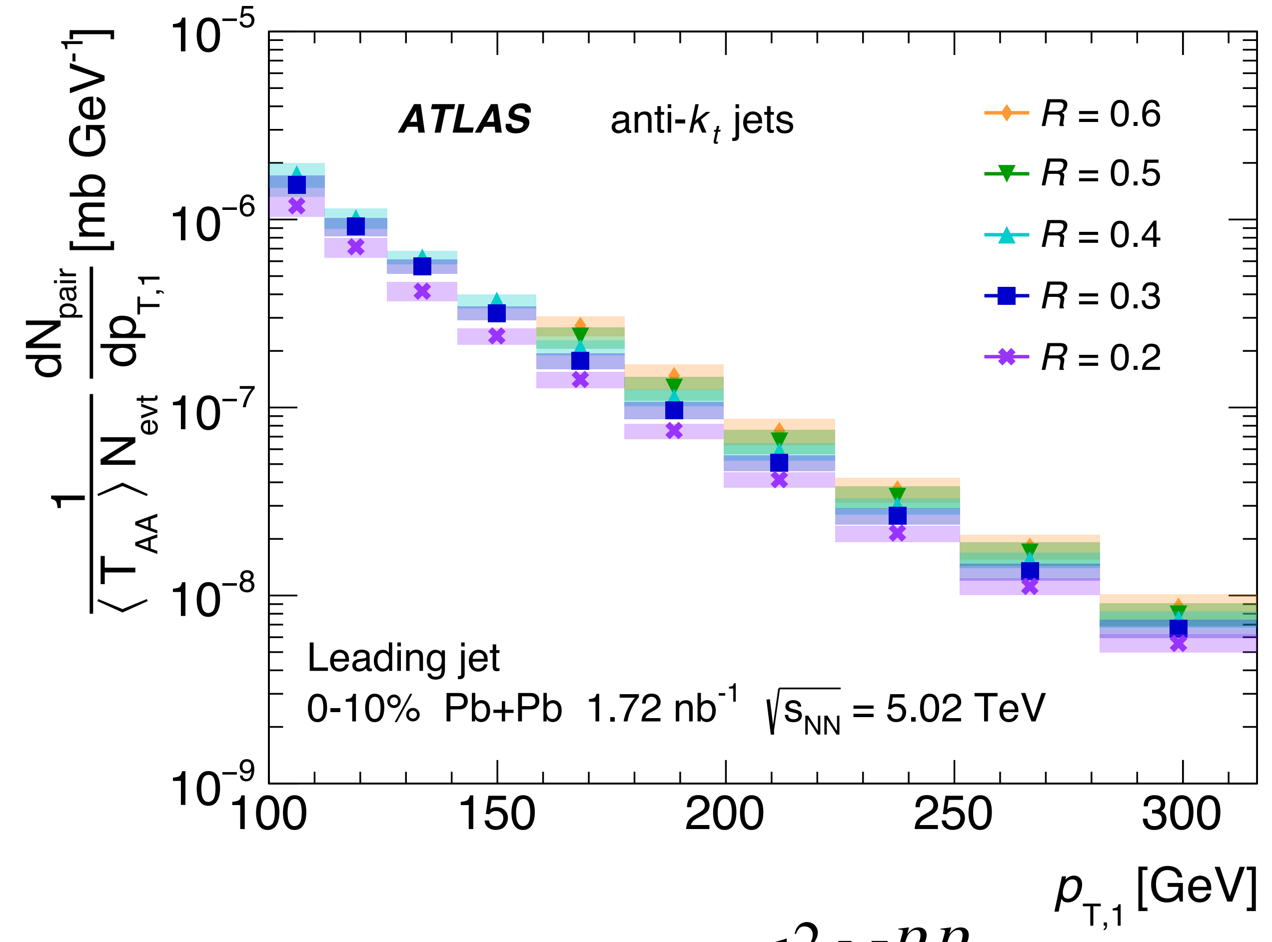


R = 0.6



dijet yields

$$\frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}} \int_{0.32\times p_{T,1}}^{p_{T,1}} \frac{d^2 N_{pair}^{AA}}{dp_{T,1}dp_{T,2}} dp_{T,2}$$



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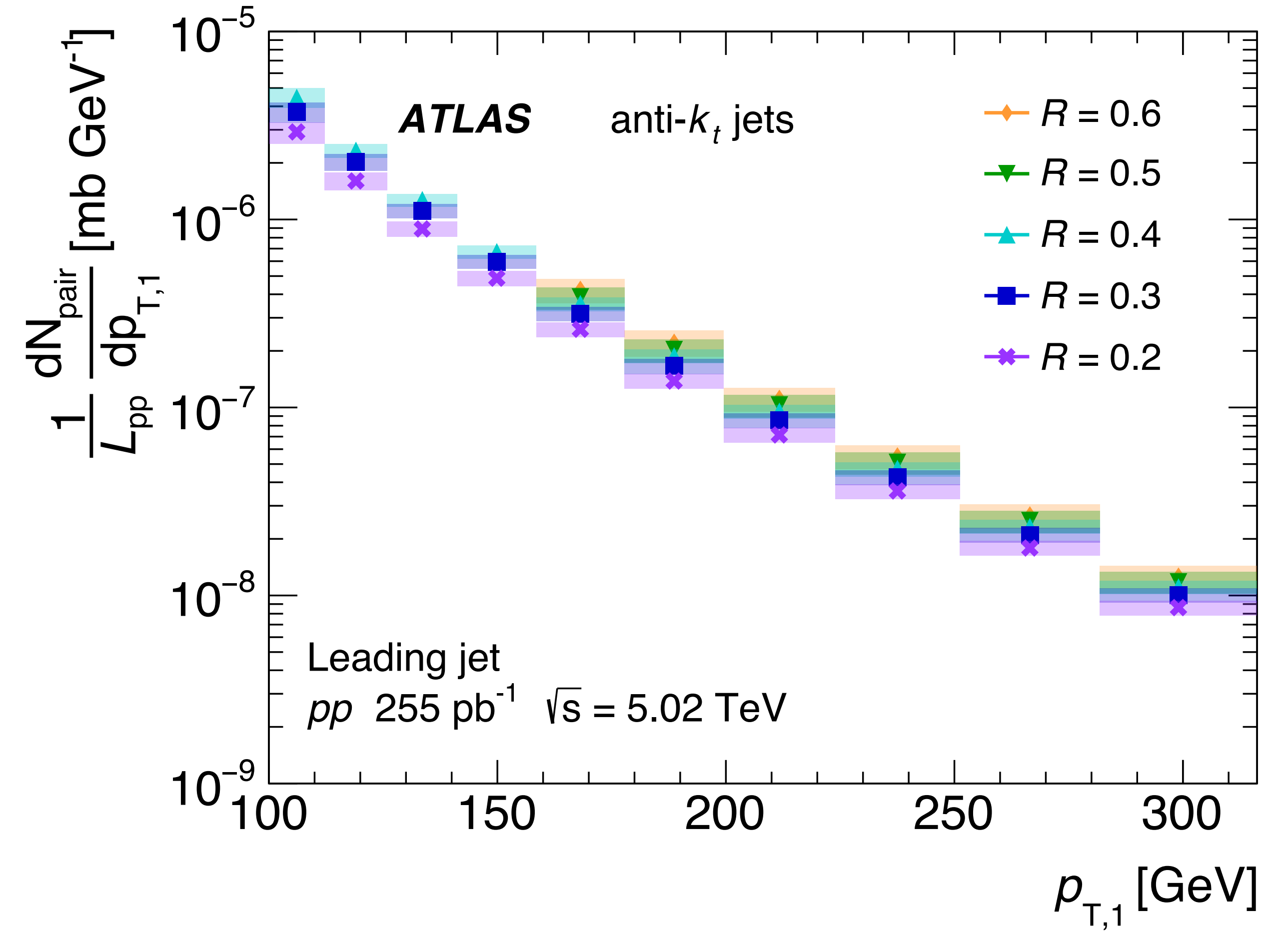

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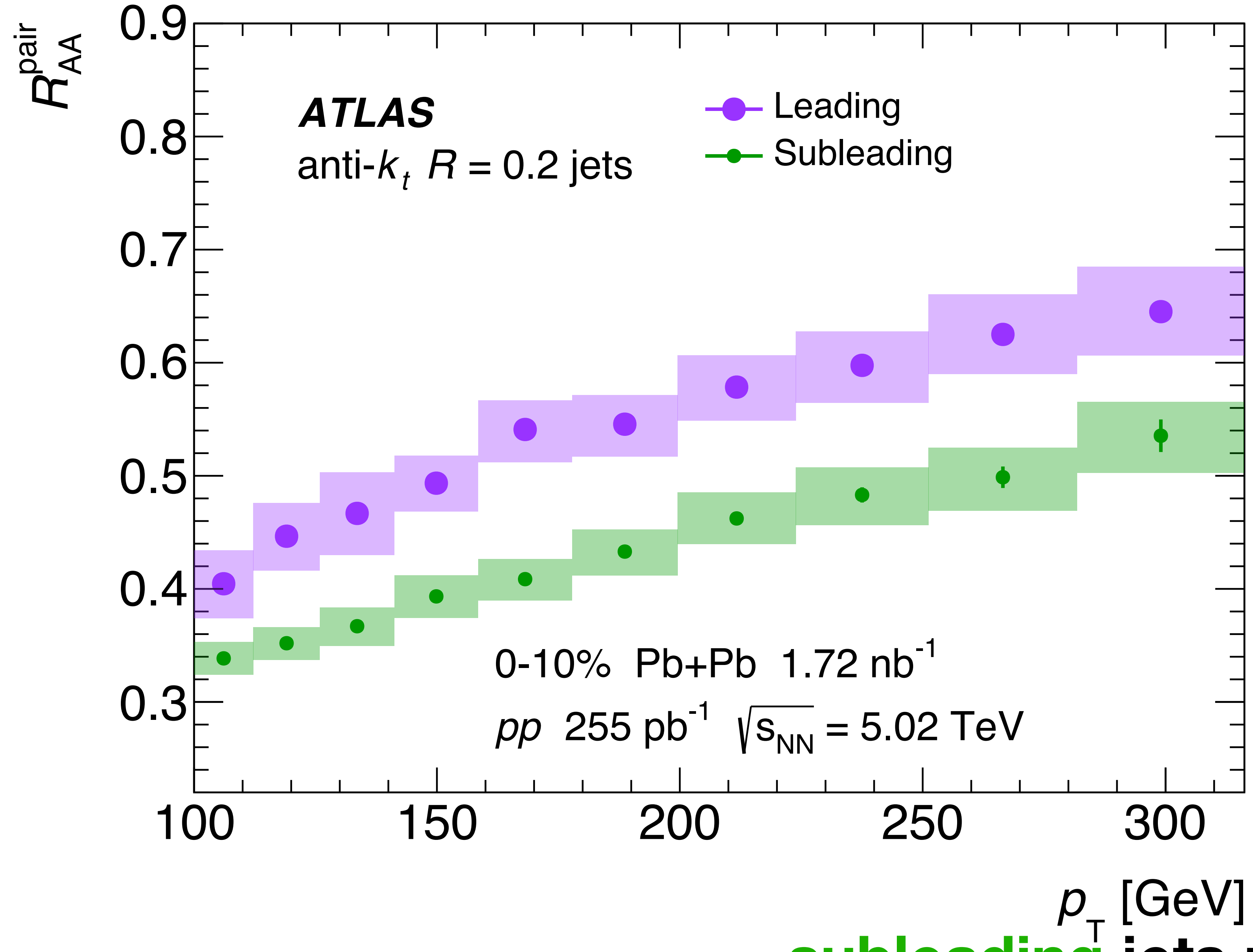

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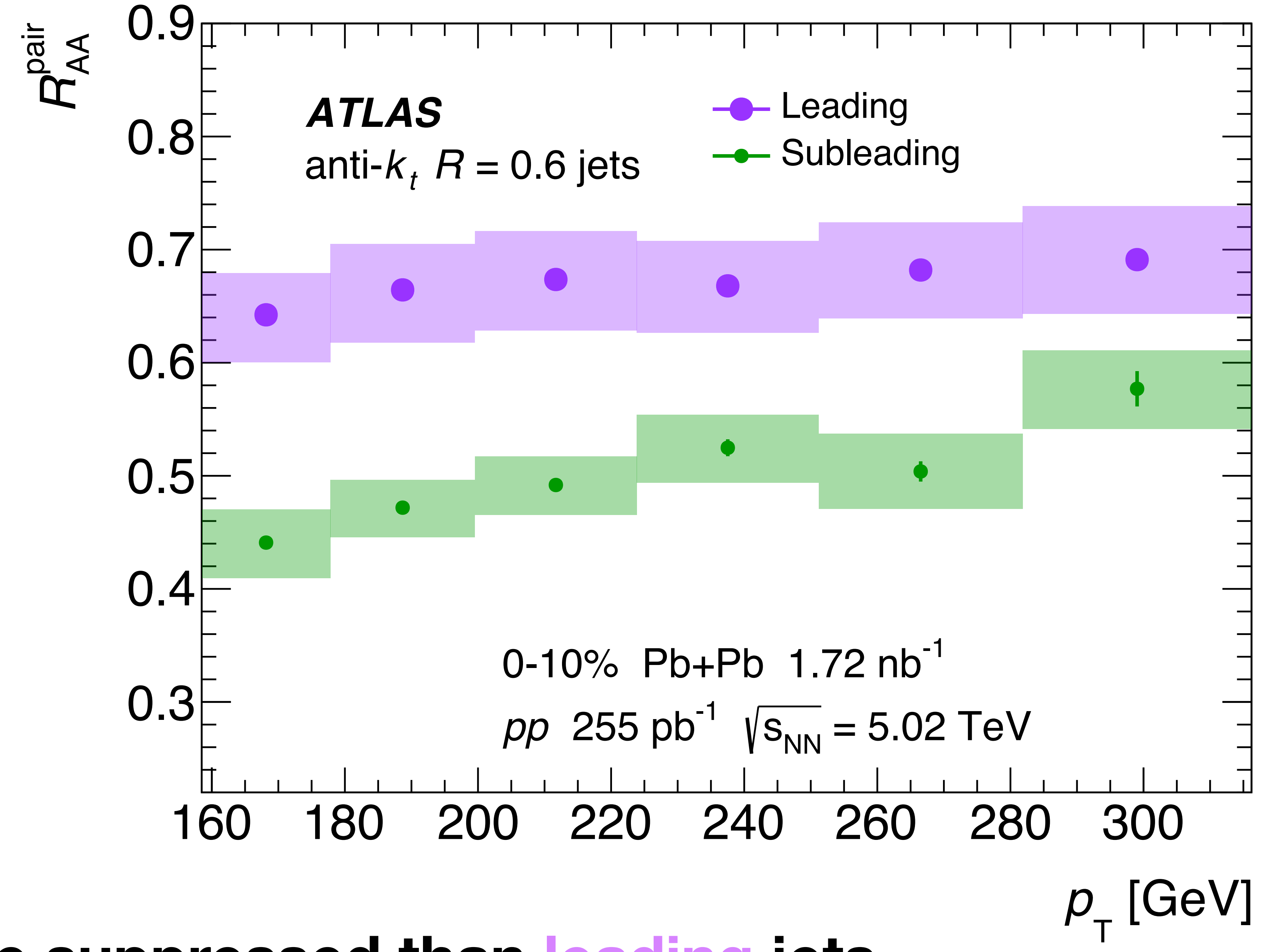
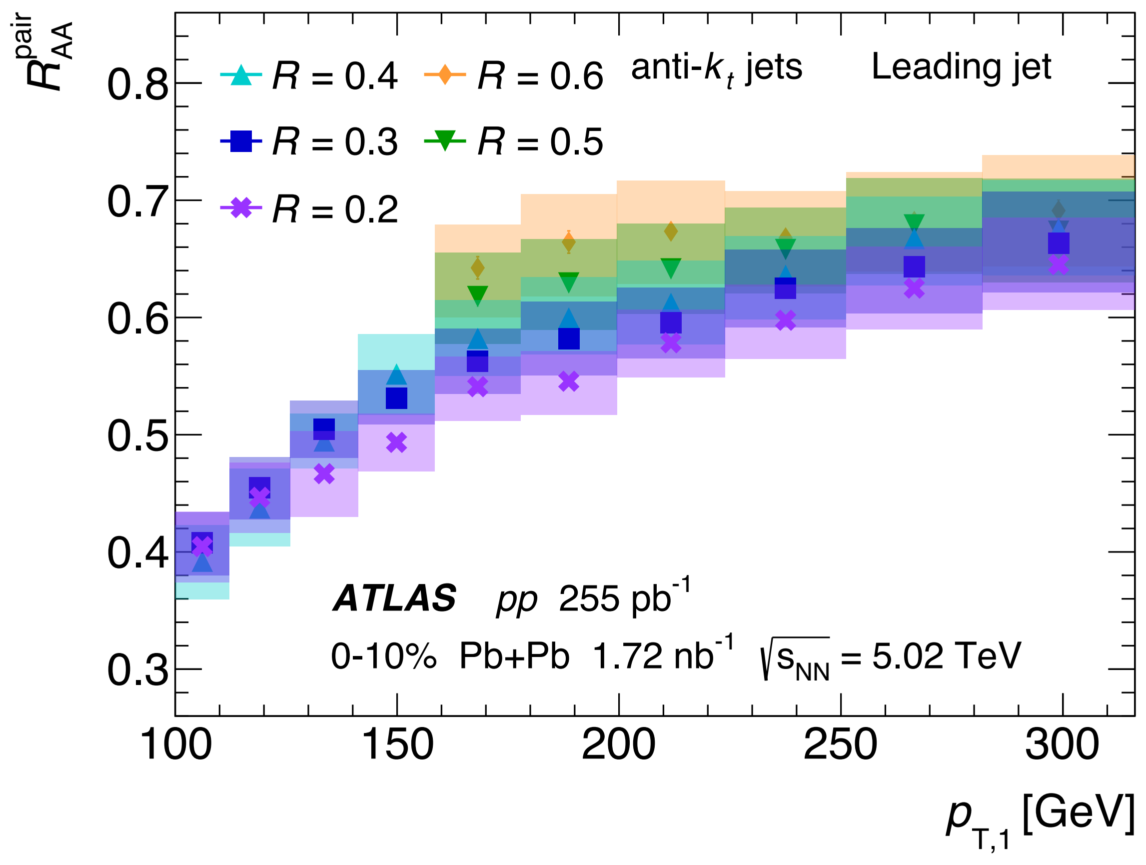


subleading jets more suppressed than leading jets

R_{AA}^{pair} vs R

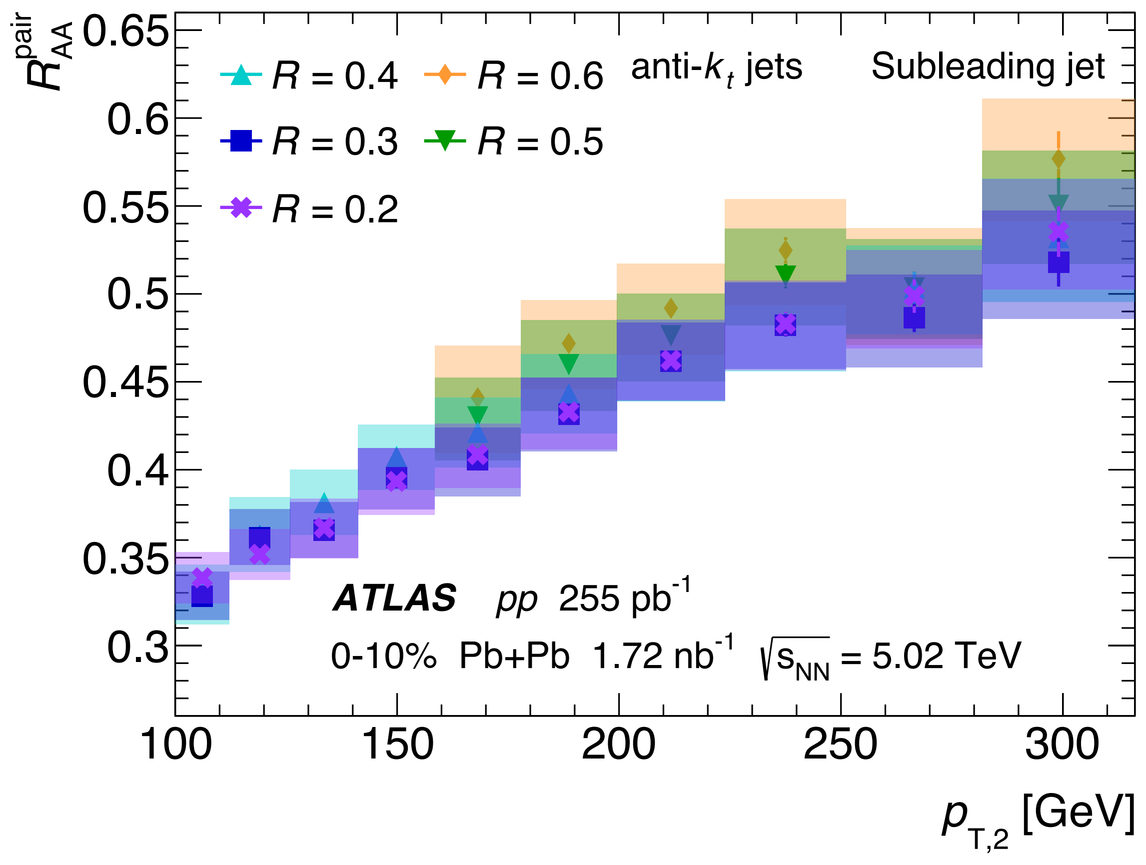
R_{AA}^{pair}

leading



(a)

subleading



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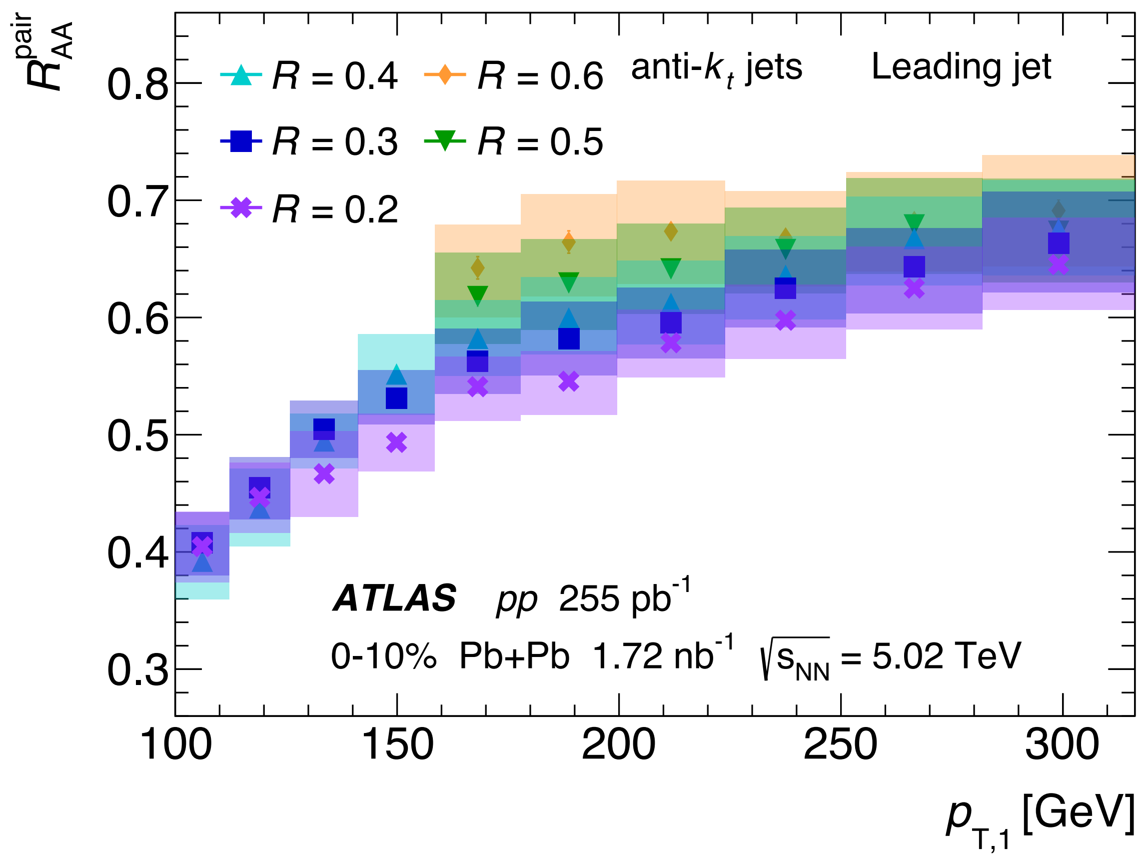
R_{AA}^{pair} vs R

R_{AA}^{pair}

$R_{AA}^{pair}(R)/R_{AA}^{pair}(0.2)$

leading



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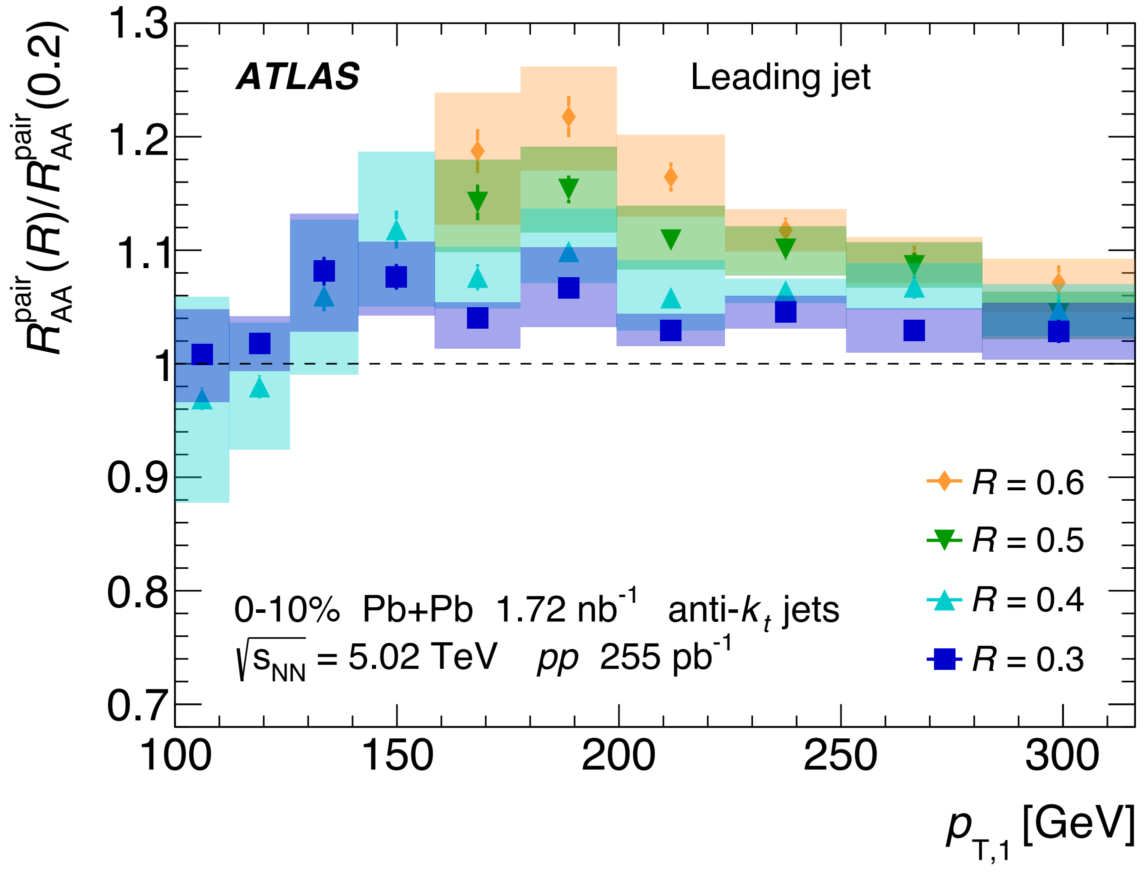
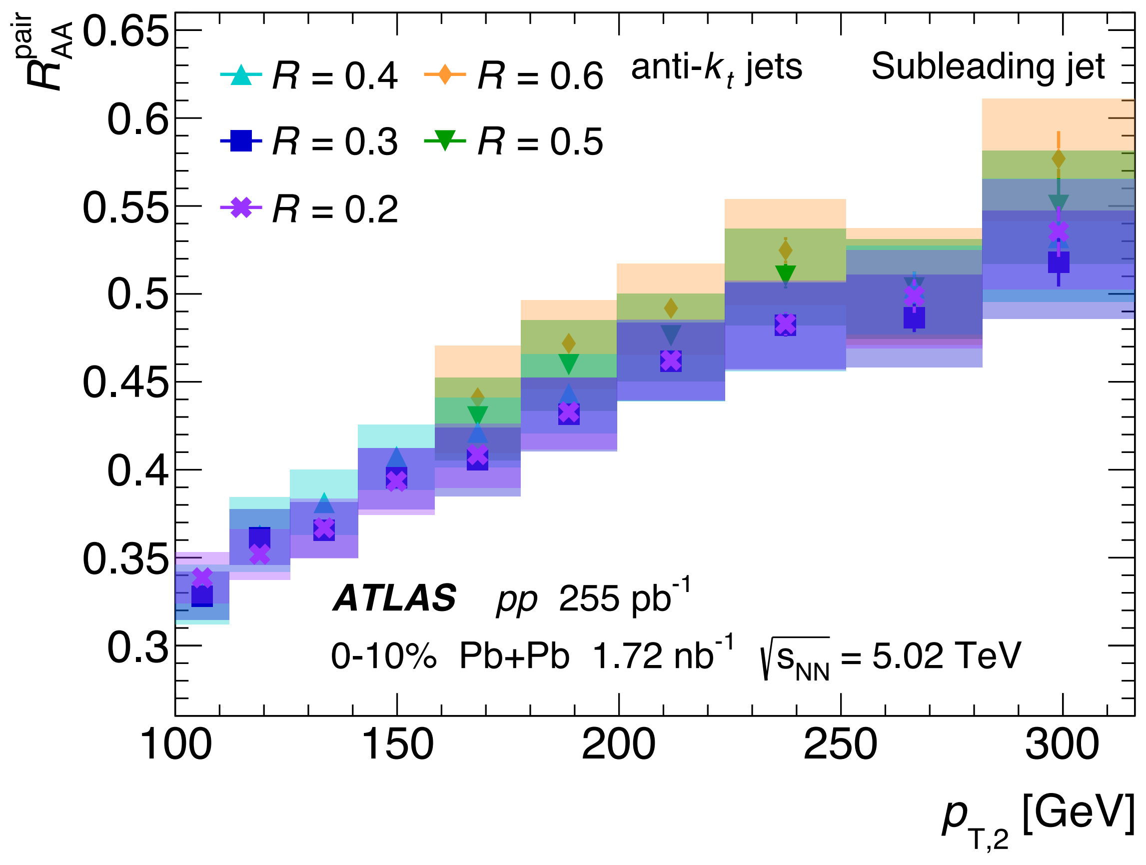
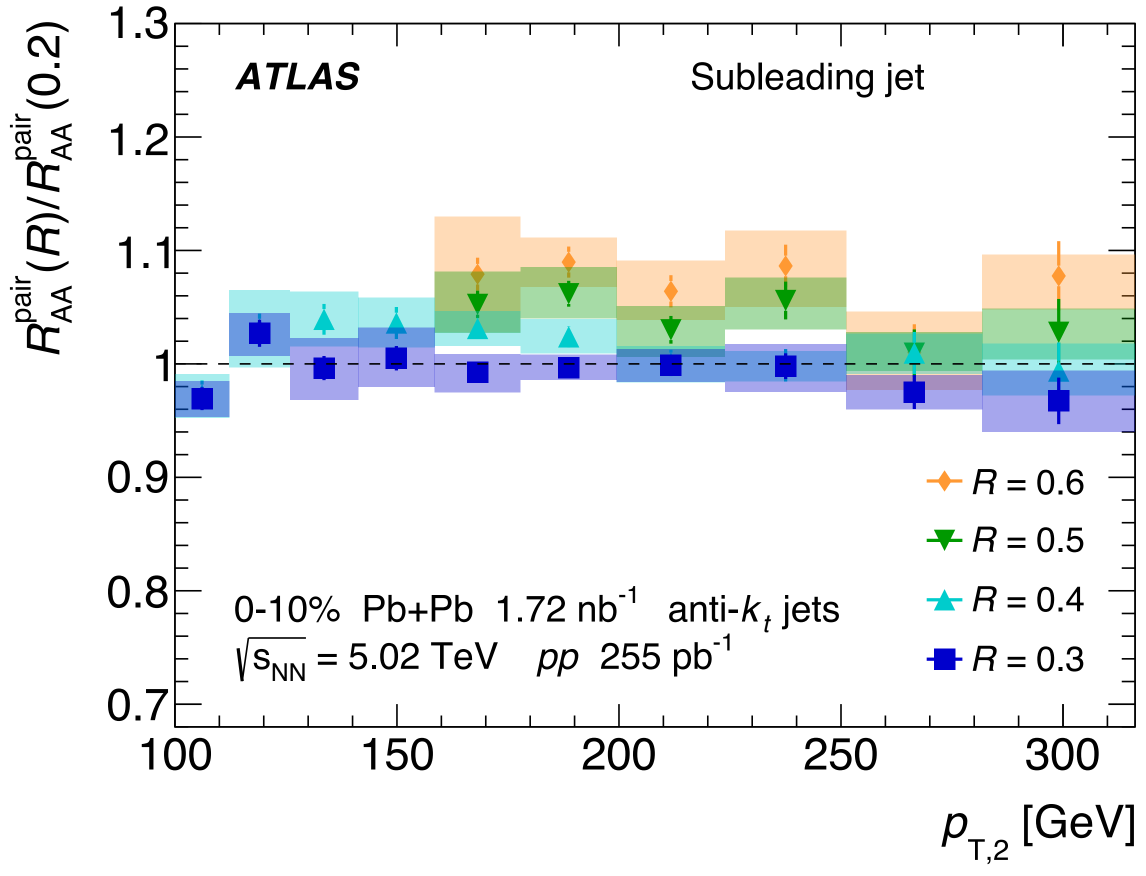


(b)

subleading





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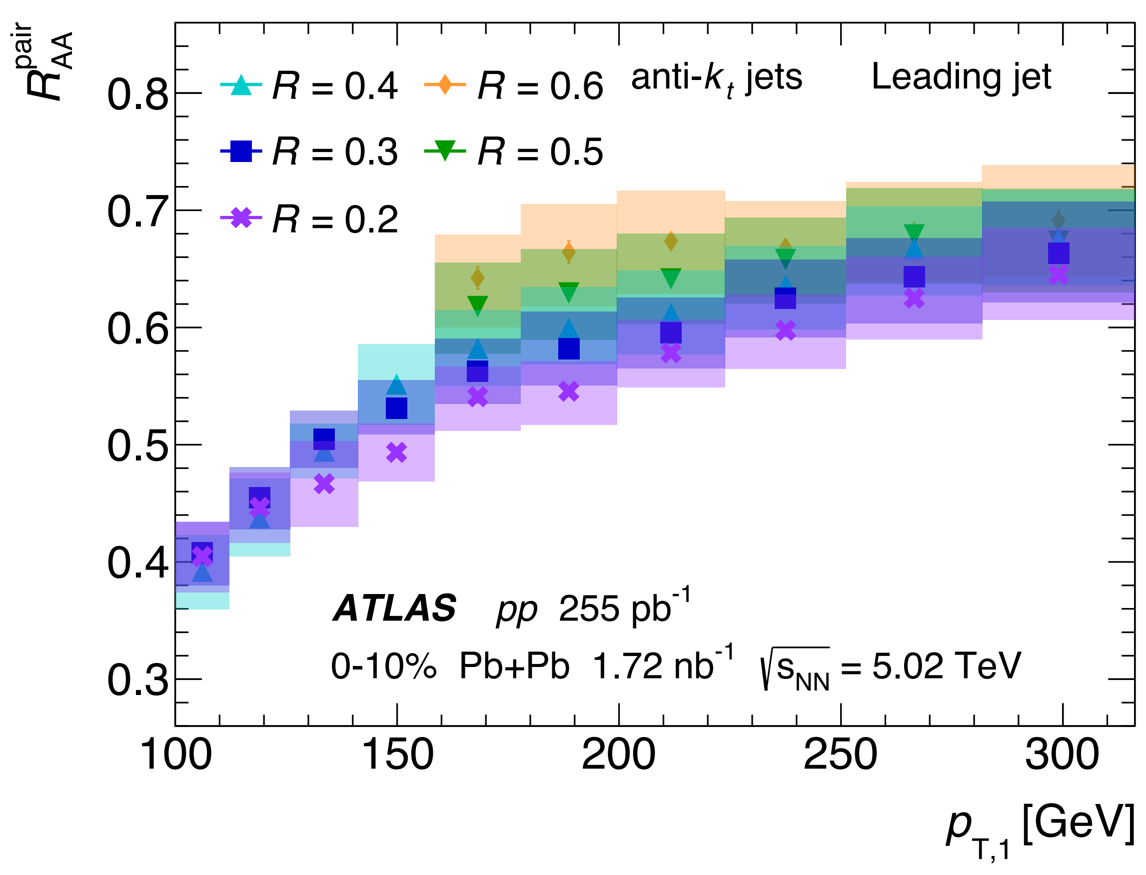
R_{AA}^{pair} vs R

R_{AA}^{pair}

$R_{AA}^{pair}(R)/R_{AA}^{pair}(0.2)$

leading



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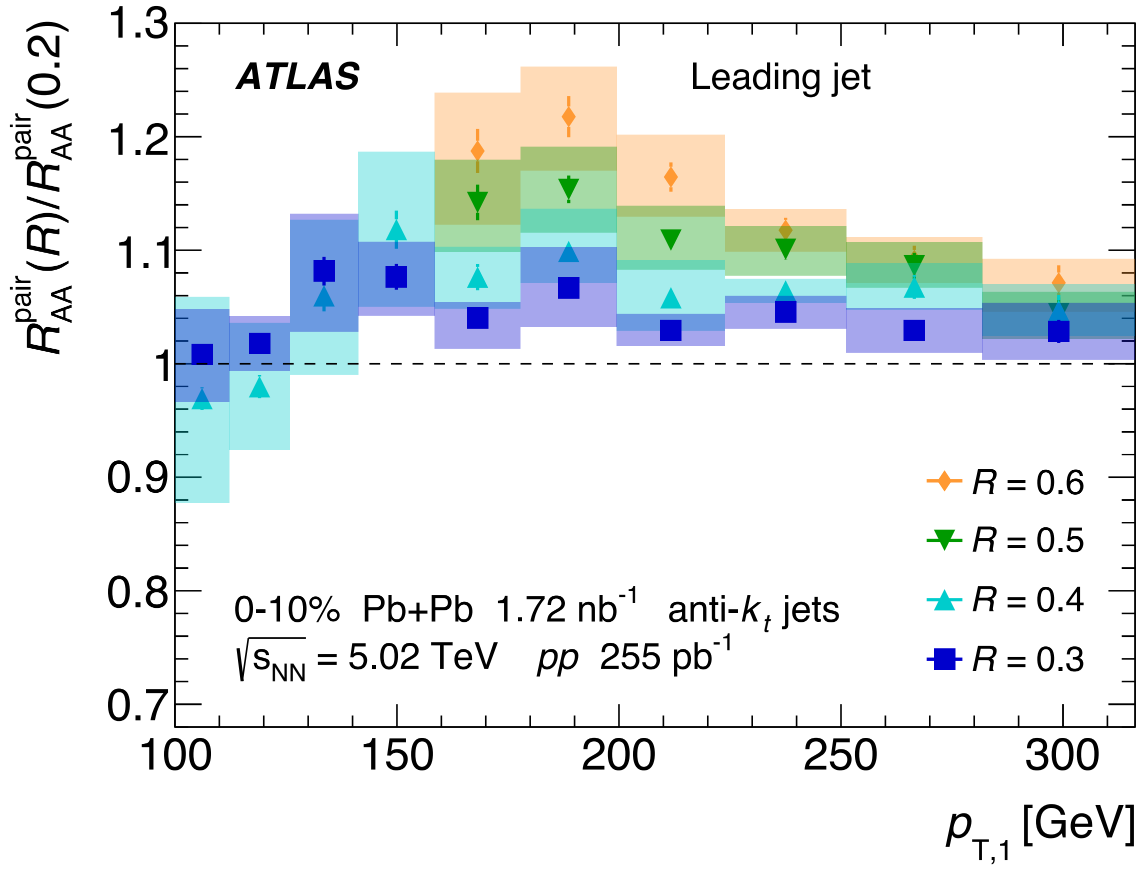
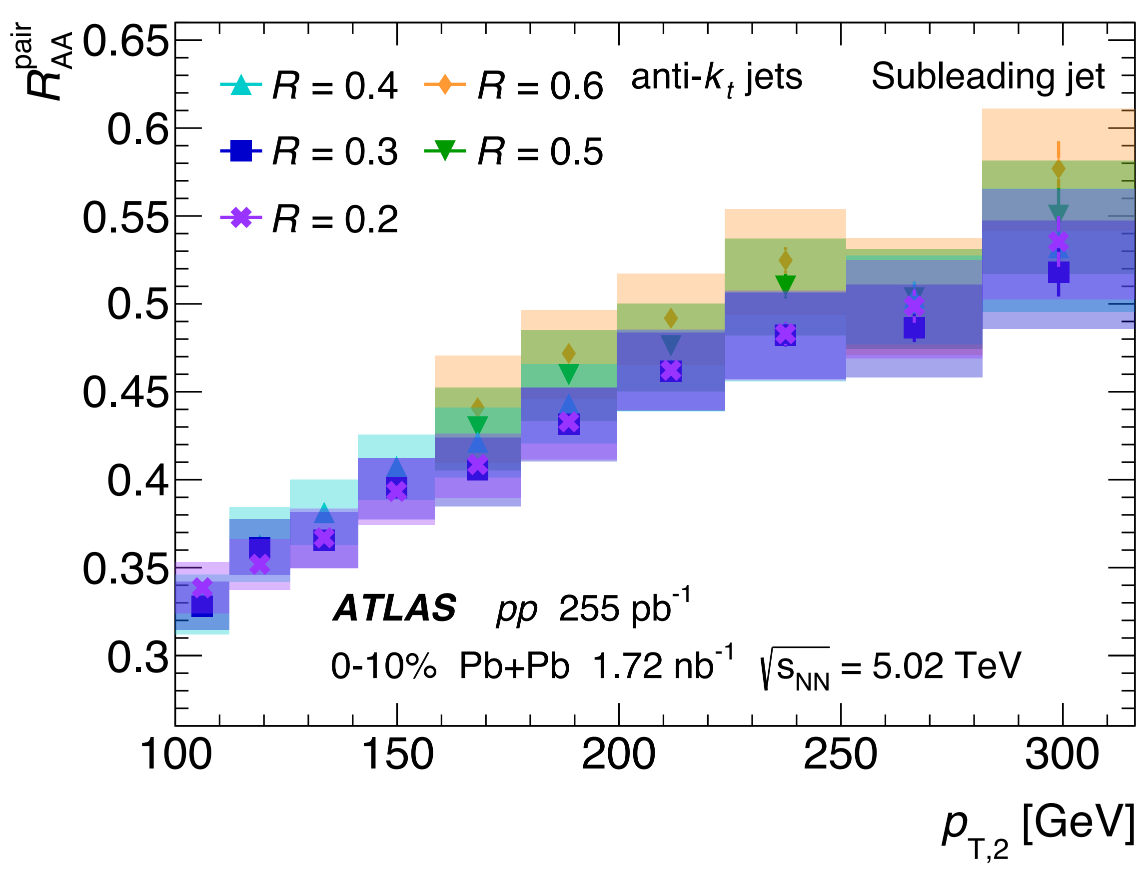
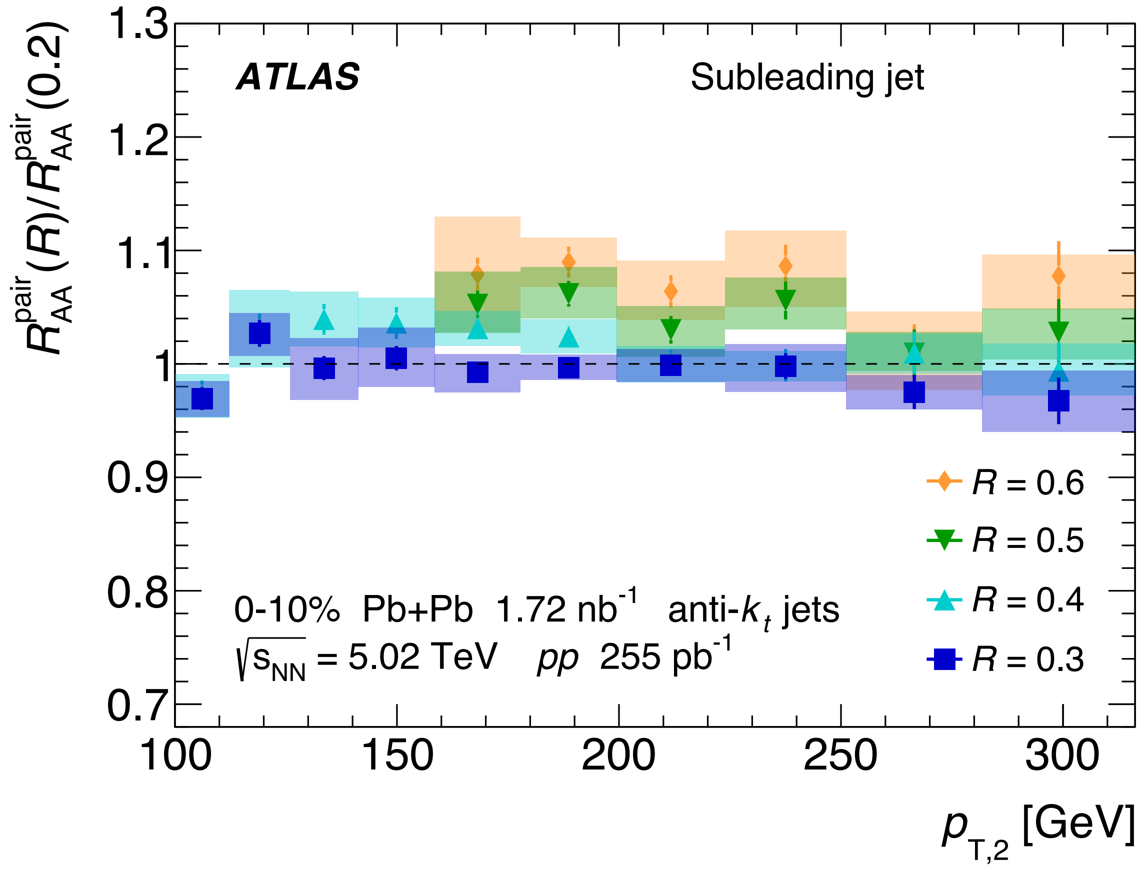


(b)

subleading





- R = 0.6 jets less suppressed that R = 0.2 jets for both leading and subleading jets
- opposite trend as suggested from ALICE single jet results (2303.00592)
- the results are not directly comparable
    - single jets vs dijets
    - different kinematic range
    - different rapidity range

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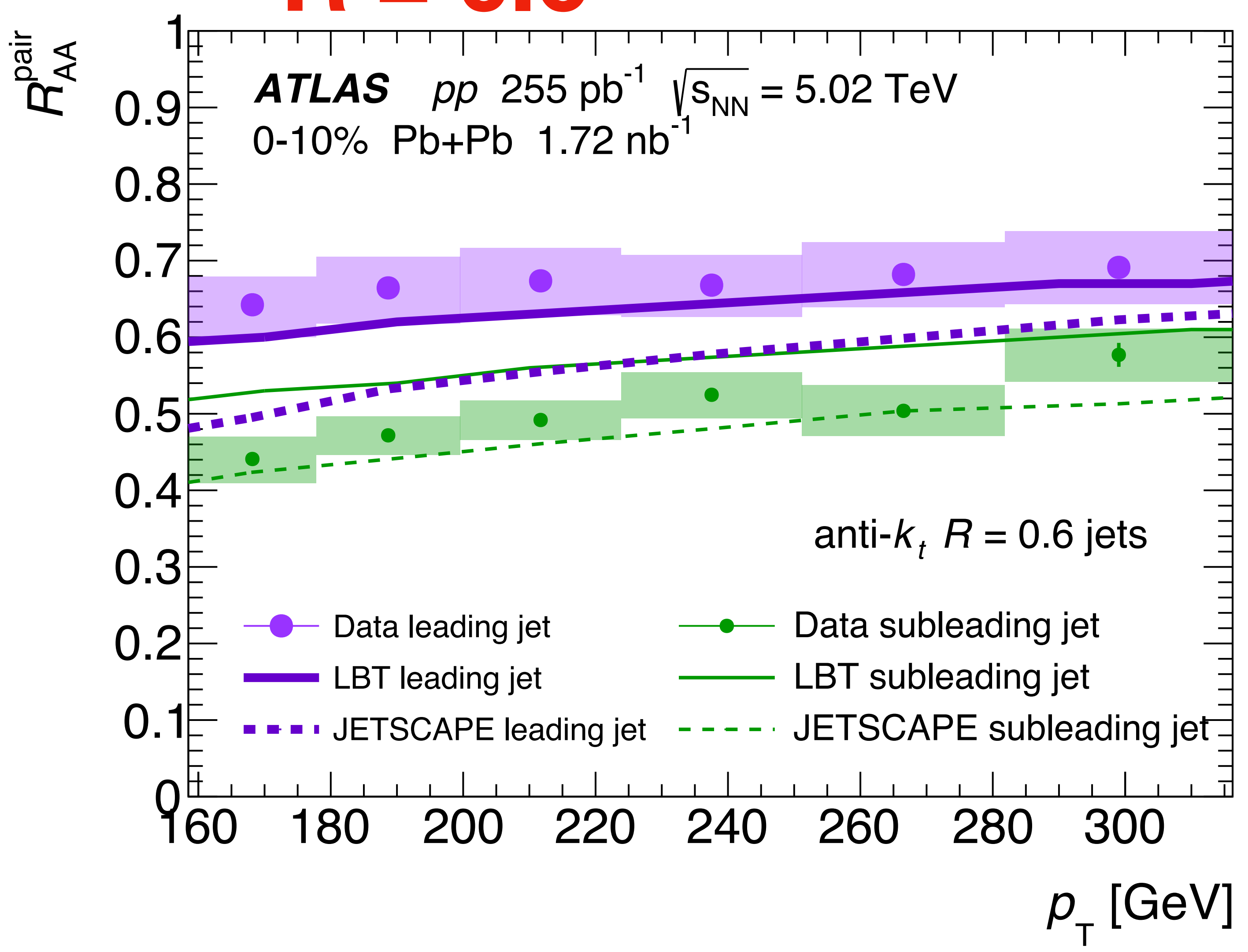
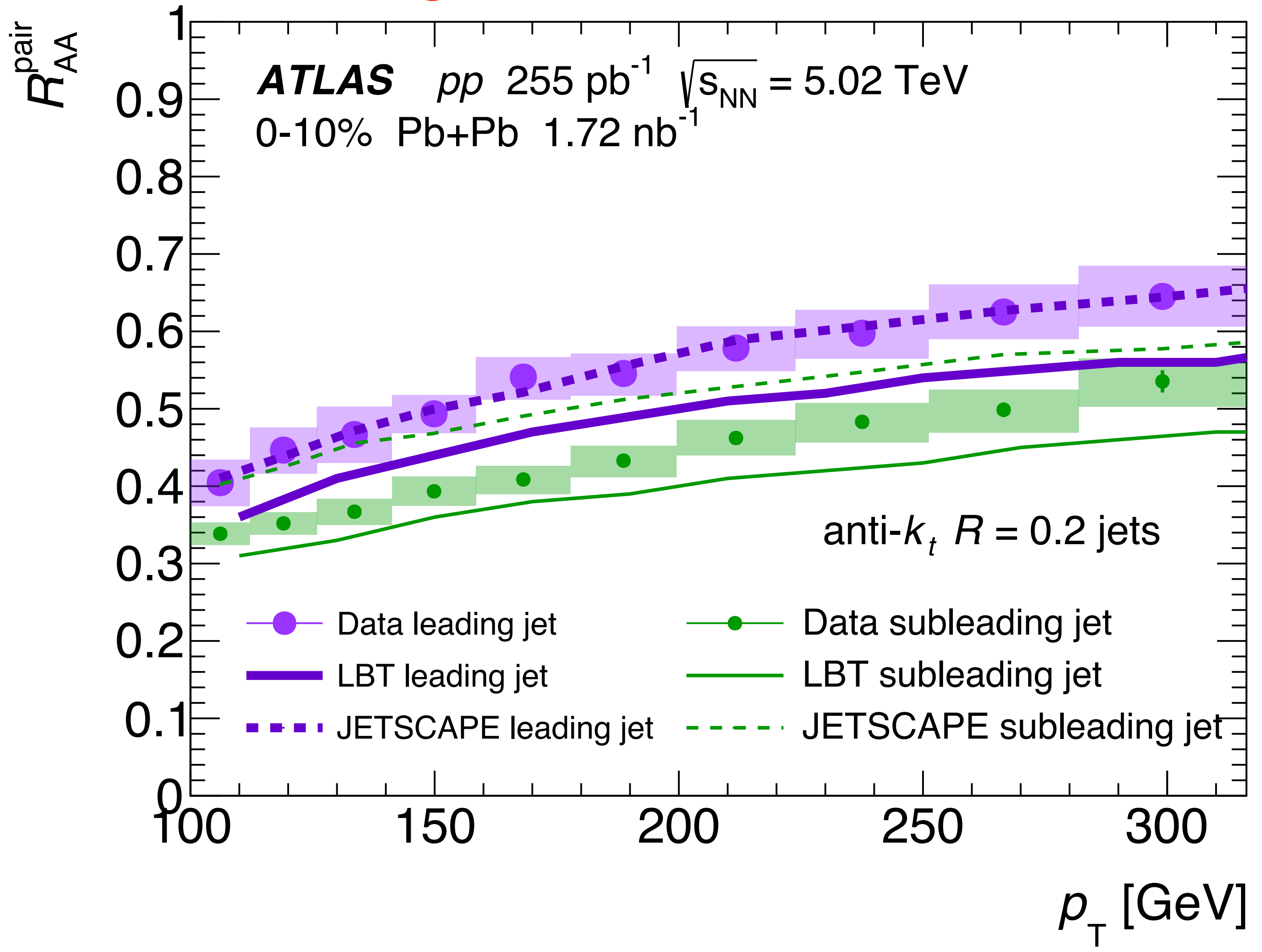
R_{AA}^{pair} vs R, theory

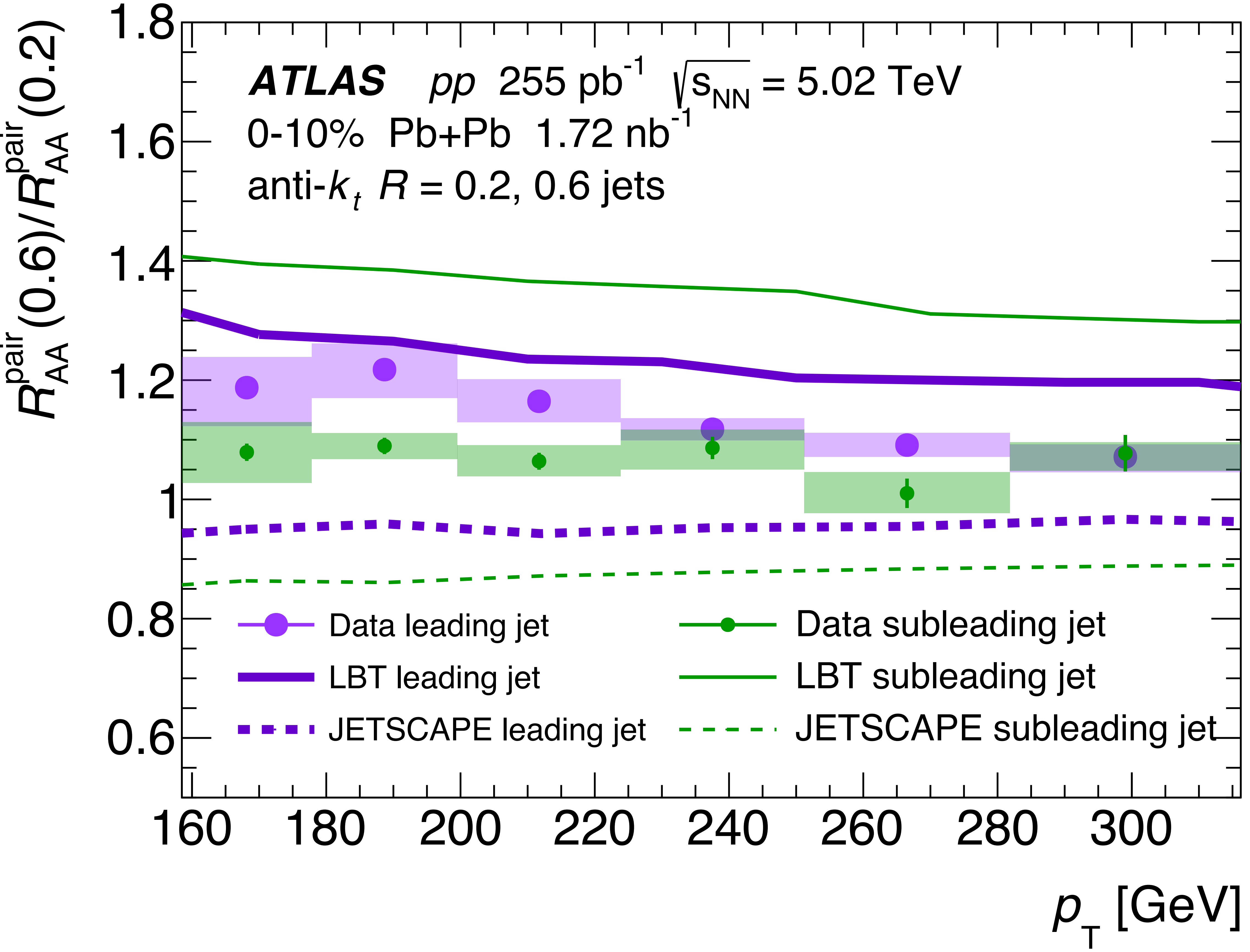
R = 0.6



R = 0.2



R = 0.6 / R = 0.2



R = 0.6 jets *less* suppressed than R = 0.2 jets, differs from both LBT & JETSCAPE

summary

- presented comprehensive study of the jet radius dependence of dijet production
- suppression of balanced dijets is radius independent and larger than that of imbalanced dijets
  - imbalanced dijets are less suppressed with increasing jet radius
- the R_{AA}^{pair} values for leading and subleading jets increase with increasing R
- comprehensive study provides new information about jet quenching over a wide kinematic range

all ATLAS Heavy Ion Results: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/HeavyIonsPublicResults

backups

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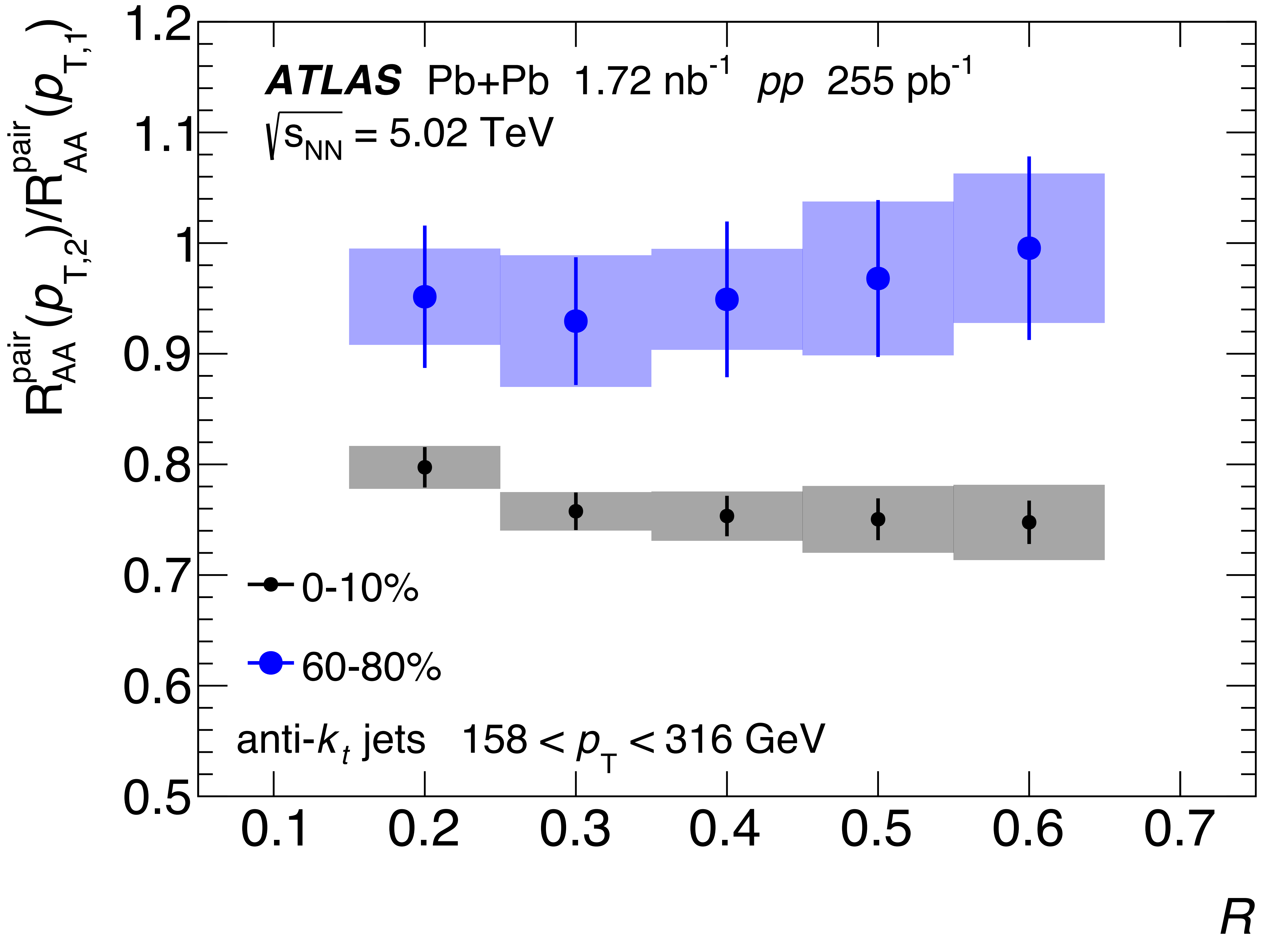
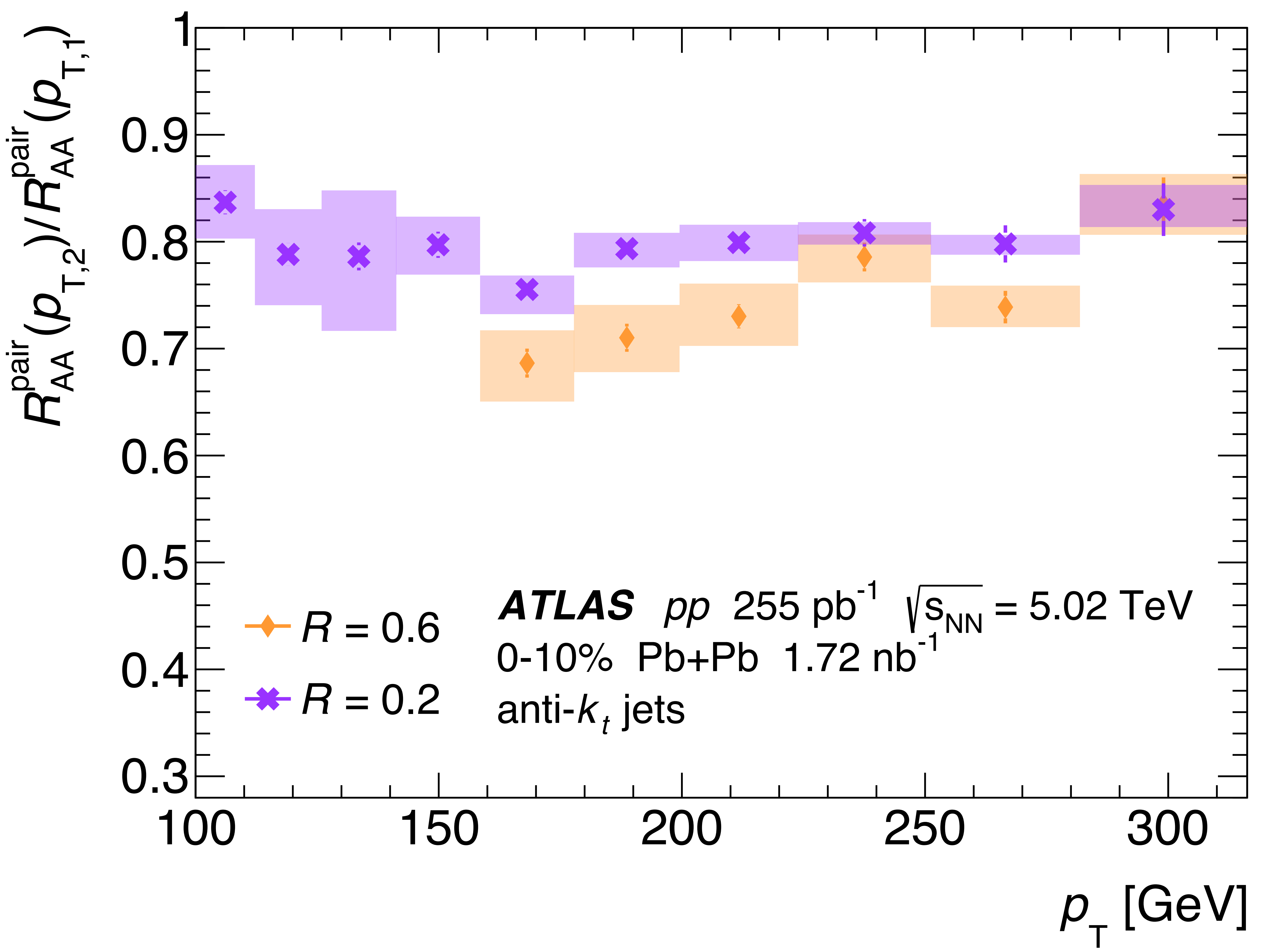
ratio of subleading / leading R_{AA}^{pair}

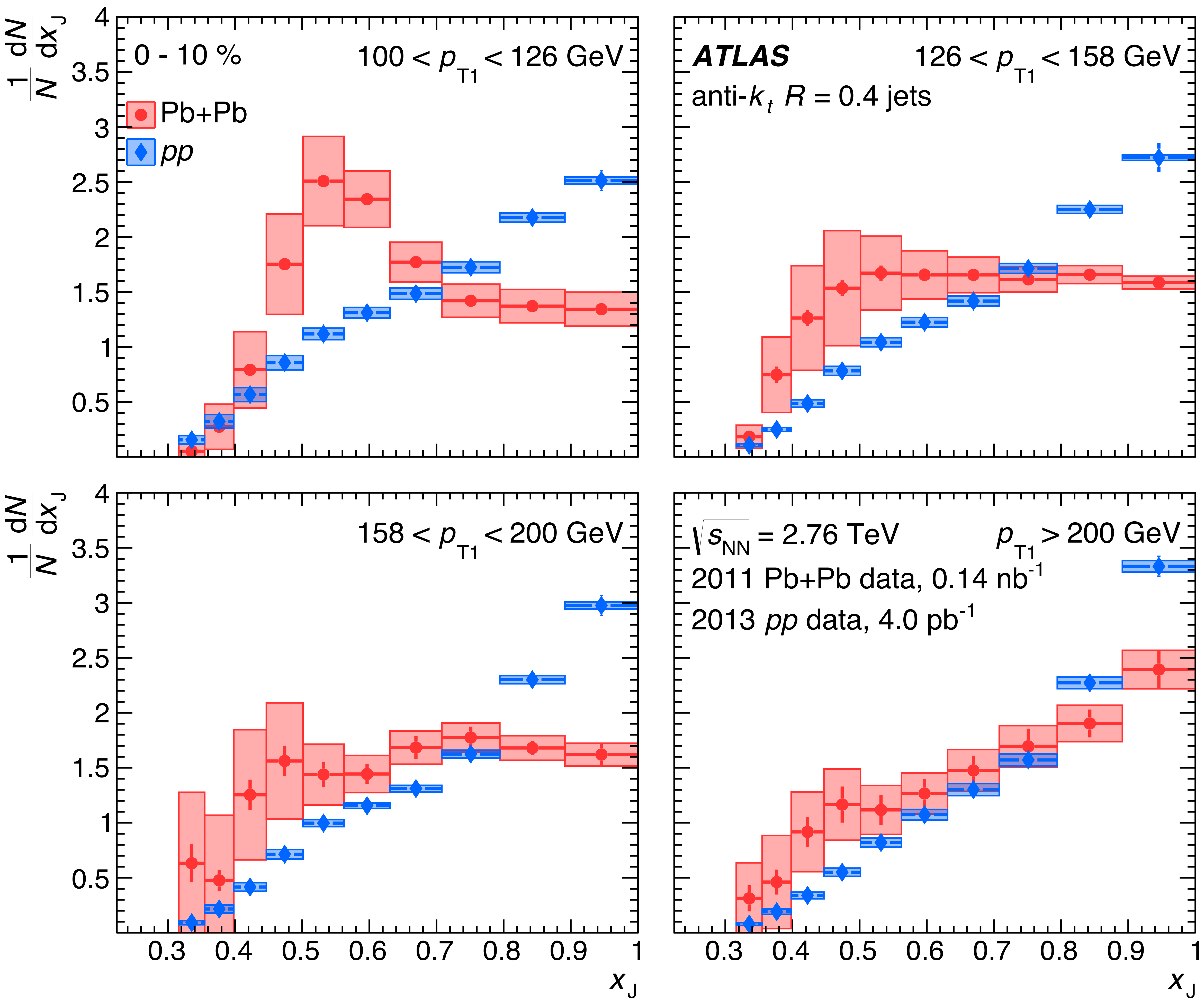




little R dependence to subleading / leading suppression in central collisions; maybe some p_T dependence for R = 0.6 dijets

dijets at 2.76 TeV

- shift from balanced jets to imbalanced jets makes sense in a surface bias picture
- however, these distributions are sensitive only to the shape (area normalization)
- which jets are actually being suppressed?
- also, what's that peak?



1706.09363

x_J = momentum of jet 2 / momentum of jet 1

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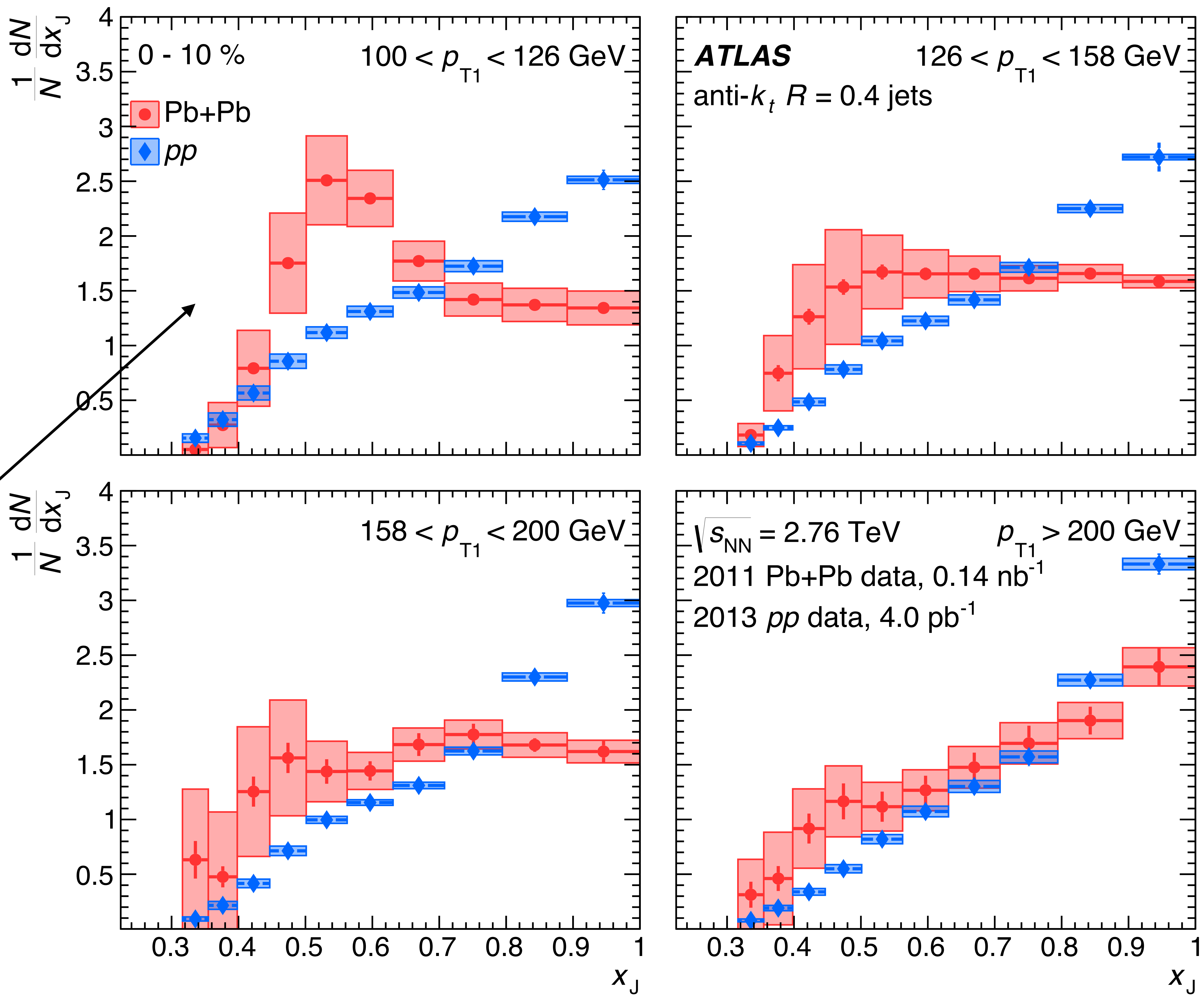

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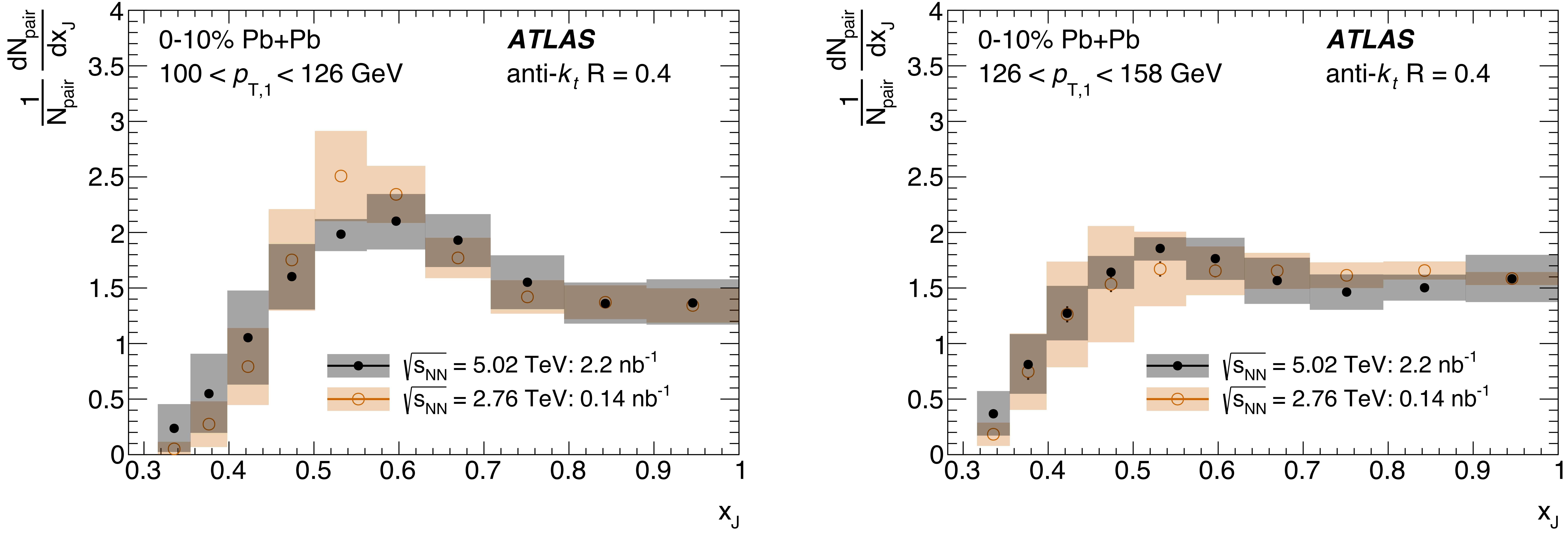
comparison of 5.02 TeV & 2.76 TeV



x_J distributions have consistent shapes at the two collision energies

2205.00682