

Measurement of suppression of large-radius jets and its dependence on substructure in Pb+Pb at 5.02 TeV with ATLAS



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Introduction

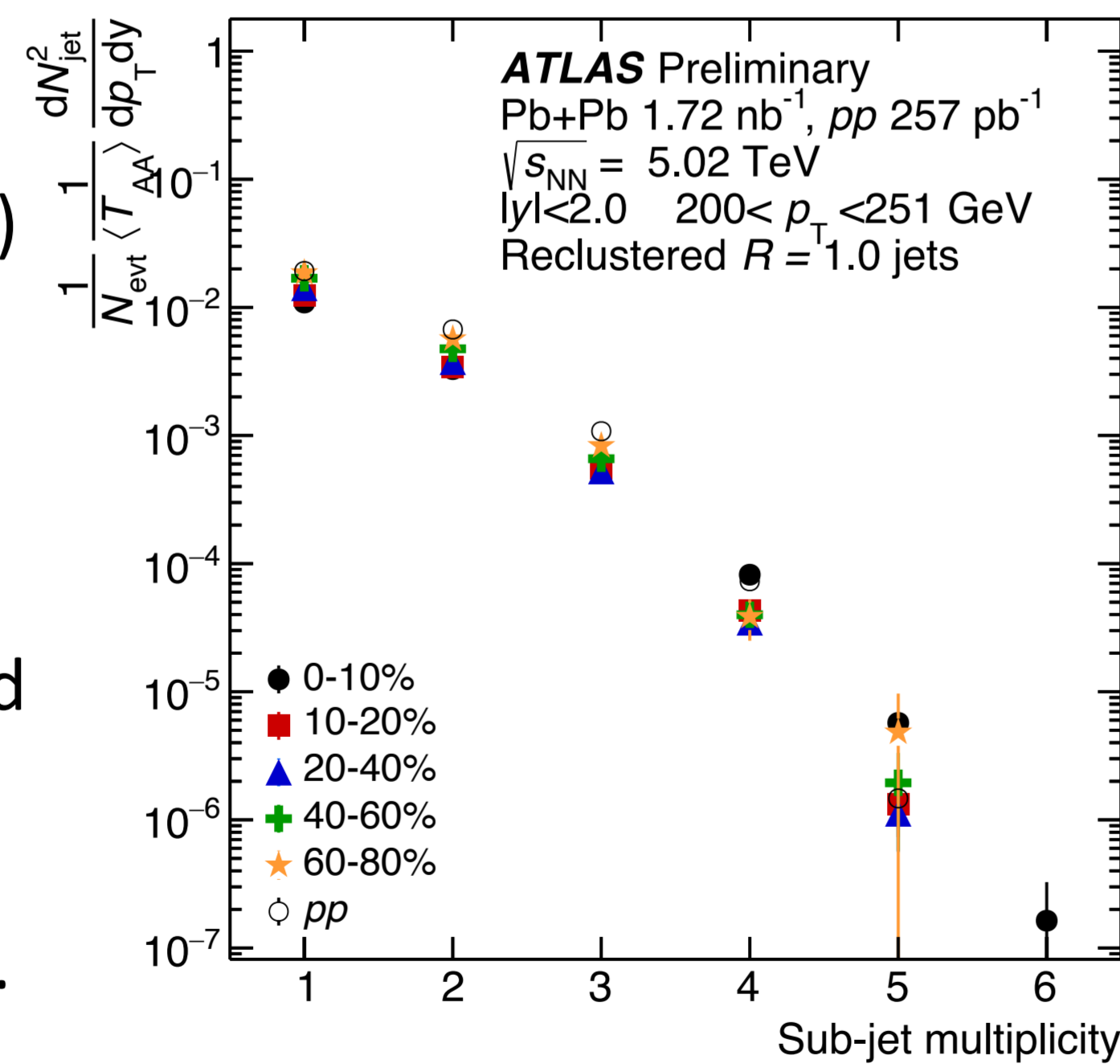
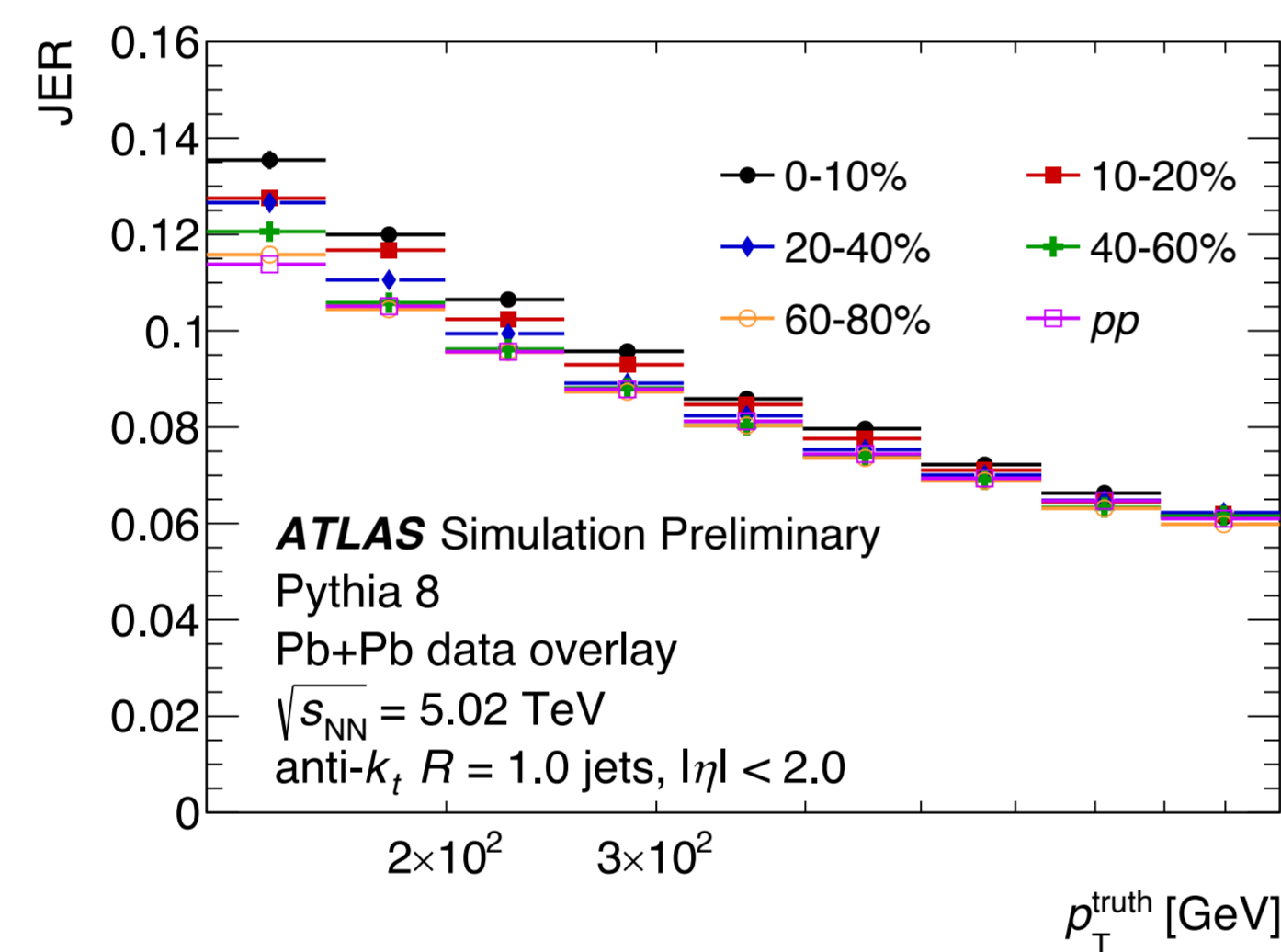
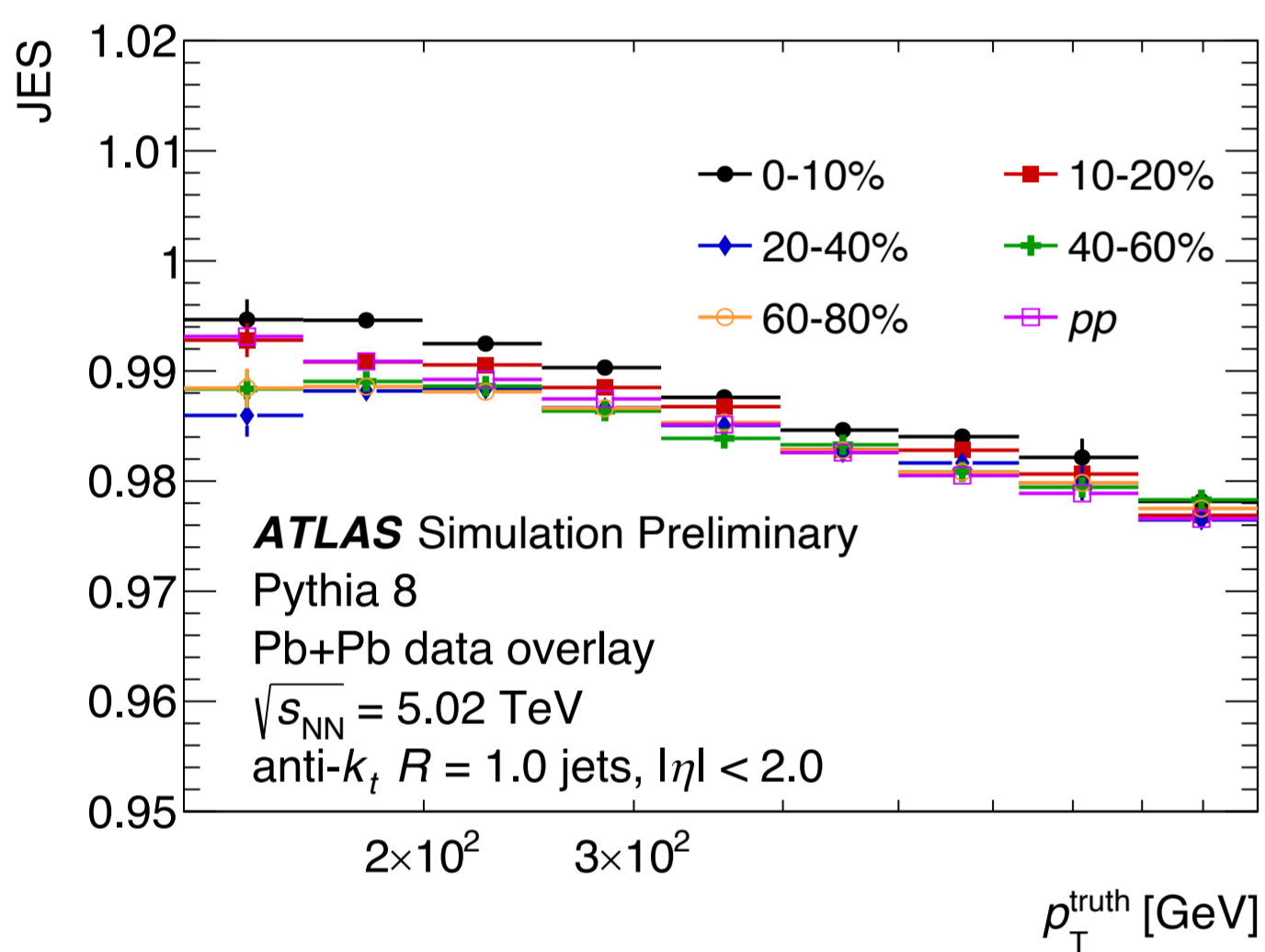
- Measurements of the suppression of the jet yield in Pb+Pb compared to pp provide insight into the energy-loss process and the properties of the quark-gluon plasma (QGP).
- In some models [1] which describe the jet energy loss in the QGP, the medium can only resolve partonic fragments at certain **transverse resolution scale**, below which they act **coherently** as a single emitter.
- To study this, nuclear modification factor, R_{AA} is measured with **large-radius jets** and dependence on splitting scale $\sqrt{d_{12}}$.
- This measurement [2] is carried out with 2018 Pb+Pb (1.72 nb^{-1}) and 2017 pp (257 pb^{-1}) data, both recorded at 5.02 TeV.

$$R_{AA} = \frac{1}{N_{\text{evt}}^{\text{tot}}} \frac{d^3 N_{\text{jet}}}{dp_T d\sqrt{d_{12}} dy} \Big|_{\text{cent}} \frac{\langle T_{AA} \rangle}{\frac{d^3 \sigma_{\text{jet}}}{dp_T d\sqrt{d_{12}} dy} \Big|_{pp}}$$

Jet reconstruction and analysis procedure

- $R = 1.0$ large-radius jets: select **anti- k_t $R = 0.2$** jets [3] with $p_T > 35 \text{ GeV}$, and cluster them with **anti- k_t $R = 1.0$** algorithm within $|y| < 2.0$.
- Splitting scale $\sqrt{d_{12}}$** characterizes the jet **substructure**. Run k_t alg. to re-cluster the $R = 0.2$ sub-jets in the $R = 1.0$ jet, and at the **last** clustering step (2->1), which corresponds to the **hardest splitting** in the jet, define:

$$\sqrt{d_{12}} \equiv \min(p_{T1}, p_{T2}) \cdot \Delta R_{12}, \quad \Delta R_{12} = \sqrt{\Delta\phi_{12}^2 + \Delta y_{12}^2}$$

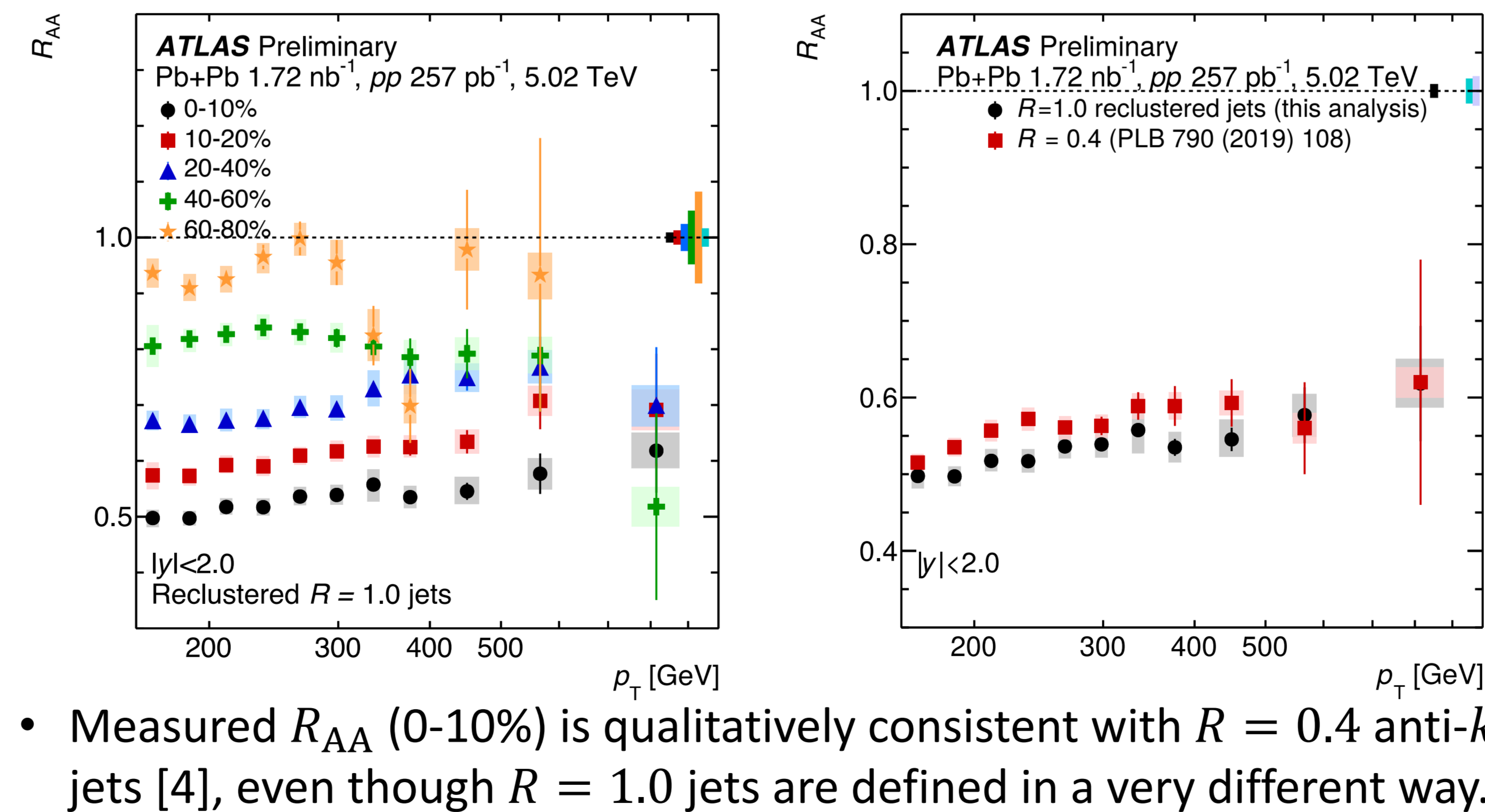


- This reconstruction method suppresses the underlying event and gives **good jet energy scale (JES)** and jet energy resolution (JER).
- Most $R = 1.0$ jets have only **one $R = 0.2$ sub-jet**.
- The centrality dependence of the sub-jet multiplicity can be attributed to the resolution and combinatorial contributions from jets produced in other independent hard scatterings.
- 2D (1D) Bayesian unfolding** is applied **in jet p_T** and $\sqrt{d_{12}}$ (in jet p_T only).
- The unfolding removes the effects of the jet energy resolution, residual jet energy scale non-closure, and the combinatorial contribution.

Systematic uncertainties

- The following systematic uncertainties are considered for this analysis:
 - Uncertainty of the jet energy scale
 - Uncertainty of the jet energy resolution
 - Sensitivity of the unfolding to the prior
 - Uncertainty from the limited number of MC events
 - Uncertainty of the mean nuclear thickness function (T_{AA}) values
 - Uncertainty of the pp luminosity
- Many cancel out between Pb+Pb and pp when calculating R_{AA} ratio.
- Dominated by the jet energy scale term.

Result: inclusive R_{AA}



- Measured R_{AA} (0-10%) is qualitatively consistent with $R = 0.4$ anti- k_t jets [4], even though $R = 1.0$ jets are defined in a very different way.

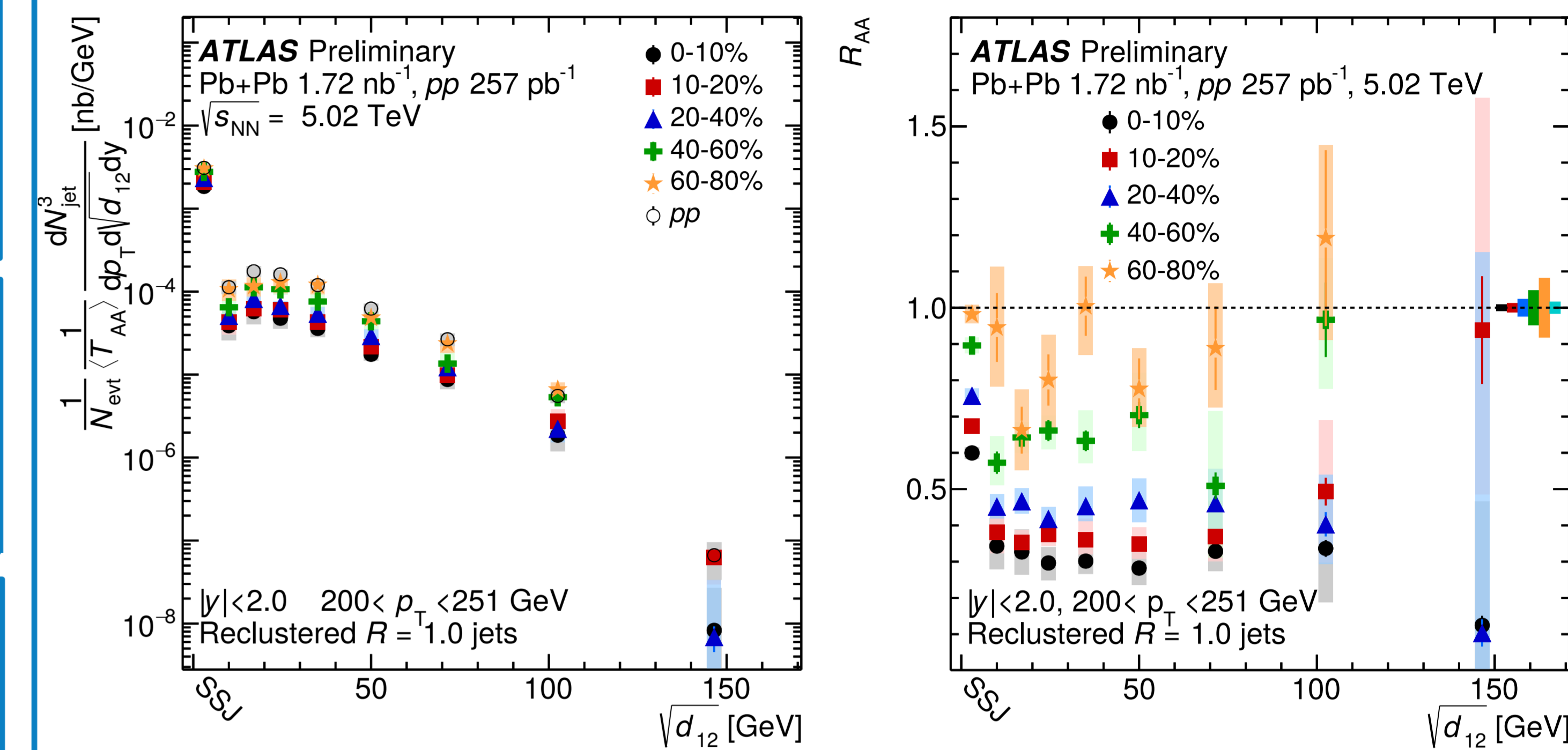
References and acknowledgements

- [1] Y. Mehtar-Tani and K. Tywoniuk, Phys. Lett. B 744 (2015) 284.
- [2] ATLAS Collaboration, ATLAS-CONF-2019-09 (2019).
- [3] M. Cacciari, G. P. Salam and G. Soyez, Eur. Phys. J. C 72 (2012) 1896.
- [4] ATLAS Collaboration, Phys. Lett. B 790 (2019) 108.

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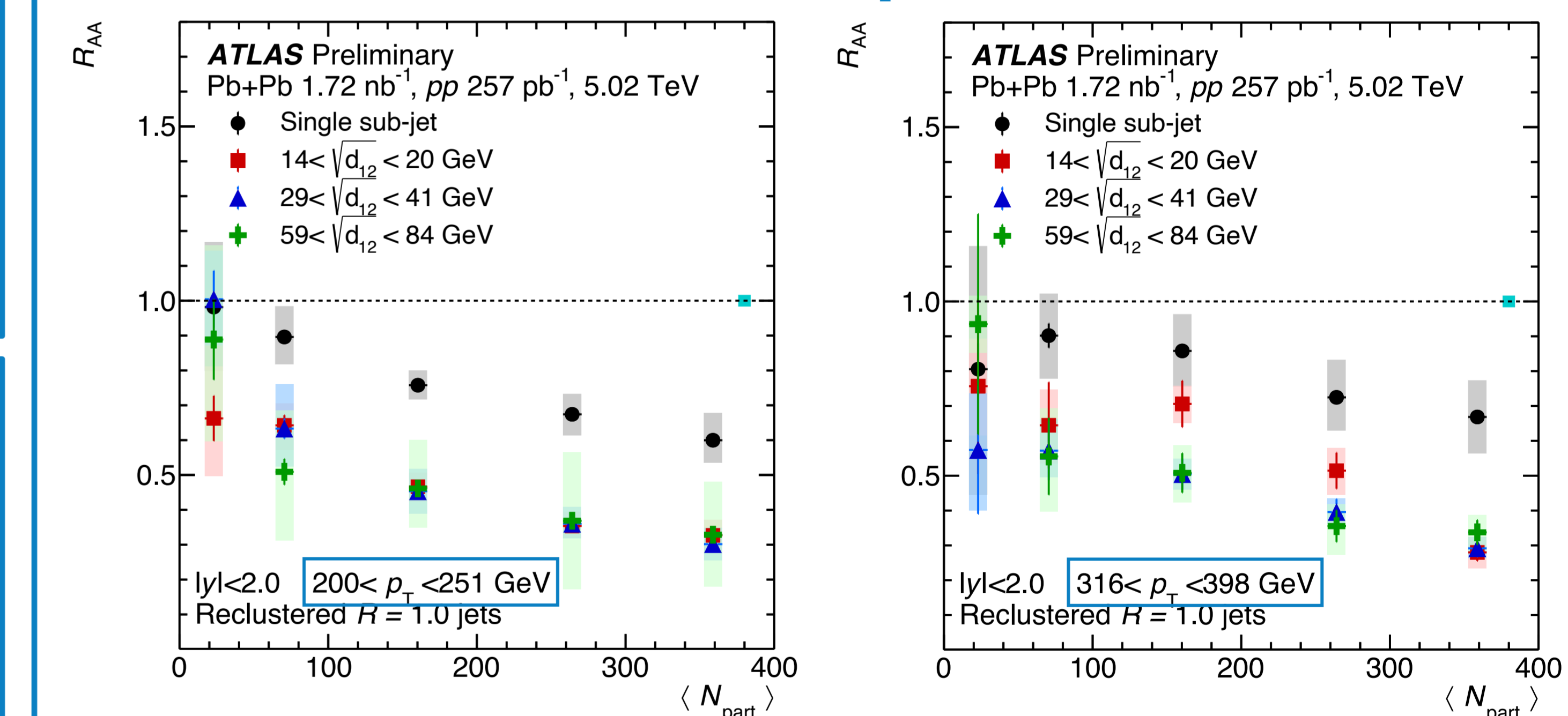
Result: R_{AA} with $\sqrt{d_{12}}$ dependence

Yields and R_{AA} vs $\sqrt{d_{12}}$



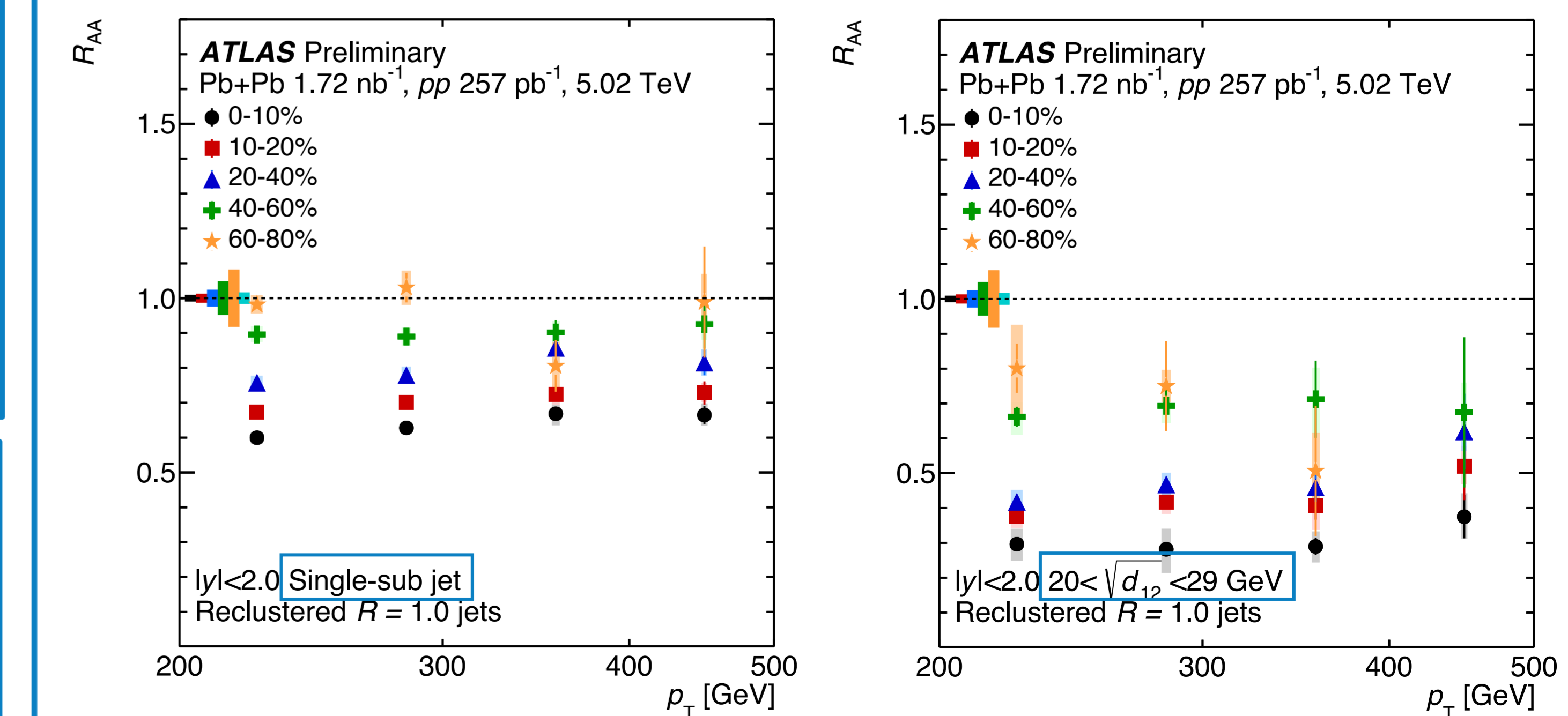
- R_{AA} drops significantly from single sub-jet (SSJ) to non-zero $\sqrt{d_{12}}$ (more complex substructure).

R_{AA} vs $\langle N_{part} \rangle$



- R_{AA} decreases as $\langle N_{part} \rangle$ increases (more central collisions).

R_{AA} vs jet p_T



- R_{AA} increases as jet p_T increases for $R = 1.0$ jets with a single sub-jet.