UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

ATLAS EXPERIMENT

Jet radius dependence of Pb+Pb and pp dijet momentum balance with the ATLAS detector

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R=0.4 results from arXiv:2205.00682

INTRODUCTION

Relativistic heavy ion collisions produce a high density and high temperature state of matter known as the quark gluon plasma (QGP).

Hard scattered partons create collimated sprays of particles, called jets, that can be measured by particle detectors.

Pairs of back to back jets are produced within the QGP and lose energy while traversing it.

Jet energy loss can be studied by measuring the ratio of the subleading (second most energetic) to leading (most energetic) jet transverse momentum (p_T):

$$x_J \equiv p_{T,2}/p_{T,1}$$

The absolutely normalized x_J distributions can be measured in Pb+Pb and pp collisions as:

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

To quantify the differences between Pb+Pb and pp, the J_{AA} is defined as:

$$J_{AA} \equiv \frac{\frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}}\frac{dN_{pair}^{AA}}{dx_J}}{\frac{1}{L_{pp}}\frac{dN_{pair}^{pp}}{dx_J}}$$

A jet radius dependent dijet measurement allows for a study of jet energy loss in the QGP.

Additionally, the dijet nuclear modification factors R_{AA}^{pair} are defined for leading and subleading jets as:

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

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

ANALYSIS

Data: 1.7 nb^{-1} of Pb+Pb data and 260 pb^{-1} of pp data, both at $\sqrt{s_{NN}}$ = 5.02 TeV.

Event selection: Dijets of jet radius R=0.2, 0.3, 0.5 and 0.6 with $\Delta\Phi > 7\pi/8$ and $|y|<2.1$. For R=0.2 and 0.3, $p_{T1}>79$ GeV and $p_{T2}>32$ GeV. For R=0.5, $p_{T1}>121$ GeV and $p_{T2}>41$ GeV. For R=0.6, $p_{T1}>121$ GeV and $p_{T2}>51$ GeV.

Procedure:

- Measure $p_{T1}p_{T2}$ distributions on leading and subleading jet p_T.
- Apply background subtraction and efficiency correction.
- Bayesian unfolding with 2D response matrix on leading and subleading jet p_T.
- Project unfolded $p_{T1}p_{T2}$ into x_J and R_{AA}^{pair} distributions.

SYSTEMATIC UNCERTAINTIES

Jet related:

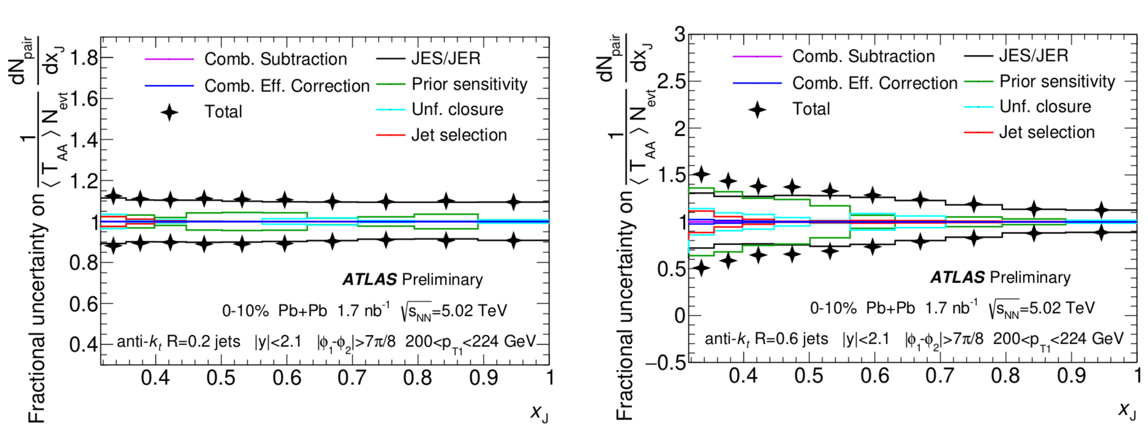
- Jet energy scale and jet energy resolution.

Unfolding:

- Prior sensitivity.
- Unfolding closure.
- Jet selection.

Combinatoric dijets:

- Subtraction.
- Efficiency correction.

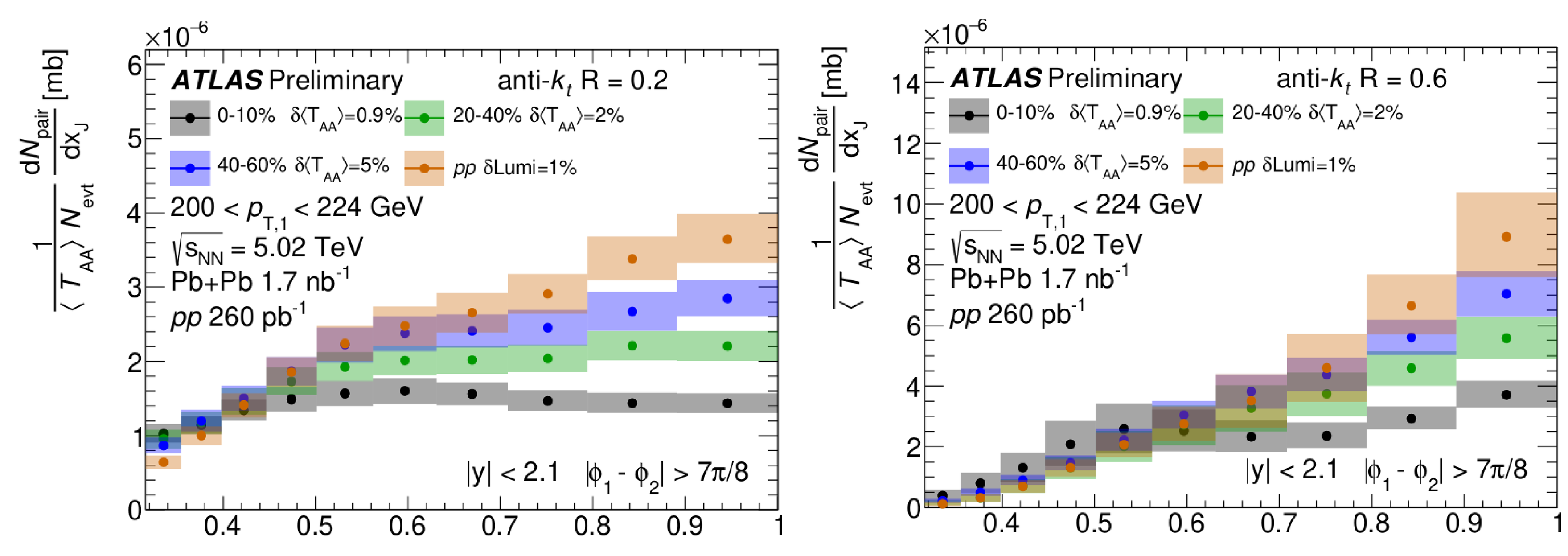


Breakdown of systematic uncertainties on the absolutely normalized x_J distributions for R=0.2 (left) and R=0.6 (right) jets in central Pb+Pb collisions.

RESULTS AND CONCLUSIONS

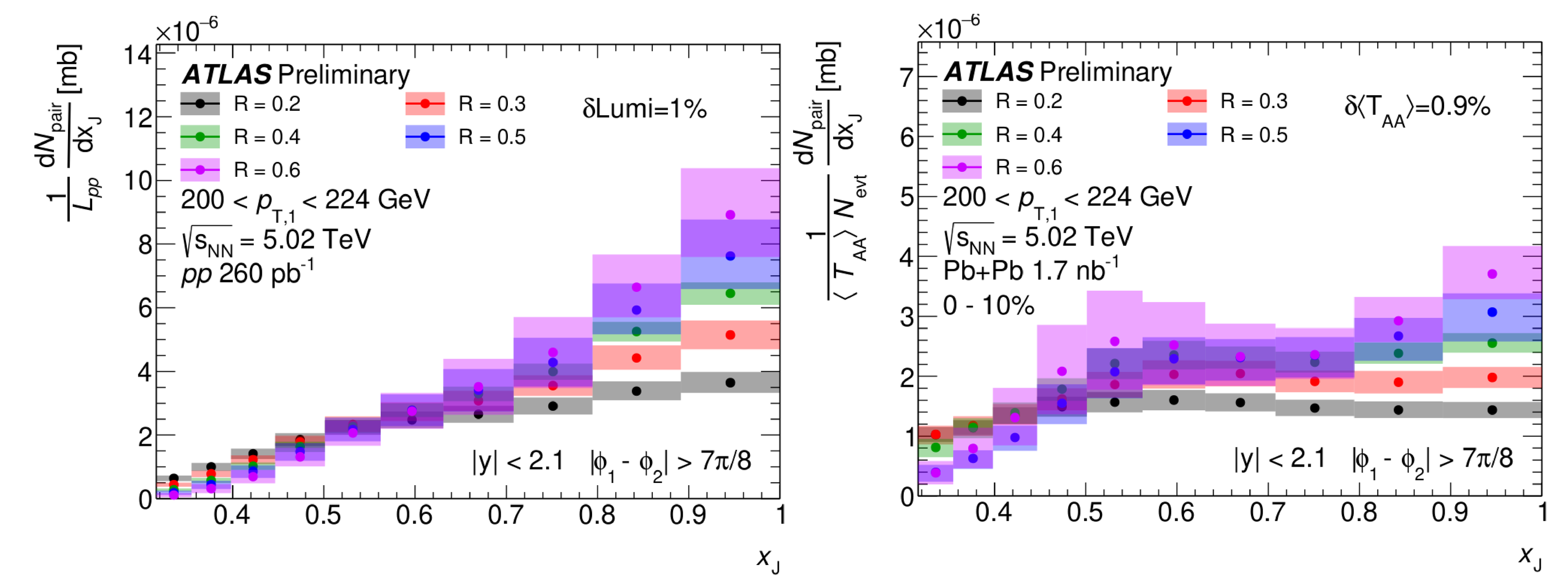
Studied dijets of R = 0.2, 0.3, 0.5, 0.6 with p_T ranging from 100 to 562 GeV in Pb+Pb and pp collisions at $\sqrt{s_{NN}}$=5.02 TeV.

Both large and small jets are more quenched towards more central collisions.

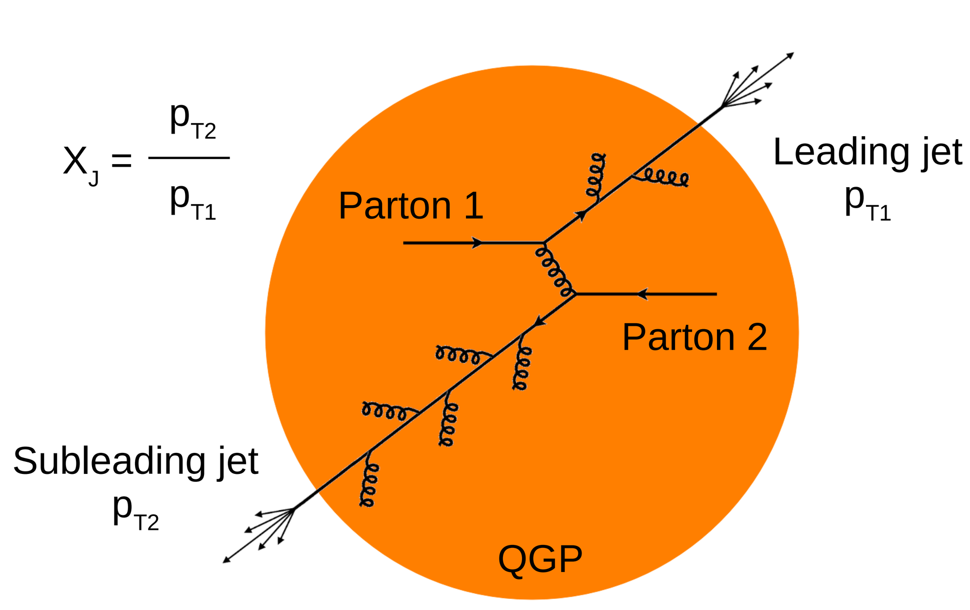


x_J distributions for R=0.2 (left) and R=0.6 (right) jets.

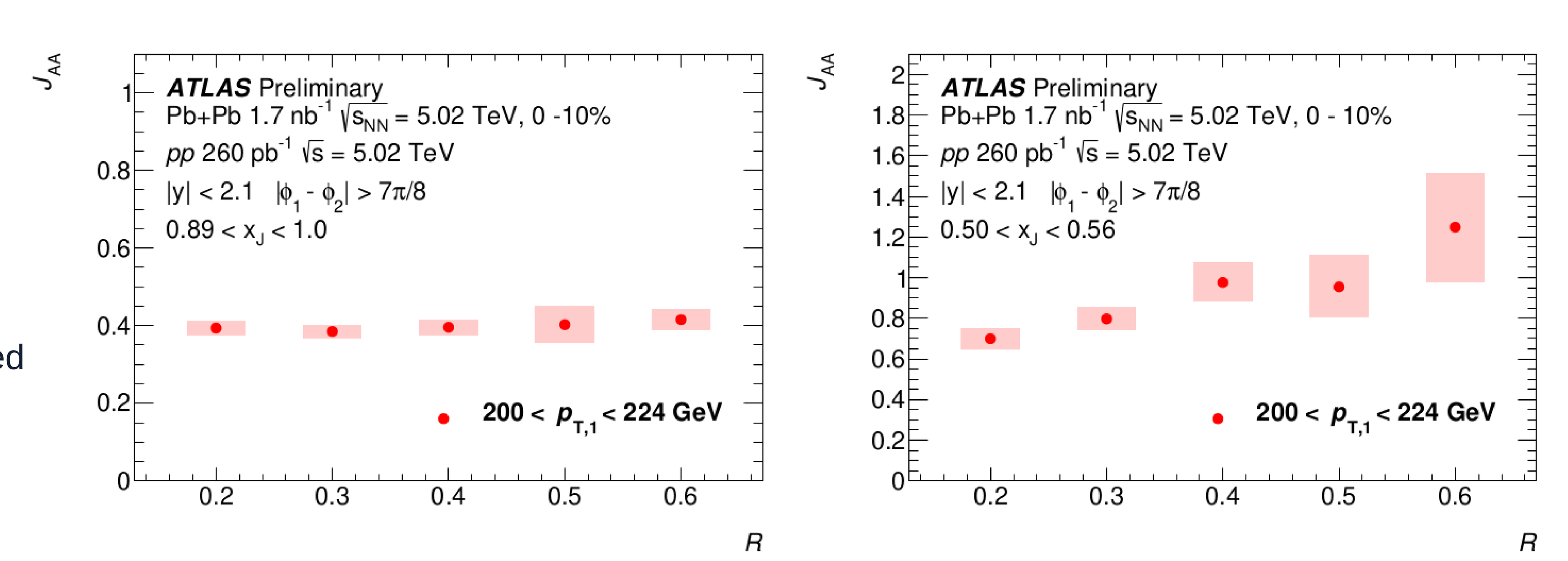
Larger dijets are more balanced in p_T.



x_J distributions for various jet radii in pp (left) and central Pb+Pb (right) collisions.

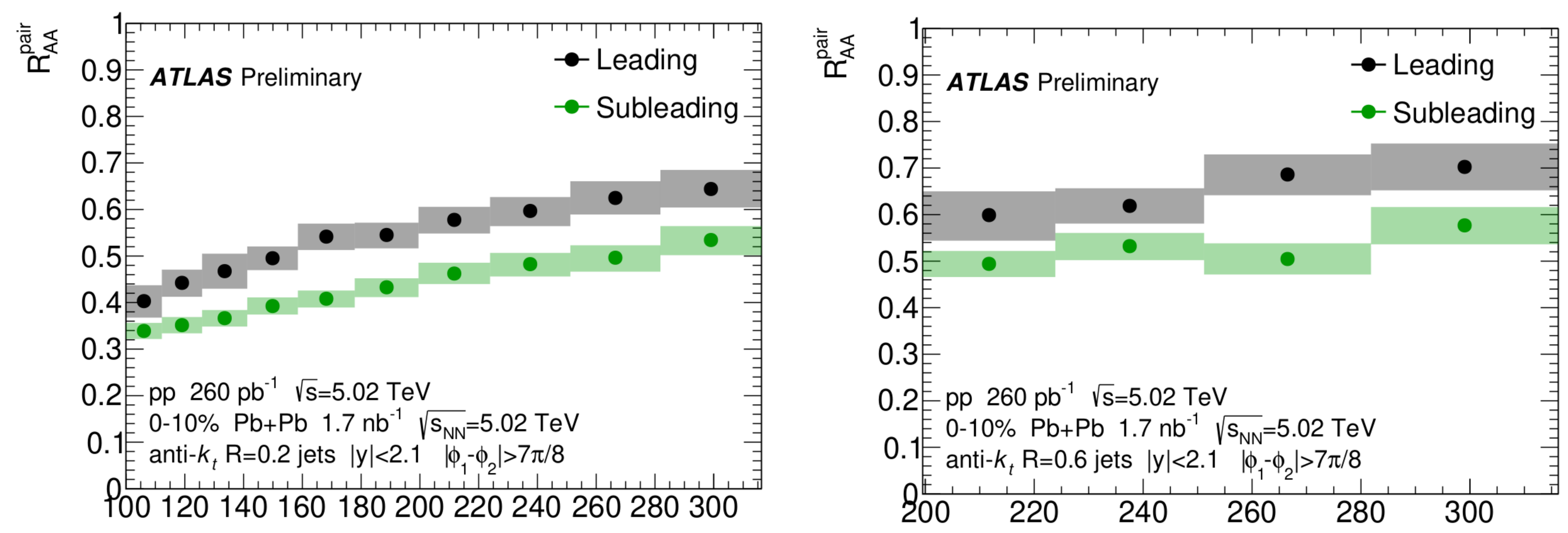


Imbalanced dijets show more dependence on the jet radius than balanced dijets.



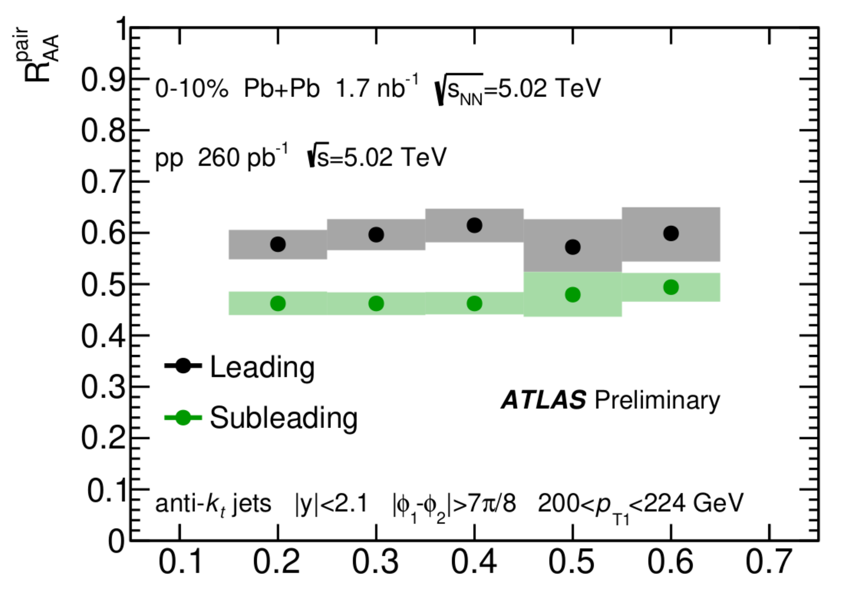
J_{AA} vs. R for balanced (left) and imbalanced (right) dijets in central Pb+Pb collisions.

Subleading jets are more quenched than leading jets, for both large and small jets.

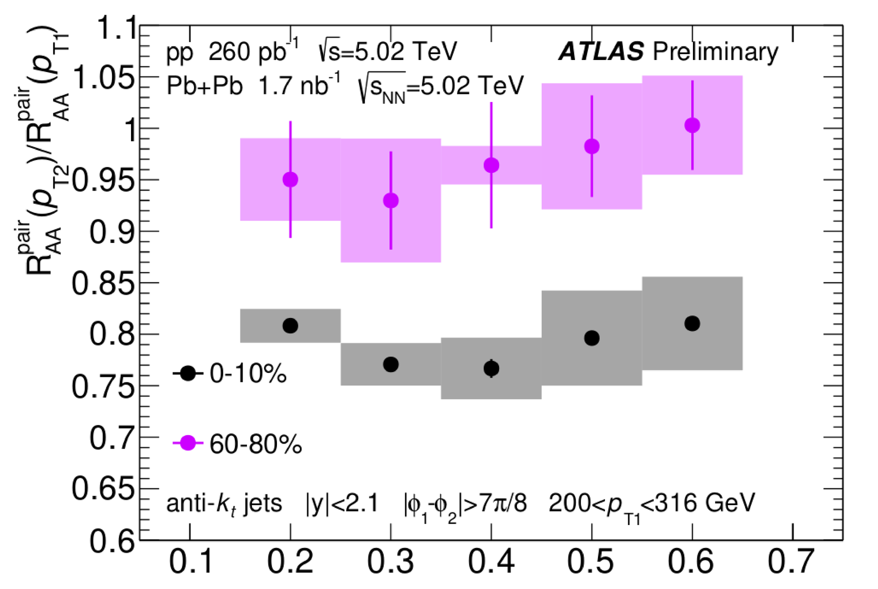


Leading and subleading jet R_{AA}^{pair} for R=0.2 (left) and R=0.6 (right) jets.

No significant dependence of the R_{AA}^{pair} on the jet radius



R_{AA}^{pair} vs. R for leading and subleading jets.



Double ratio of subleading to leading jet R_{AA}^{pair} vs. R for central and peripheral collisions.