Novel measurements of dijet quenching with ATLAS

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on behalf of ATLAS collaboration

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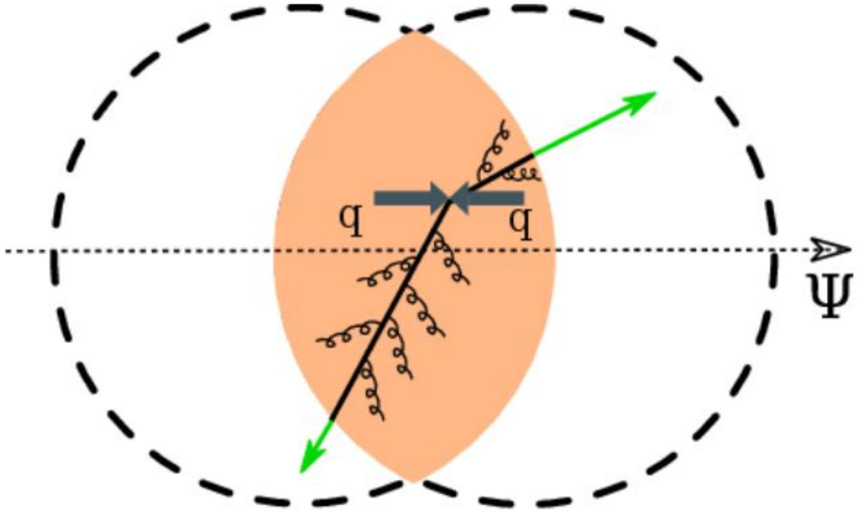
Aschaffenburg

Dijet measurement

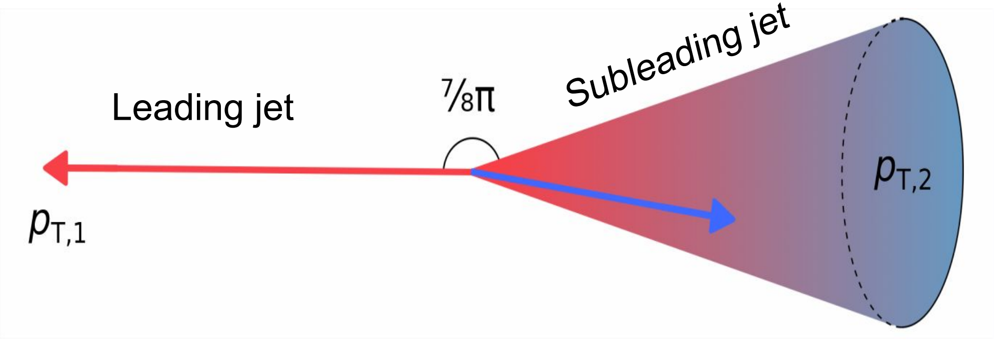
- Dijets can provide more information than inclusive jets
- Put more constraints on path-length dependence
- More sensitive to fluctuations in the energy loss



cartoon by M.Rybar

Observables

arXiv: 2205.00682



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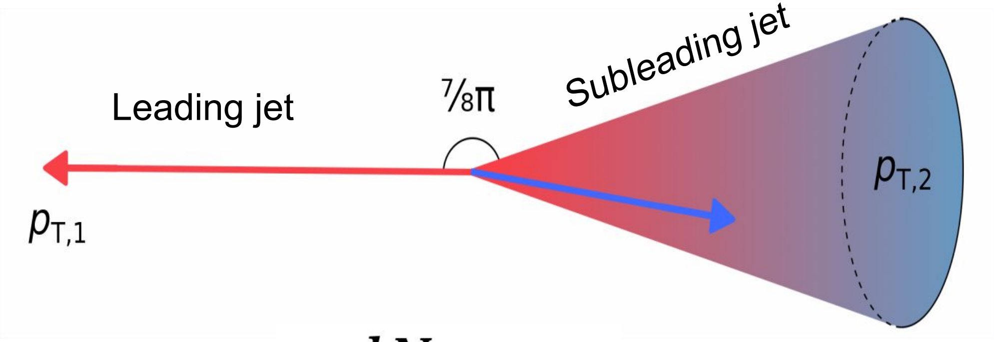
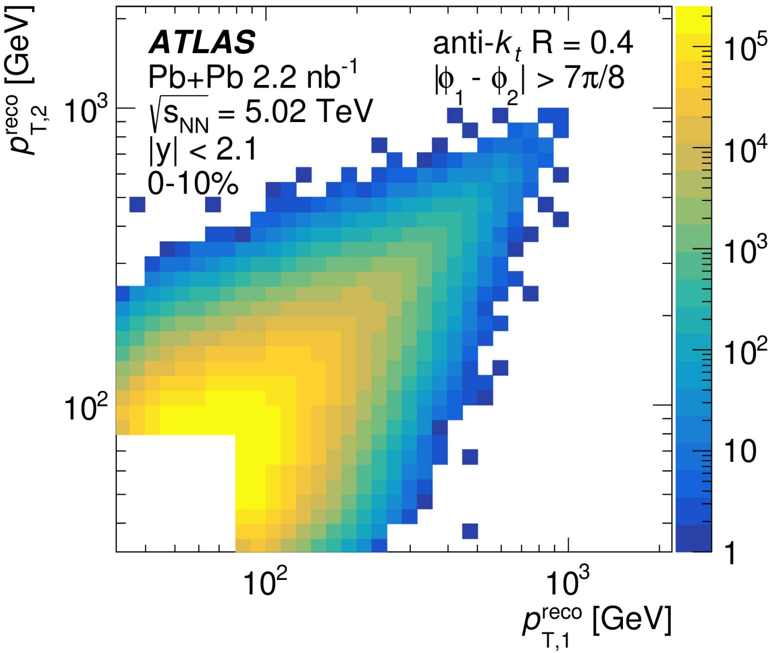


$$\frac{dN_{pair}}{dp_{T,1}dp_{T,2}}$$



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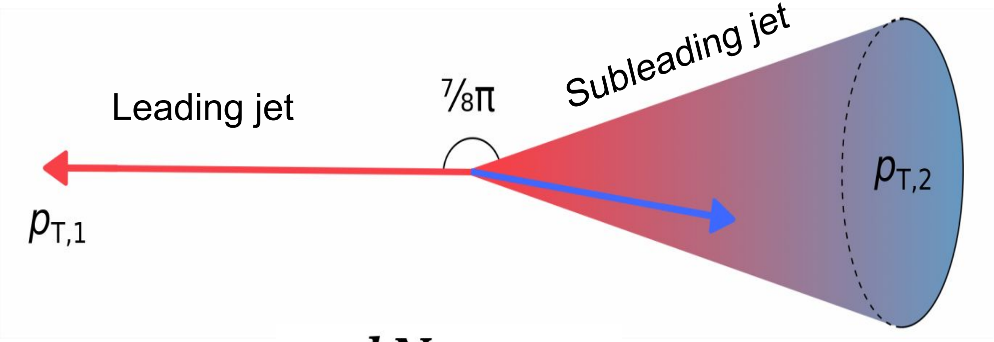

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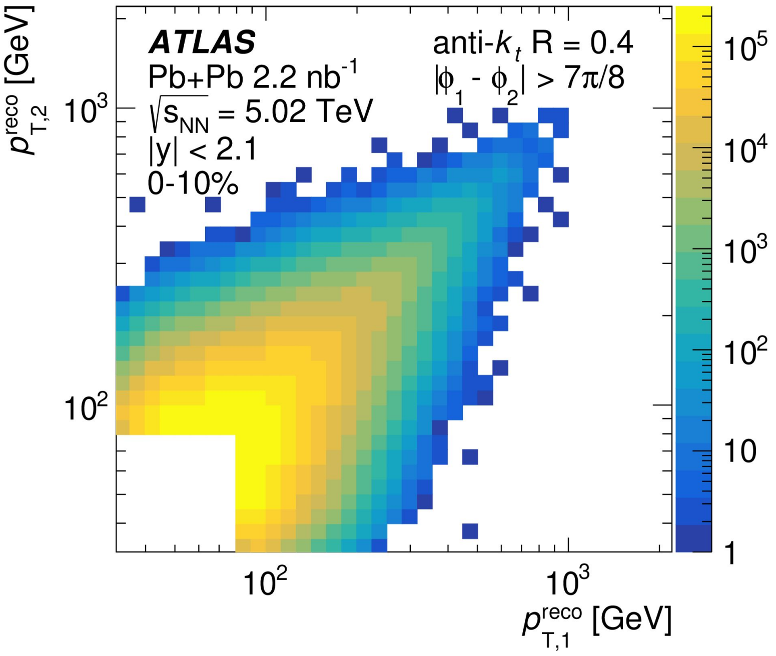


- ($p_{T,1}$,$p_{T,2}$) distributions are:
  - Corrected for background jets
  - Unfolded
  - Used to obtain final observables

Dijet momentum balance distribution

$$x_{\mathrm{J}} = \frac{p_{\mathrm{T}_2}}{p_{\mathrm{T}_1}}$$

Dijet momentum balance

Two normalizations

$$\frac{1}{N_{\mathrm{pair}}} \frac{\mathrm{d}N_{\mathrm{pair}}}{\mathrm{d}x_{\mathrm{J}}}$$

Per-pair normalized

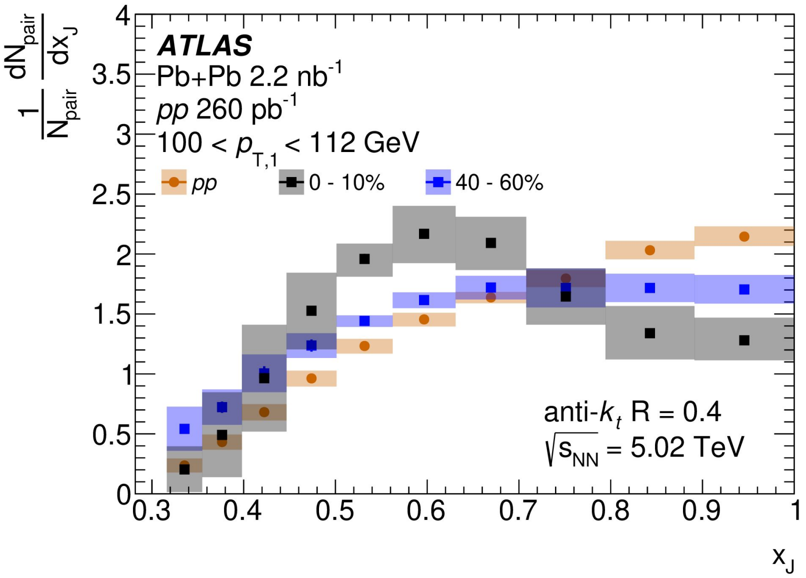
$$\frac{1}{N_{\mathrm{evt}}} \frac{1}{\langle T_{\mathrm{AA}} \rangle} \frac{\mathrm{d}N_{\mathrm{pair}}}{\mathrm{d}x_{\mathrm{J}}}$$

Absolutely normalized

- While per-pair normalized will allow us to compare shapes between the centralities, the absolute normalization will give the absolute yields.

Per-pair normalized x_J

arXiv: 2205.00682



- Significant modification in Pb+Pb collisions compared to *pp* in all $p_{T,1}$ intervals
- The distribution is peaked at x_J ~ 0.6 in the lowest $p_{T,1}$

Per-pair normalized x_J

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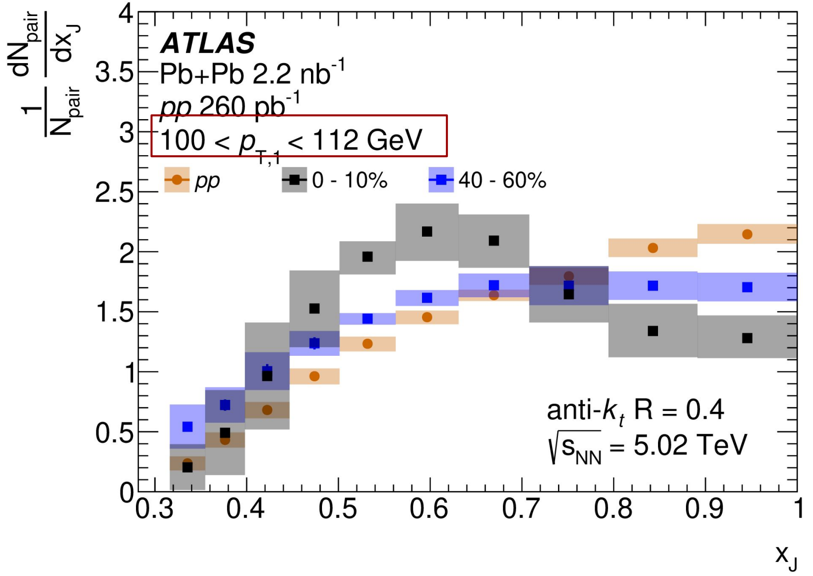
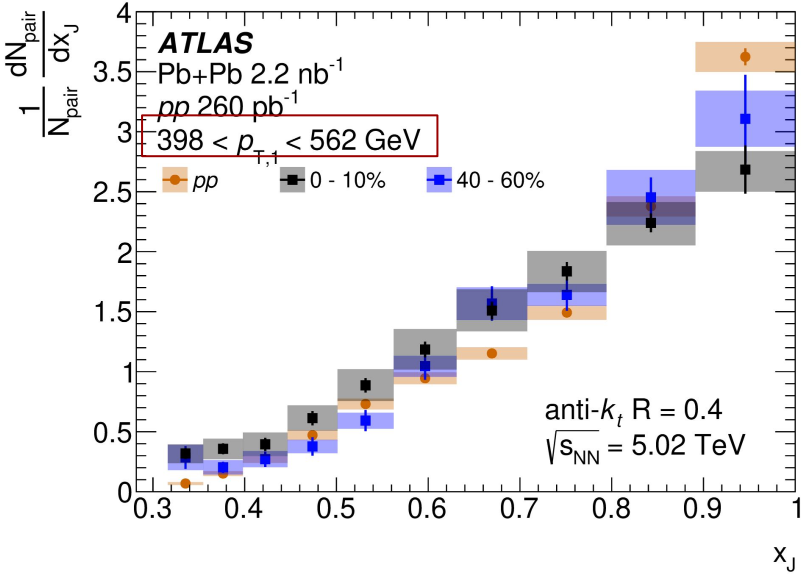


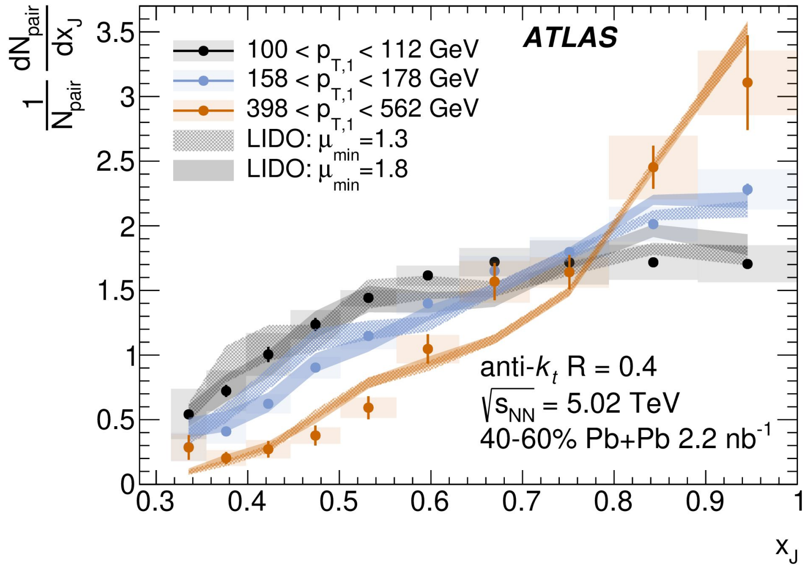


- Significant modification in Pb+Pb collisions compared to *pp* in all $p_{T,1}$ intervals
- The distribution is peaked at x_J ~ 0.6 in the lowest $p_{T,1}$

- *pp* collisions have a sharper maximum at x_J=1
- The difference between Pb+Pb and *pp* distributions decreases with increasing $p_{T,1}$.

Per-pair normalized x_J - model predictions

arXiv: 2205.00682



- LIDO predictions:
  - Reproduces the behaviour at high $p_{T,1}$ and in 40-60% centrality intervals

LIDO arXiv: 2007.02645

Per-pair normalized x_J - model predictions

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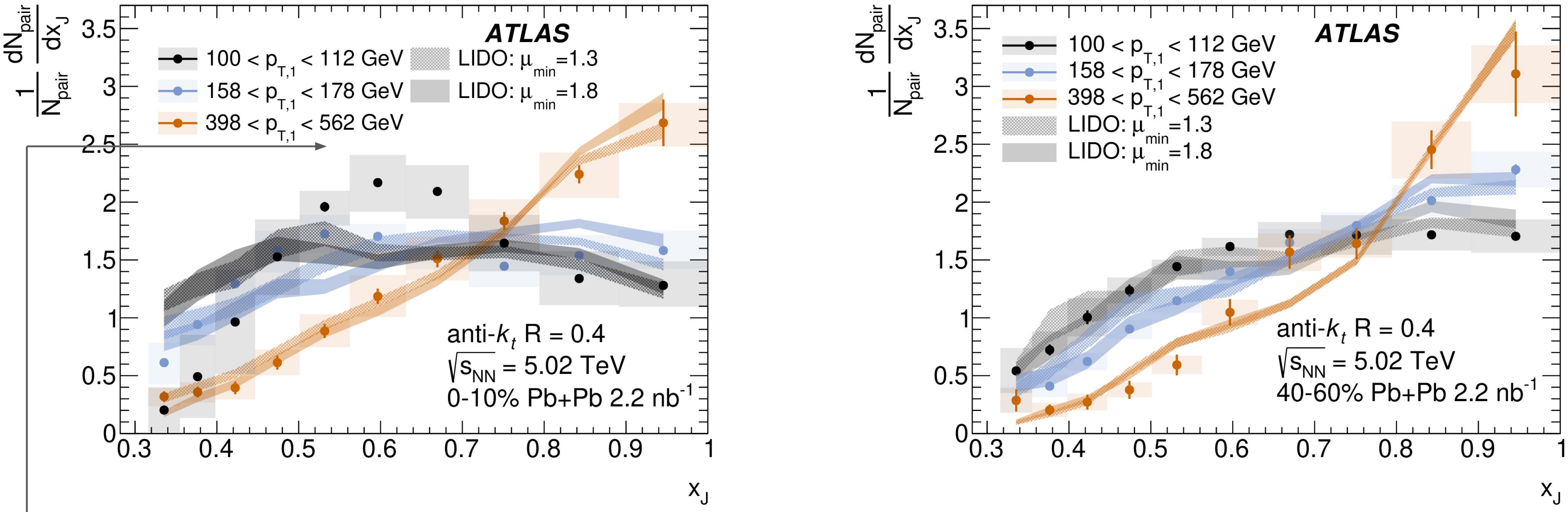
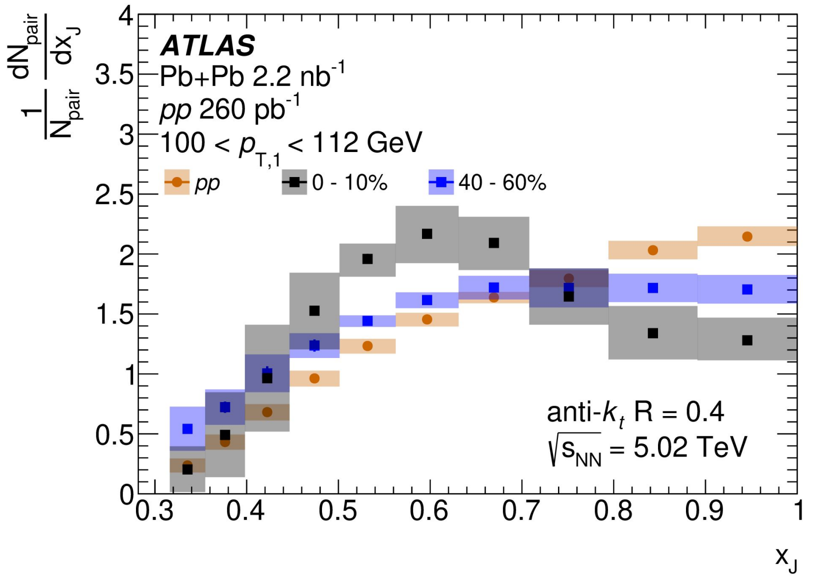


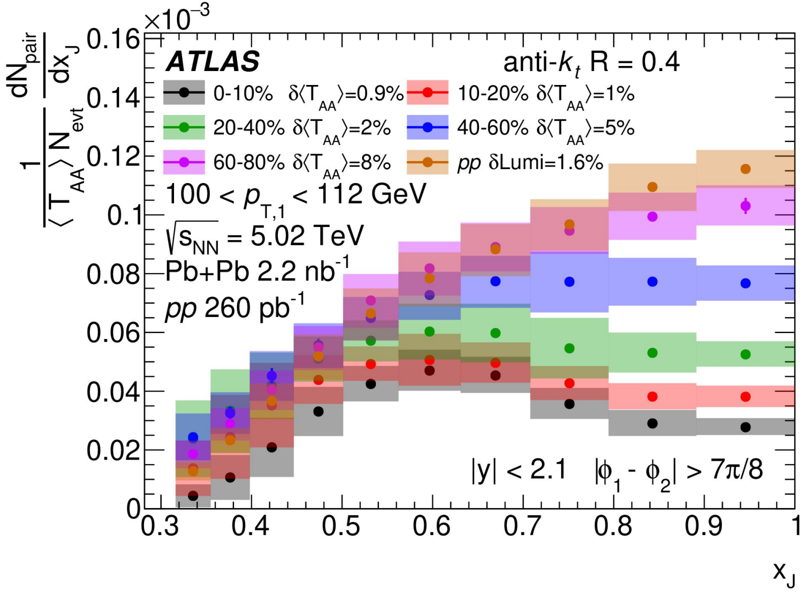
- LIDO predictions:
  - Reproduces the behaviour at high $p_{T,1}$ and in 40-60% centrality intervals
  - Does not reproduce well the relative enhancement in 0-10%

LIDO arXiv: 2007.02645

Absolutely normalized x_J

arXiv: 2205.00682



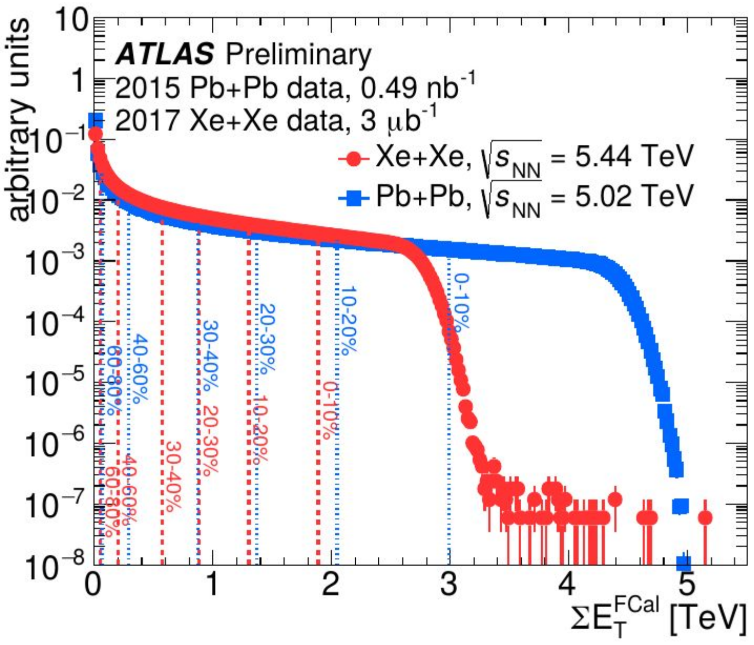


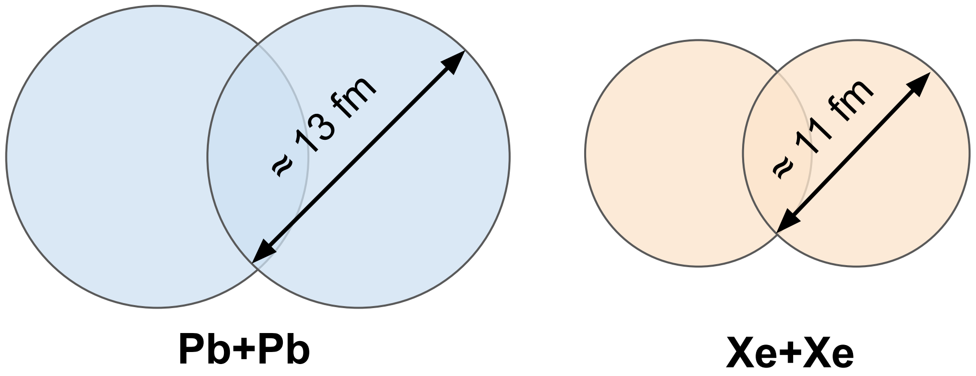
- Peak-like structure may falsely suggest the enhancement of production of imbalanced jets
- Absolutely normalized x_J show that balanced jets are more suppressed compared to imbalanced ones
- Smooth centrality evolution

How will this change in a different system?

ATLAS-CONF-2018-007

- Centrality is calculated using energy deposited in forward calorimeter





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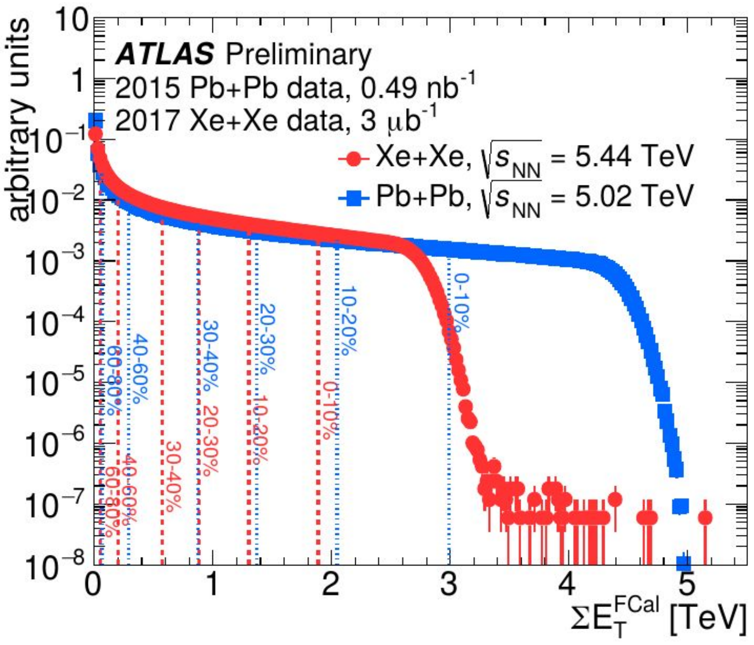
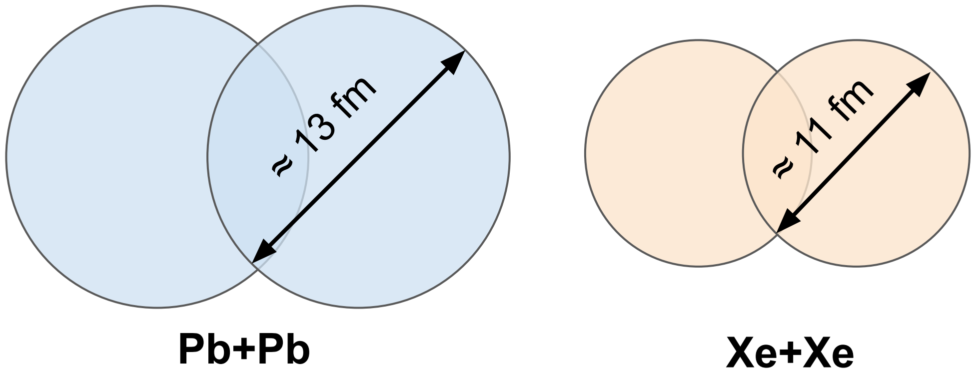


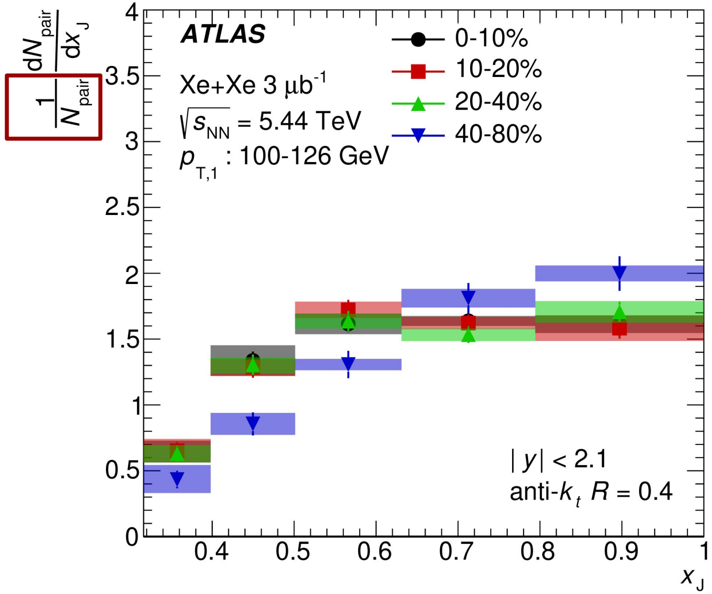


Same event activity (Same overlap)

Xe+Xe Cent.	Pb+Pb Cent.
0–7.7%	10–20%
7.7–29.9%	20–40%
29.9–53.2%	40–60%

The x_J distributions in Xe+Xe

arXiv: 2302.03967



Per-pair normalized

- Substantial difference between central and peripheral collisions
- Peak-like structure from Pb+Pb is not observed (smaller nuclear overlap)
- Not as pronounced differences as in Pb+Pb

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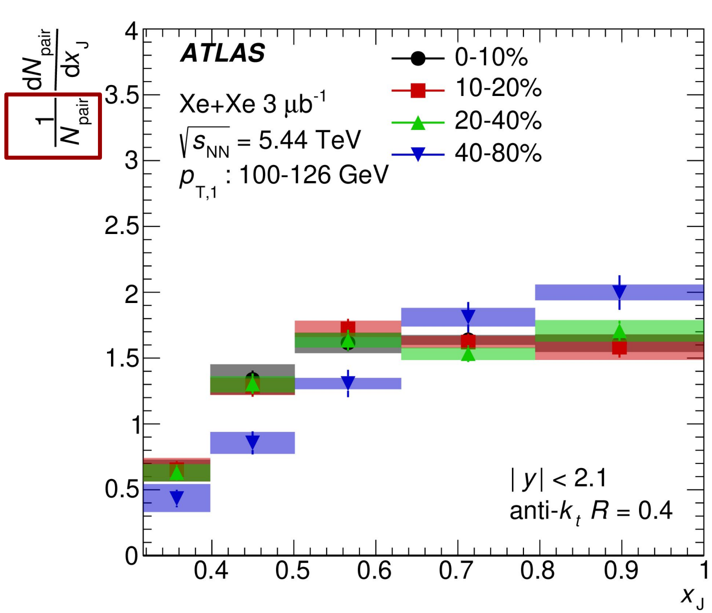
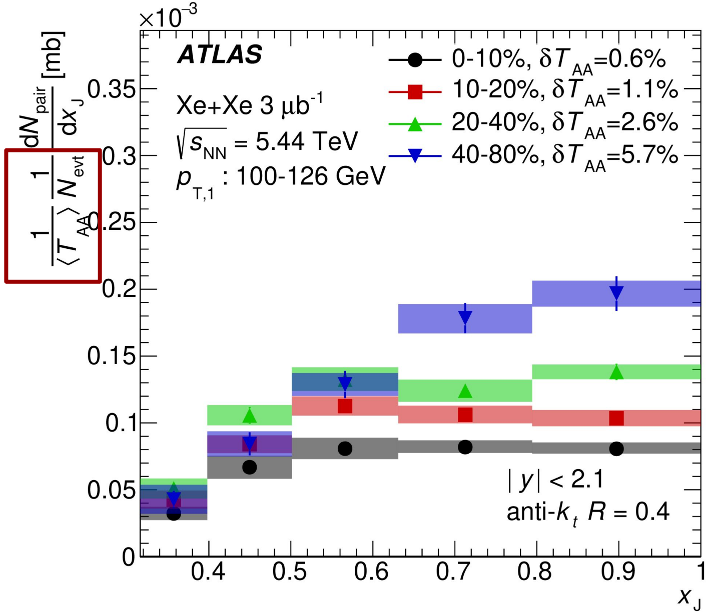




Per-pair normalized

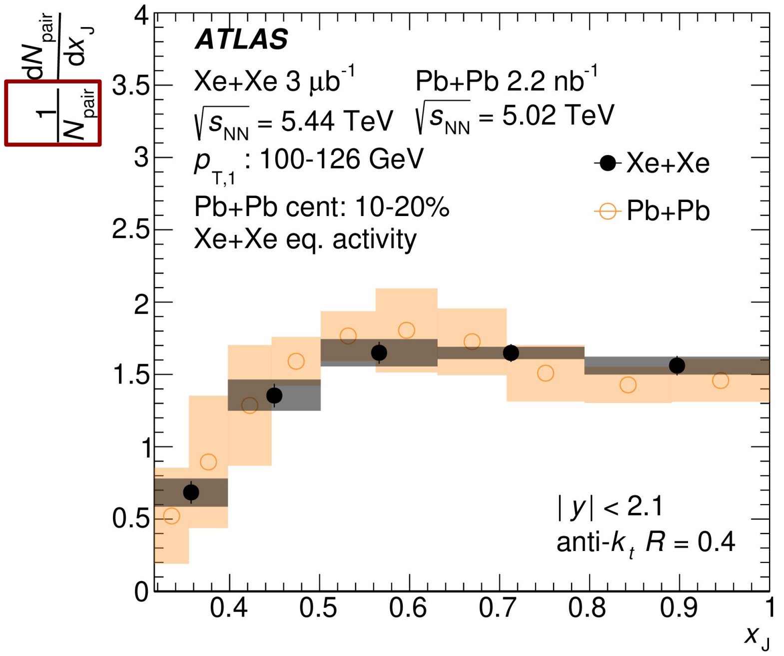
- Substantial difference between central and peripheral collisions
- Peak-like structure from Pb+Pb is not observed (smaller nuclear overlap)
- Not as pronounced differences as in Pb+Pb

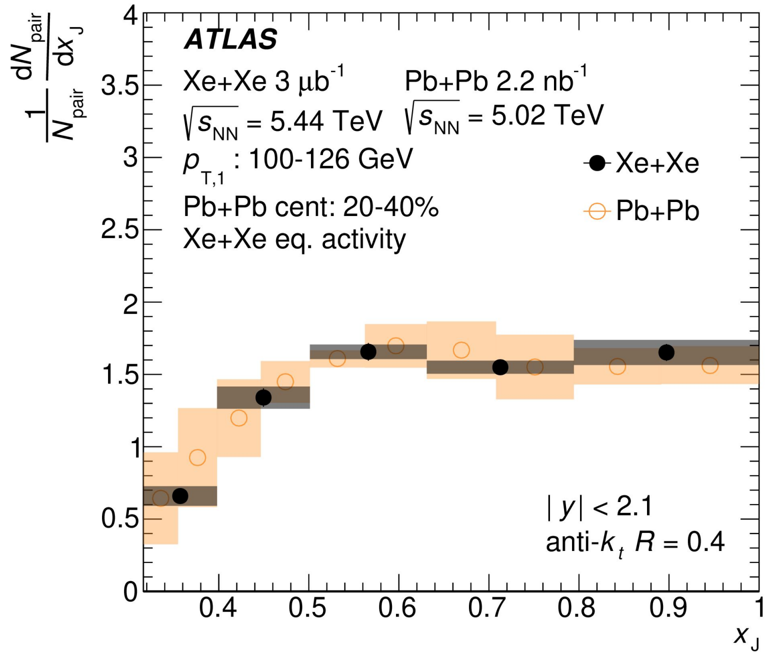
Absolutely normalized

- As in Pb+Pb, a depletion of balanced jets is observed
- Clear centrality evolution

Comparison between Pb+Pb and Xe+Xe

arXiv: 2302.03967





- When ΣE_T^{FCal} intervals from Xe+Xe are matched to Pb+Pb, the distributions are consistent between Pb+Pb and Xe+Xe

Comparison between Pb+Pb and Xe+Xe

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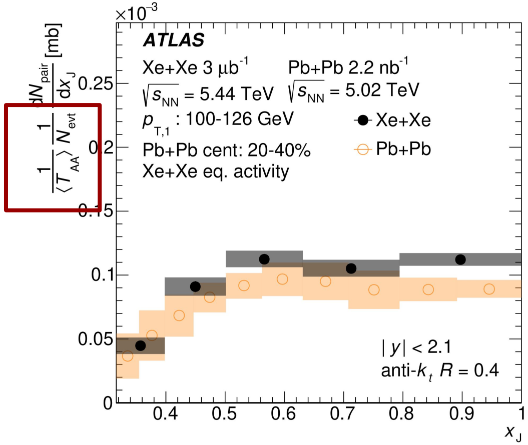

- A larger absolute dijet yield is seen in Xe+Xe collisions compared to Pb+Pb collisions
- This may be in part due to difference in the CME affecting the hard partonic cross-section

Comparison between Pb+Pb and Xe+Xe

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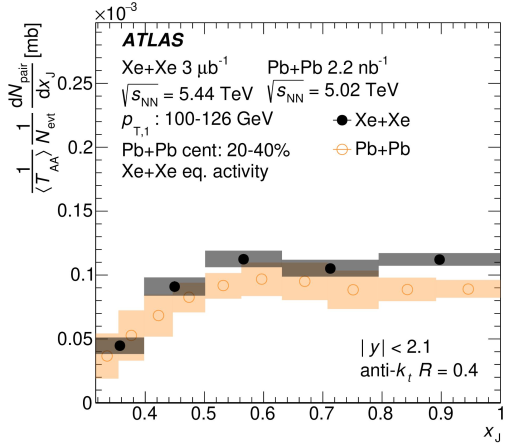
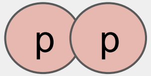
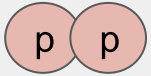


- A larger absolute dijet yield is seen in Xe+Xe collisions compared to Pb+Pb collisions
- This may be in part due to difference in the CME affecting the hard partonic cross-section
- Correction factor introduced to correct for the difference in the CME:

$C(p_{T,1})$ =



| **5.44 TeV**, MC PYTHIA

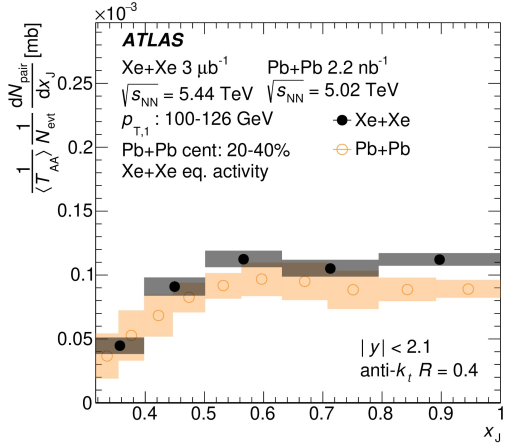


| **5.02 TeV**, MC PYTHIA

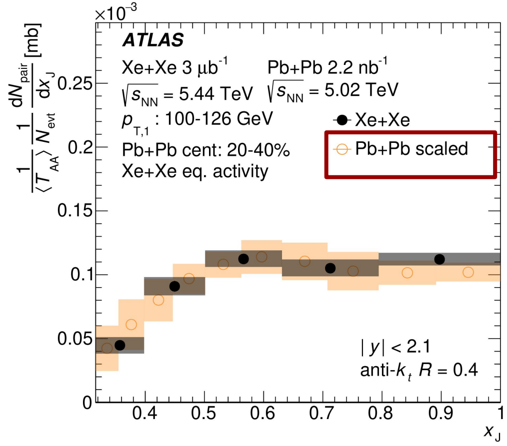
Comparison between Pb+Pb and Xe+Xe

arXiv: 2302.03967

No CME correction



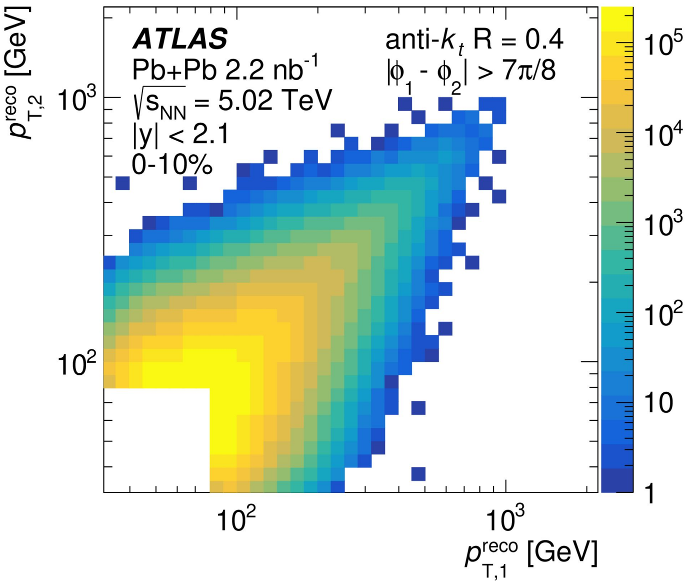
Corrected for CME



Good agreement after scaling

Pair R_{AA}

- The ($p_{T,1}$,$p_{T,2}$) distribution is projected to $p_{T,1}$ and $p_{T,2}$ axes to get leading and sub-leading jet yields, respectively.
- These can then be used to construct pair nuclear modification factor.



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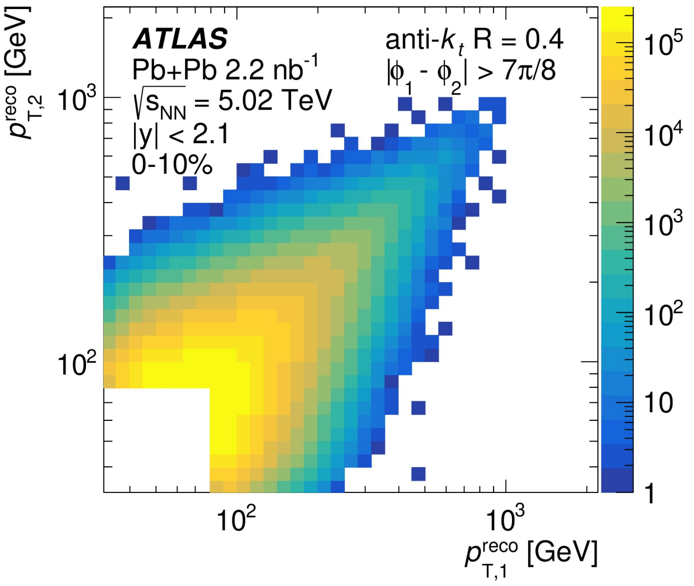

$$R_{\mathrm{AA}}^{\mathrm{pair}}(p_{\mathrm{T},1}) = \frac{\frac{1}{\langle T_{\mathrm{AA}}\rangle N_{\mathrm{evt}}^{\mathrm{AA}}} \int_{0.32\times p_{\mathrm{T},1}}^{p_{\mathrm{T},1}} \frac{\mathrm{d}^2 N^{\mathrm{pair}}(\mathrm{AA})}{\mathrm{d}p_{\mathrm{T},1}\mathrm{d}p_{\mathrm{T},2}} \mathrm{d}p_{\mathrm{T},2}}{\frac{1}{\mathcal{L}_{pp}} \int_{0.32\times p_{\mathrm{T},1}}^{p_{\mathrm{T},1}} \frac{\mathrm{d}^2 N^{\mathrm{pair}}(pp)}{\mathrm{d}p_{\mathrm{T},1}\mathrm{d}p_{\mathrm{T},2}} \mathrm{d}p_{\mathrm{T},2}}$$

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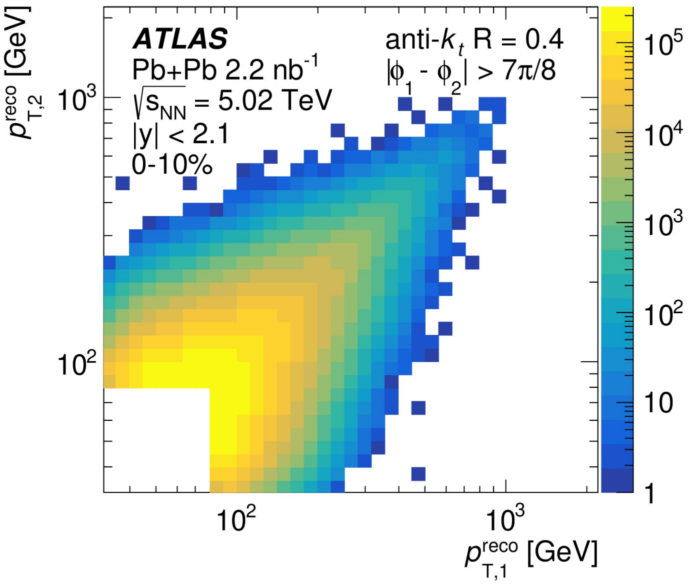
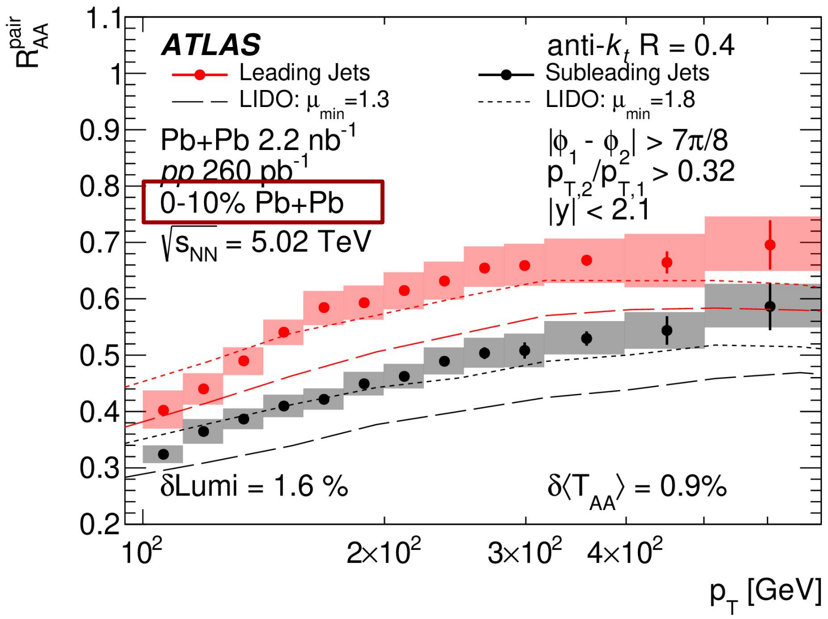


$$R_{AA}^{pair}(p_{T,1}) = \frac{\frac{1}{\langle T_{AA}\rangle N_{evt}^{AA}} \int_{0.32\times p_{T,1}}^{p_{T,1}} \frac{d^2 N^{pair}(AA)}{dp_{T,1}dp_{T,2}} dp_{T,2}}{\frac{1}{\mathcal{L}_{pp}} \int_{0.32\times p_{T,1}}^{p_{T,1}} \frac{d^2 N^{pair}(pp)}{dp_{T,1}dp_{T,2}} dp_{T,2}}$$

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

Pair R_{AA} Pb+Pb

arXiv: 2205.00682



- Both, leading and subleading jets show significant suppression
- LIDO reproduces the data better for μ_{min} = 1.8

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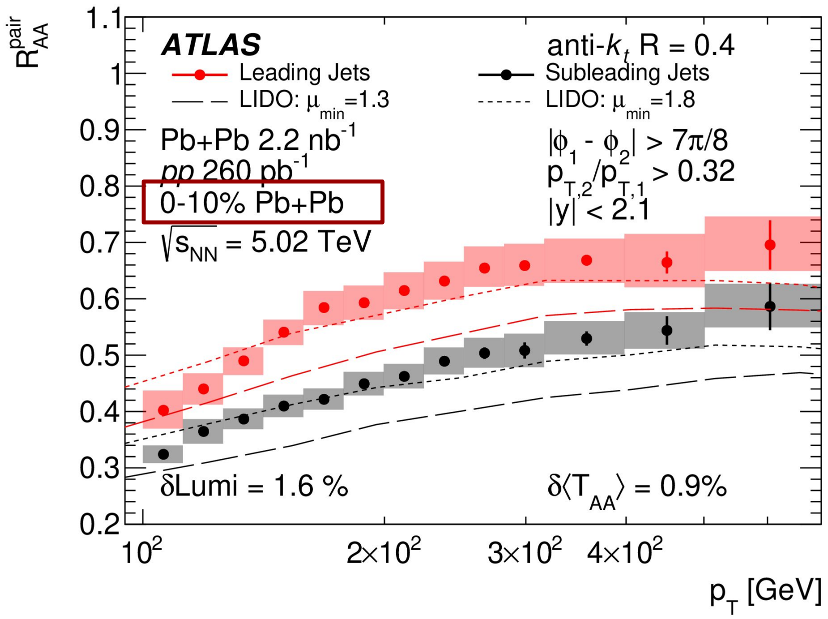
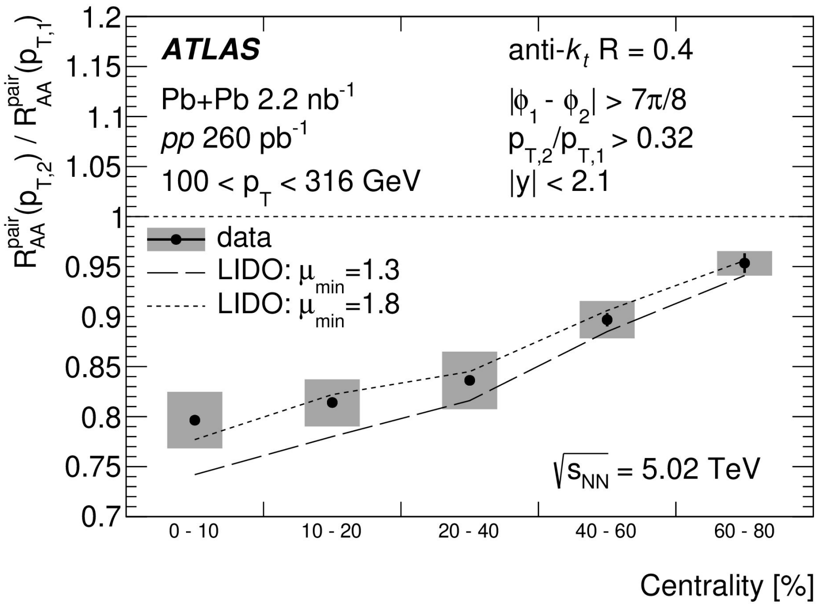




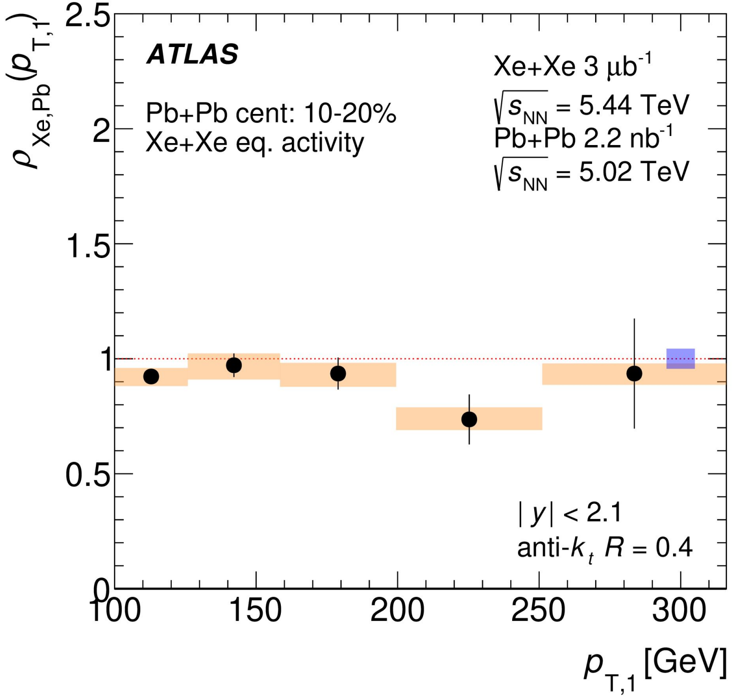
- Both, leading and subleading jets show significant suppression
- LIDO reproduces the data better for μ_{min} = 1.8

- Subleading jets are more suppressed than leading jets
- The difference in the suppression is the most significant in the most central collisions

Pair R_{AA} Xe+Xe

arXiv: 2302.03967

$$\rho_{\mathrm{Xe,Pb}}(p_{\mathrm{T},1}) = \frac{R_{\mathrm{AA}}^{\mathrm{pair}}(p_{\mathrm{T},1})|_{\mathrm{Xe+Xe}}}{R_{\mathrm{AA}}^{\mathrm{pair}}(p_{\mathrm{T},1})|_{\mathrm{Pb+Pb}}}$$



- Allows to quantify the difference in the dijet suppression with respect to that measured in Pb+Pb
- Consistent with unity

Conclusions

- Imbalanced dijets are more probable configuration than balanced ones in both Pb+Pb and Xe+Xe collisions
- Xe+Xe and Pb+Pb dijet yields are consistent with each other when compared in the same activity intervals and after correcting for the difference in the CME between Pb+Pb and Xe+Xe