



ATLAS
EXPERIMENT

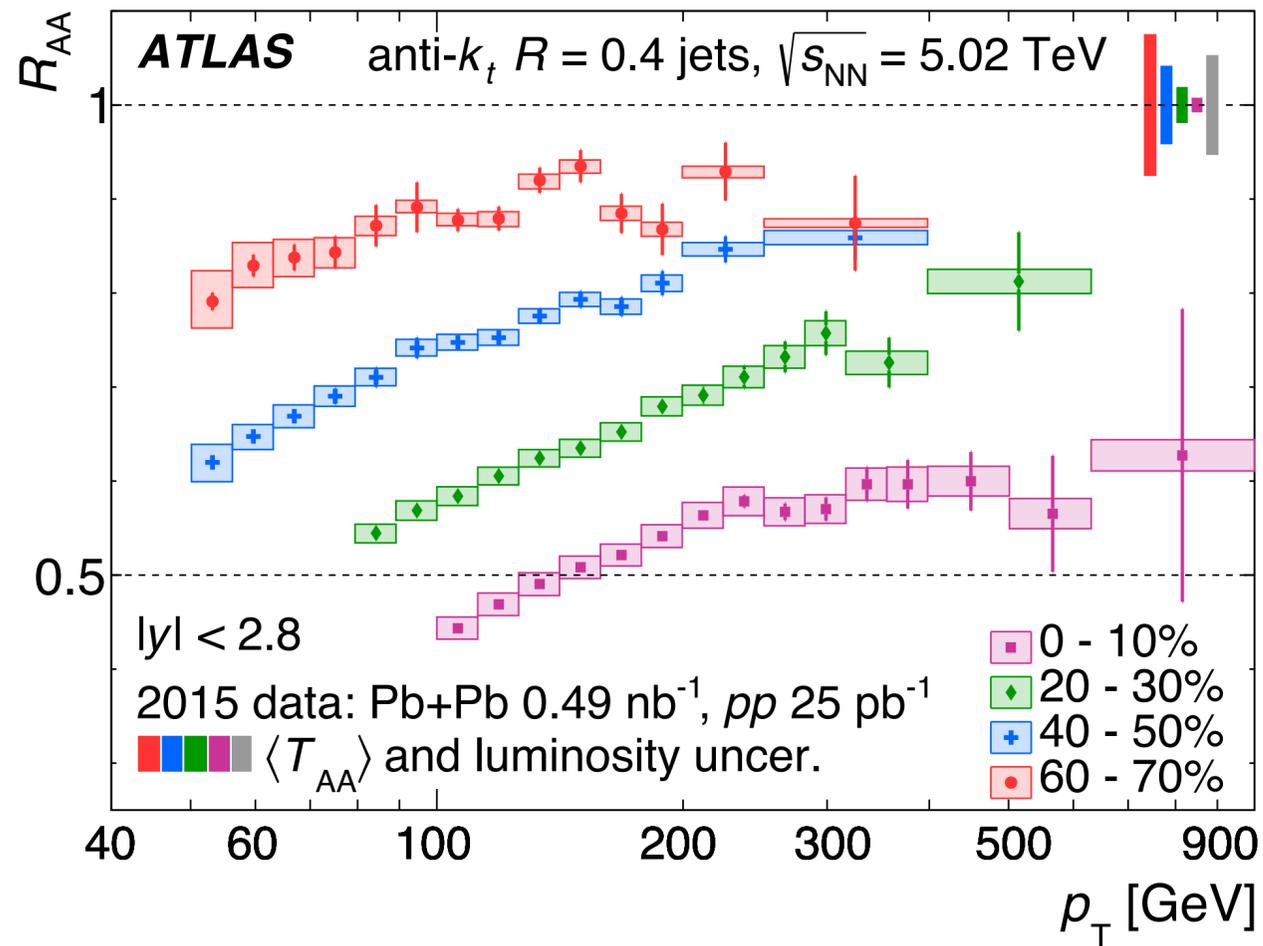
ATLAS measurements of b-jet suppression and heavy-flavor azimuthal correlations in 5.02 TeV Pb+Pb collisions

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September 5, 2023



Run: 286665
Event: 419161
2015-11-25 11:12:50 CEST

PLB 790 (2019) 108



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

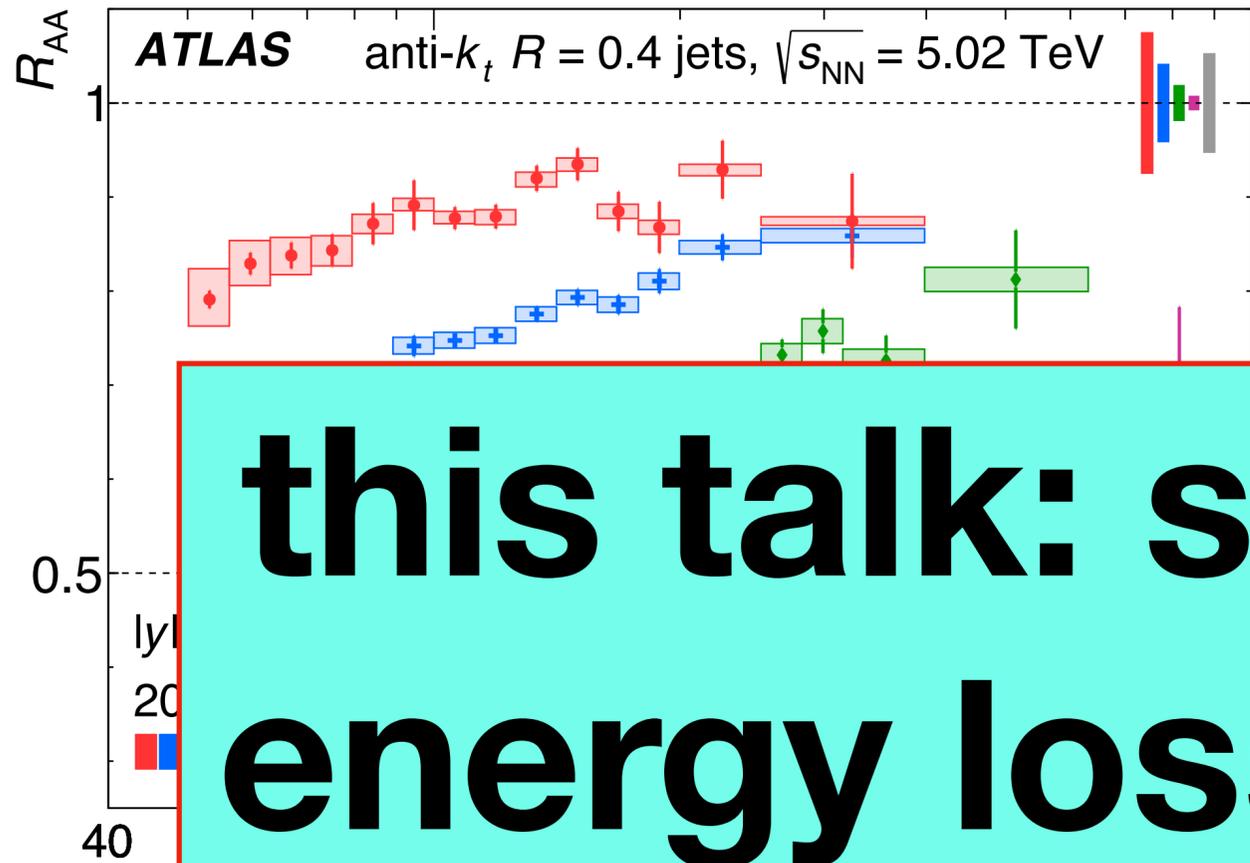
how do we understand the observed suppression in terms of geometry & jet properties?

dijets & jet v_n

$n > 2$ & large kinematic reach

mass/substructure dependent R_{AA}

absolutely normalized measurements to directly compare energy loss



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

this talk: studies of b-quark energy loss & dijets in PbPb collisions

jet v_n

$n > 2$ & large kinematic reach

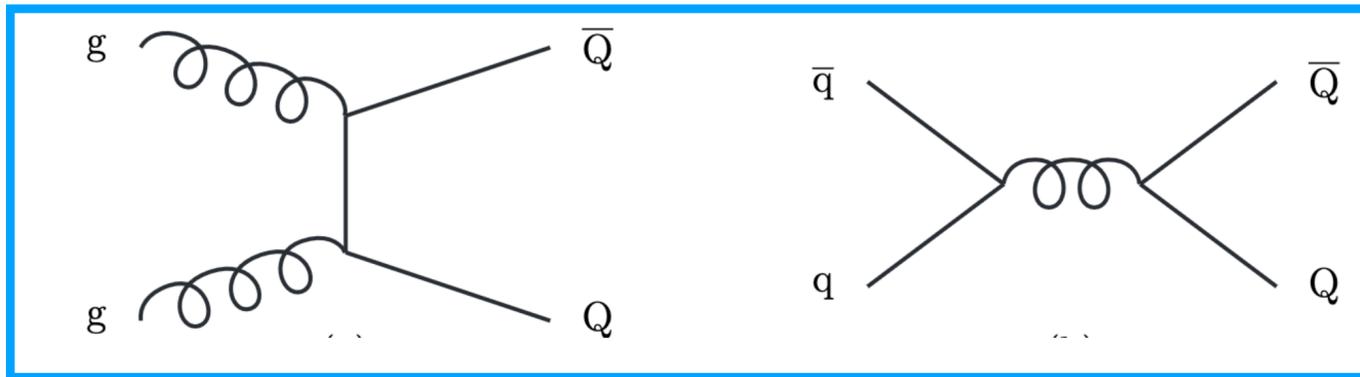
mass/substructure dependent R_{AA}

absolutely normalized measurements to directly compare energy loss

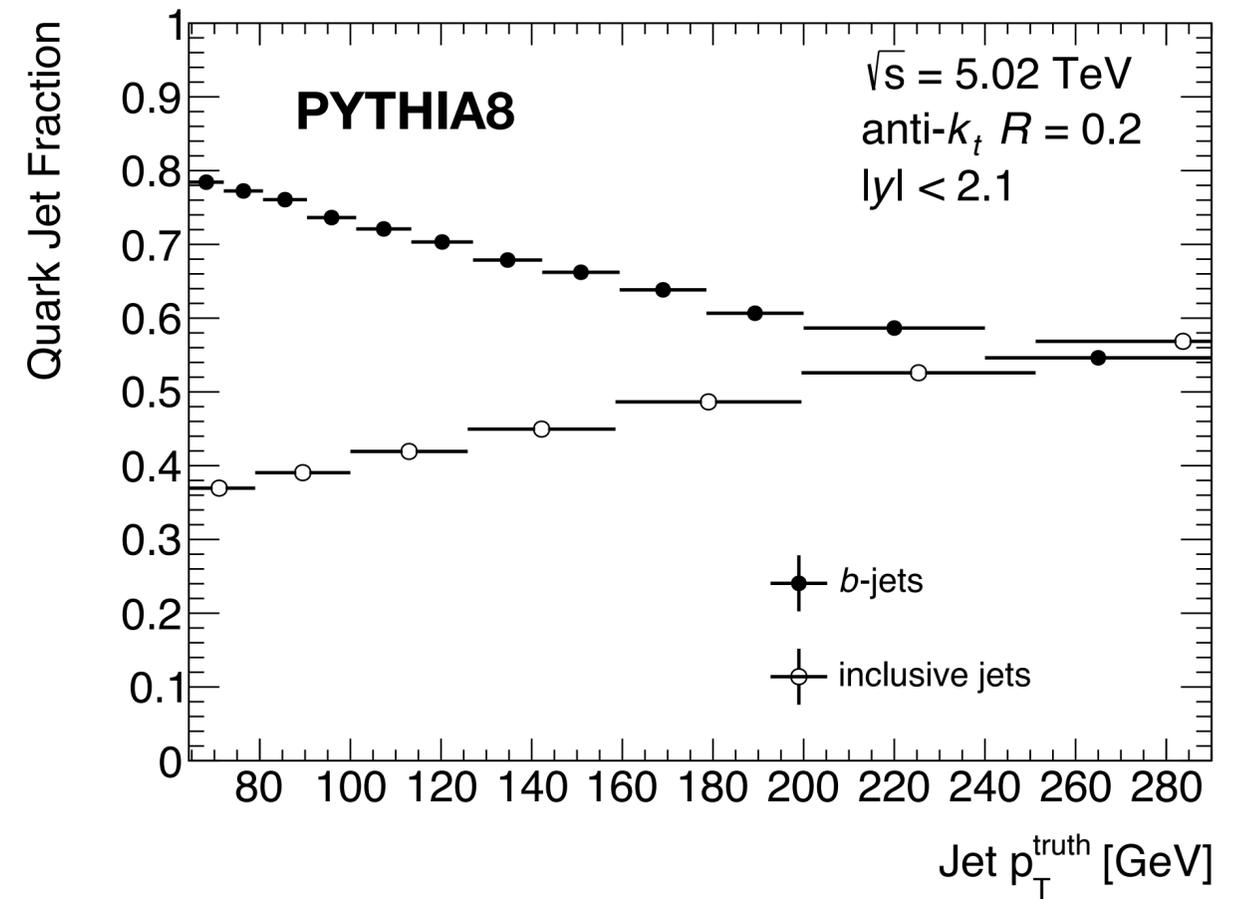
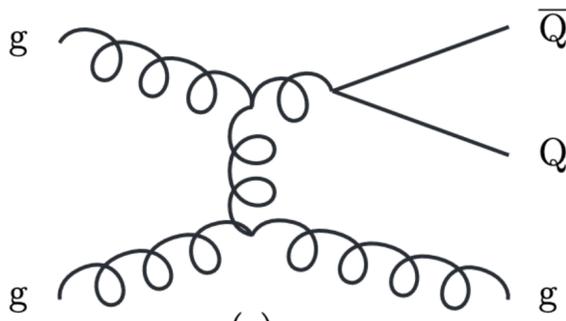
b-hadron production at the LHC

- many jets with a b-hadron, especially at high p_T , are actually from gluons with split to a $b\bar{b}$ pair
- two distinct classes of b-jets with very different expectations

flavor creation

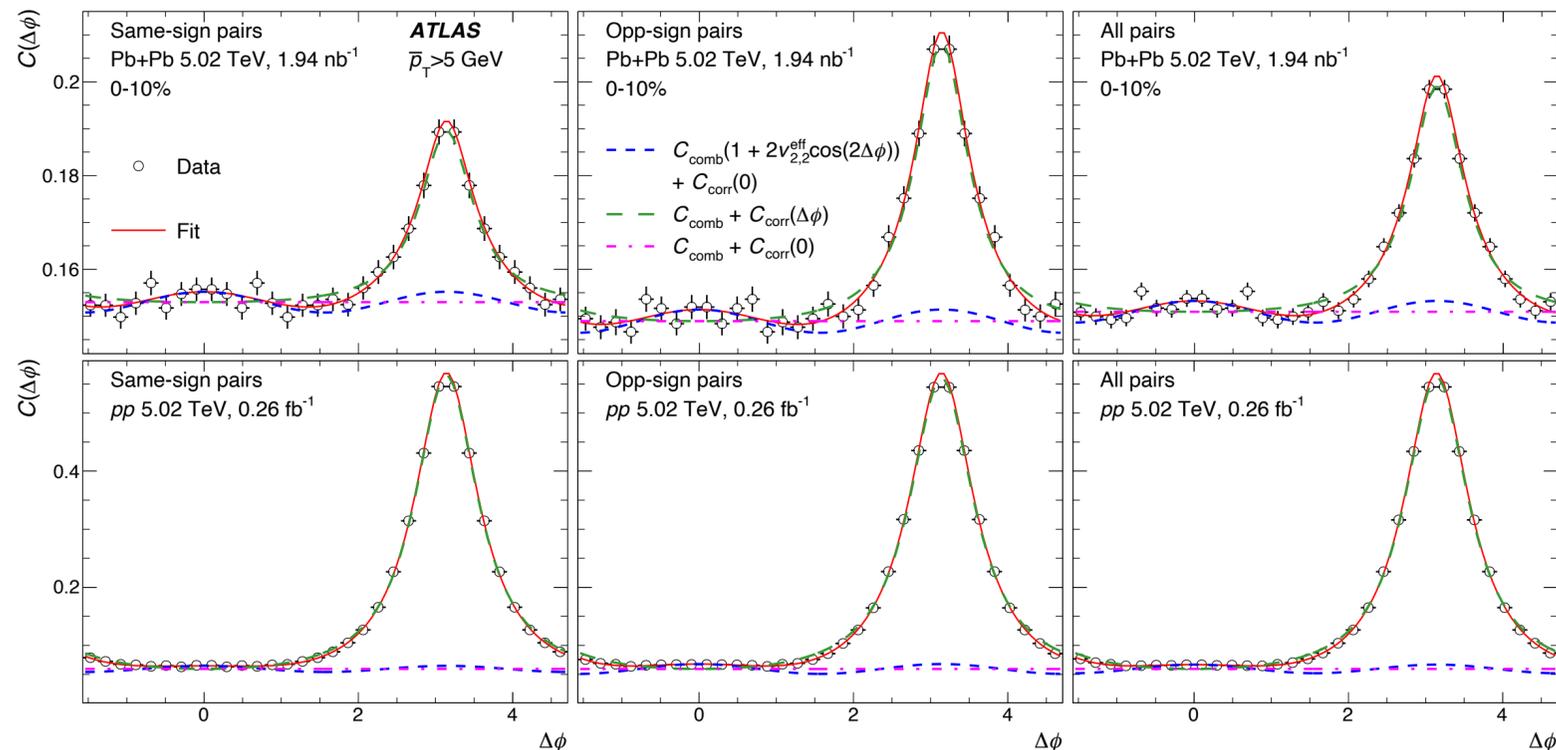


gluon splitting



dimuon angular correlations

- select specifically on flavor creation processes
- these create back-to-back HF hadrons
 - decays of HF hadrons can be tagged with muons produced via semi-leptonic decays



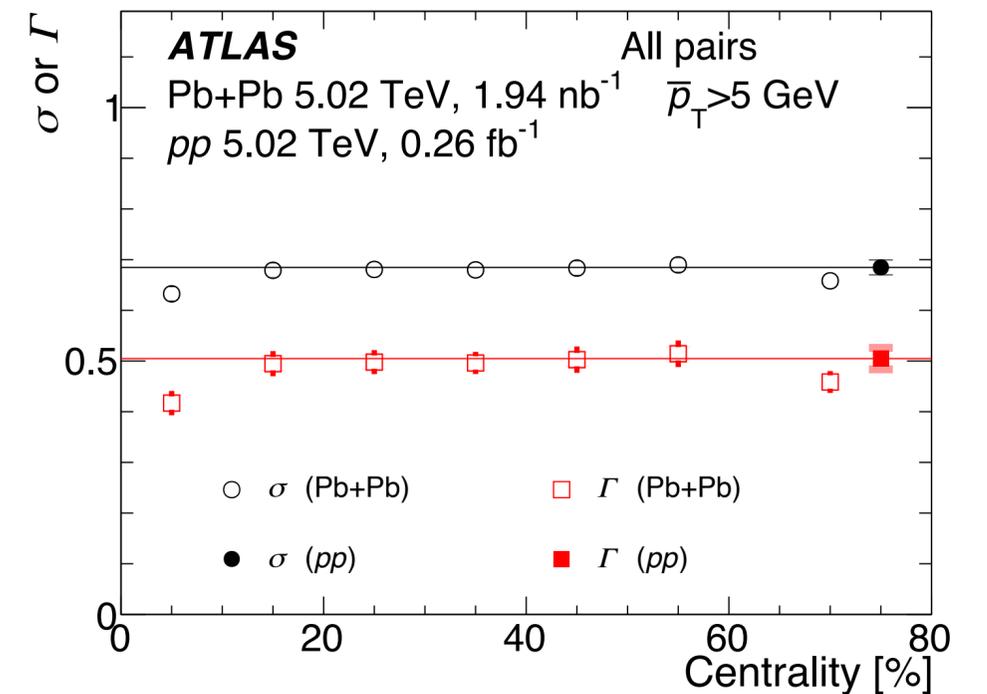
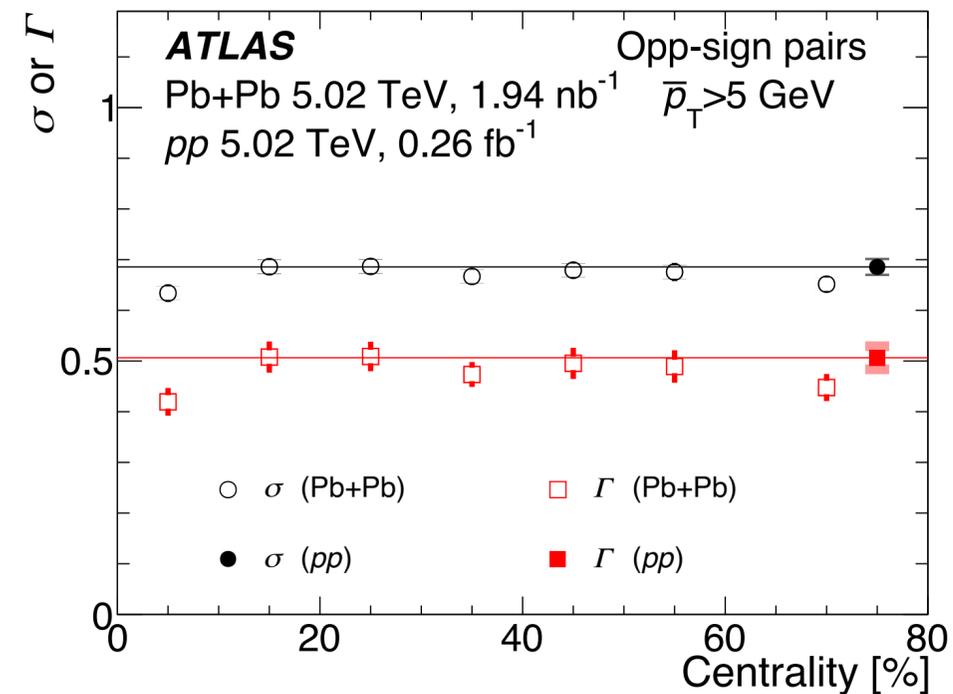
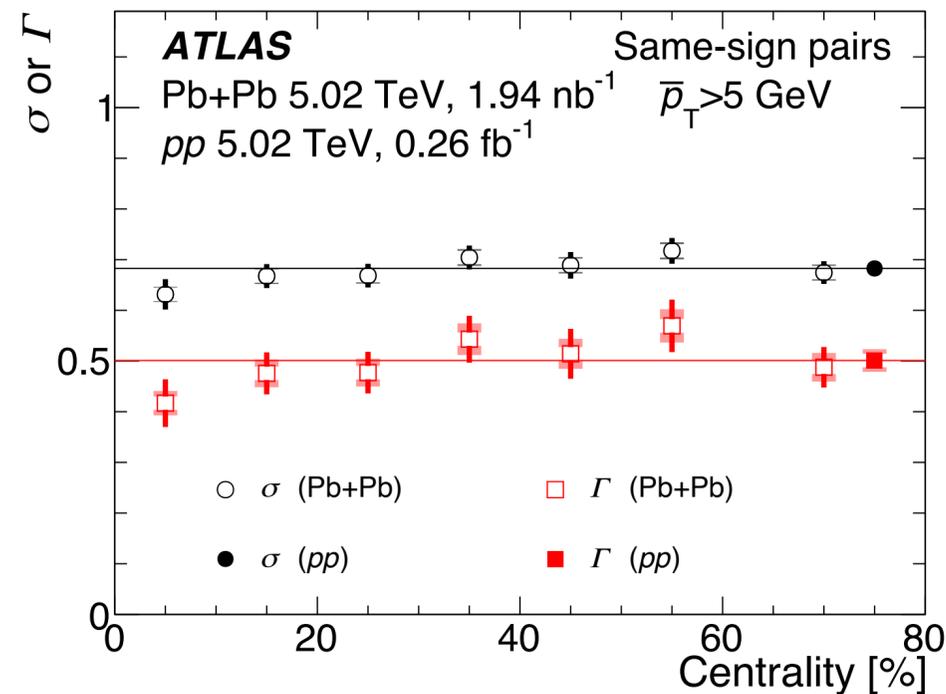
$$C^{\text{Fit}}(\Delta\phi) = C_{\text{comb}} \left[1 + 2v_{2,2}^{\text{eff}} \cos(2\Delta\phi) \right] + C_{\text{corr}}(\Delta\phi),$$

$$C_{\text{corr}}(\Delta\phi) = \frac{C_{\text{corr}}^{\text{max}} \Gamma^2}{(\Delta\phi - \pi)^2 + \Gamma^2}.$$

correlation width

arXiv: 2308.16652

$$\sigma \equiv \sqrt{\int (\Delta\phi - \pi)^2 (C_{\text{corr}}(\Delta\phi) - C_{\text{corr}}(0)) d\Delta\phi.}$$

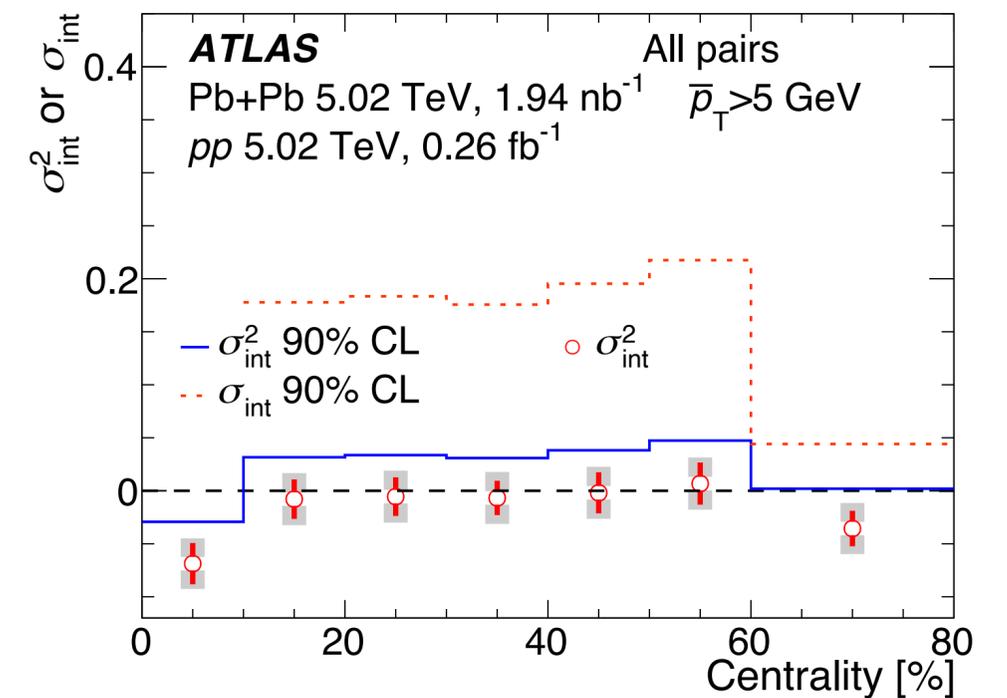
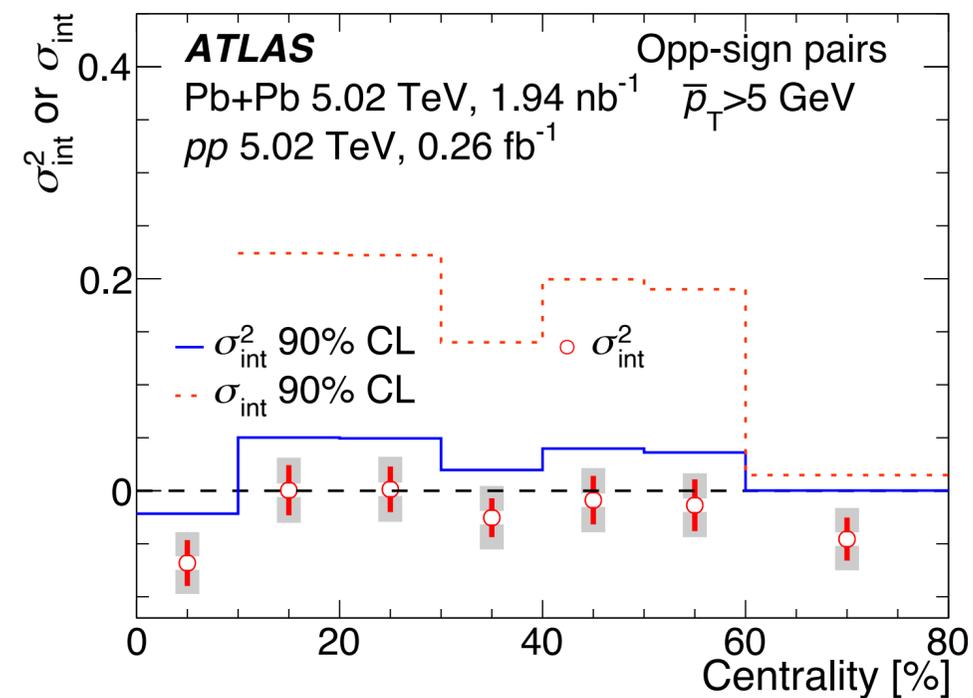
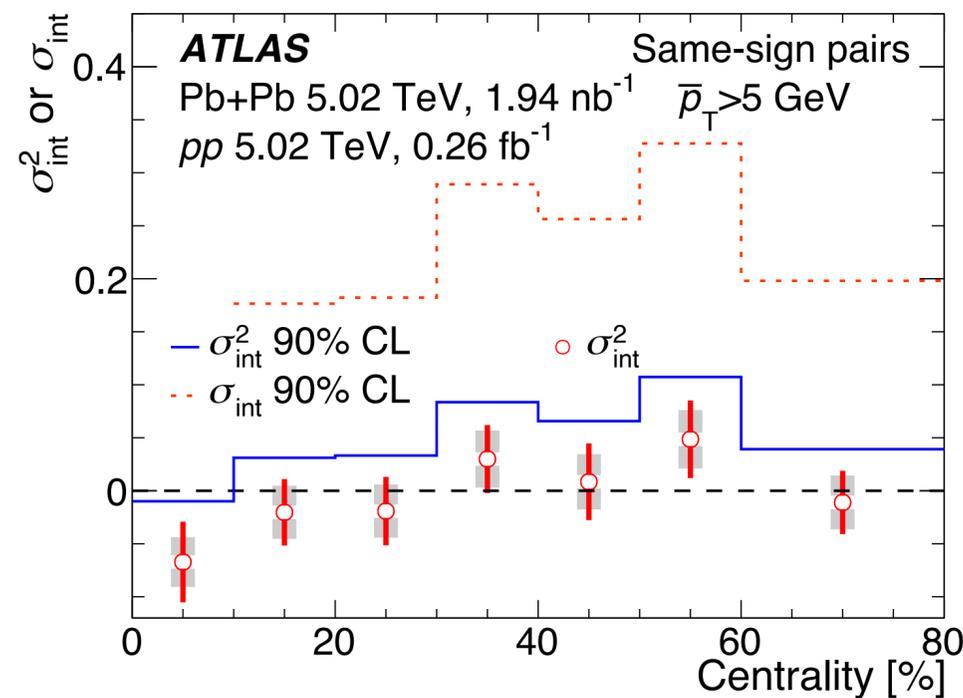


- both sign combinations dominated by b-bbar pairs according to POWHEG but c-cbar only contributes to opposite sign pairs
- no significant centrality dependence → no broadening of the correlations due to energy loss

limits on broadening from pp to PbPb collisions

arXiv: 2308.16652

$$\sigma_{\text{int}}^2 = \sigma_{\text{Pb+Pb}}^2 - \sigma_{\text{pp}}^2$$

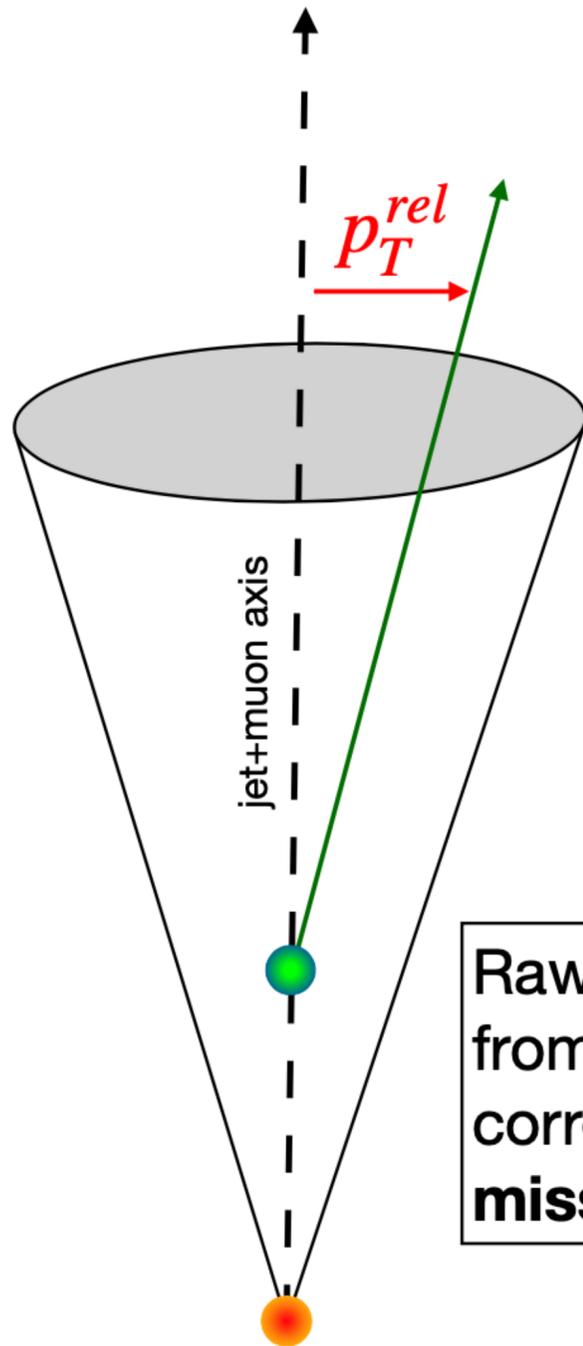


- both sign combinations dominated by b-bbar pairs according to PYTHIA but c-cbar only contributes to opposite sign pairs
- no significant centrality dependence → no broadening of the correlations due to energy loss

b-jets via muons

b -fraction estimated using template fit method on muon p_T -rel distribution

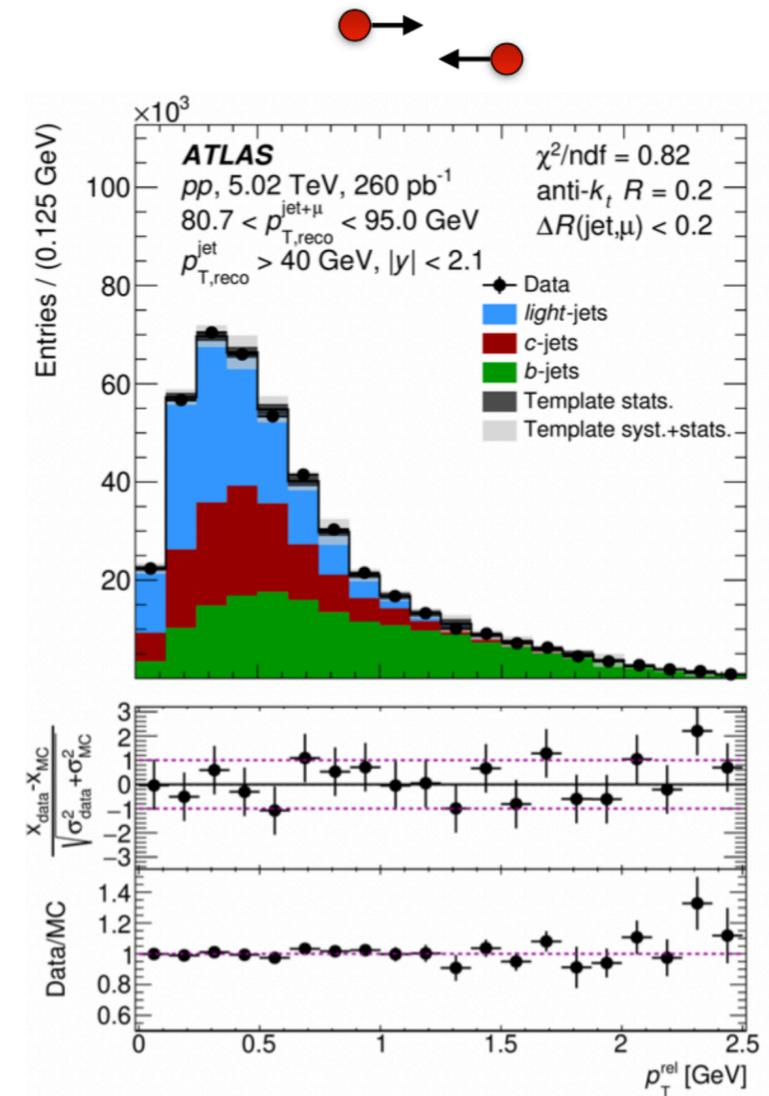
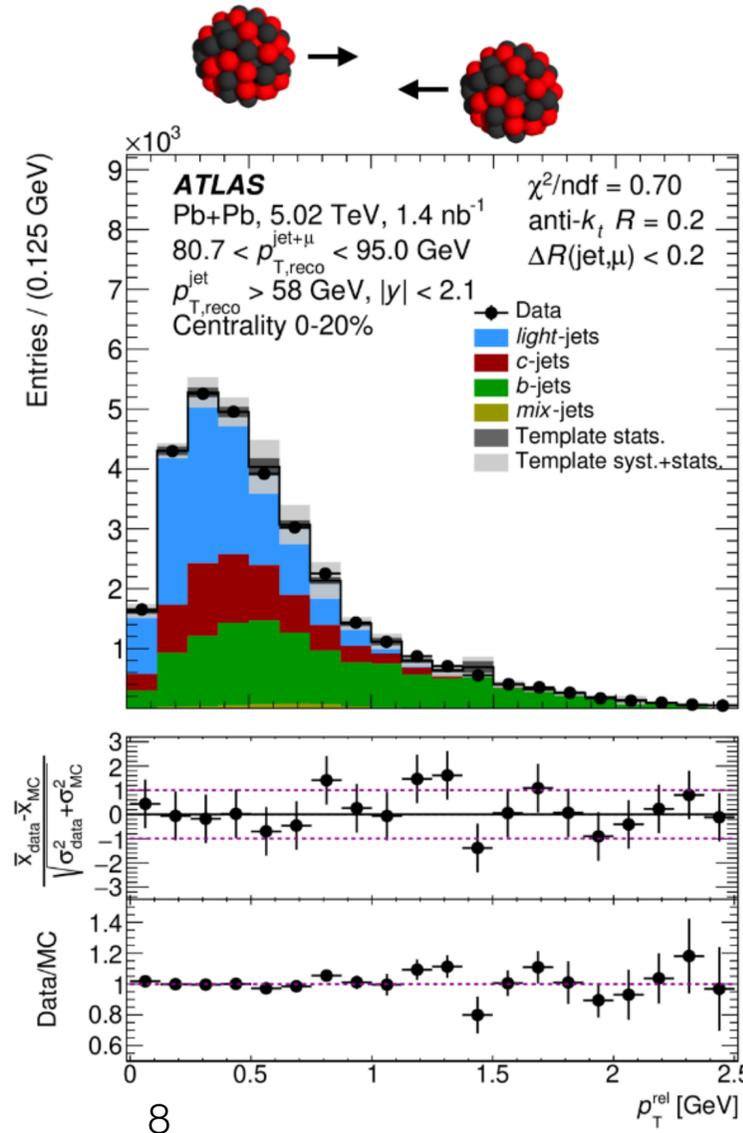
$$p_T^{rel} = ||\vec{p}_\mu \times \vec{u}||, \text{ where } \vec{u} = \frac{\vec{p}_{jet+\mu}}{||\vec{p}_{jet+\mu}||} \text{ is the jet} + \mu \text{ axis}$$



Muon selection:

- Muon $p_T > 4$ GeV
- $\Delta R(\text{jet}, \text{muon}) < R$

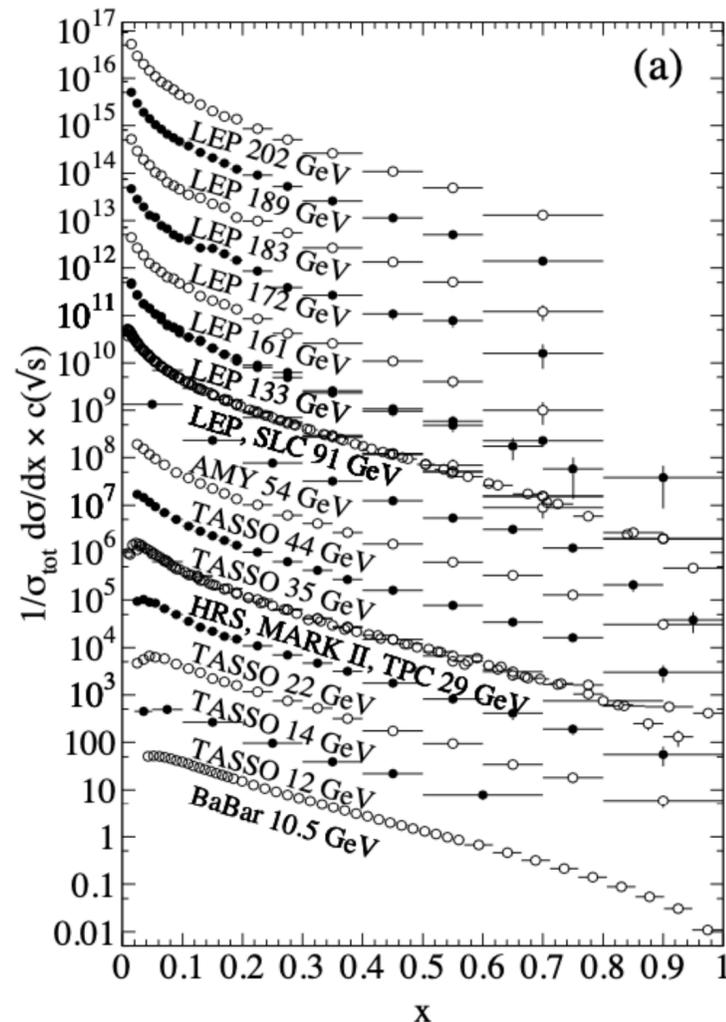
Raw b -jet spectra obtained from fit is **unfolded** to correct detector effects and **missing neutrino energy**



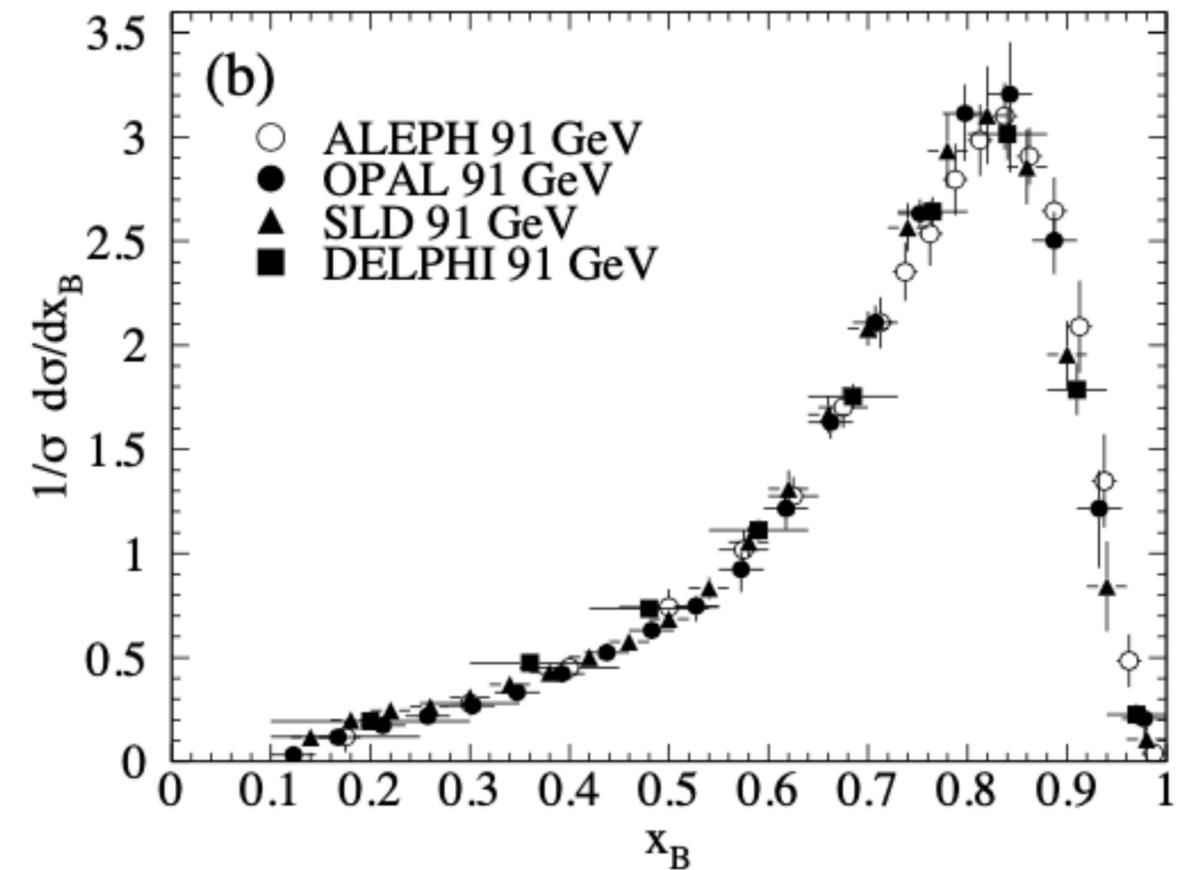
comparison of b-jets with inclusive jets

- b-jet fragmentation is very different than inclusive jets
- comparison at the jet level allows direct comparison of b- and inclusive-jets without sensitivity to fragmentation

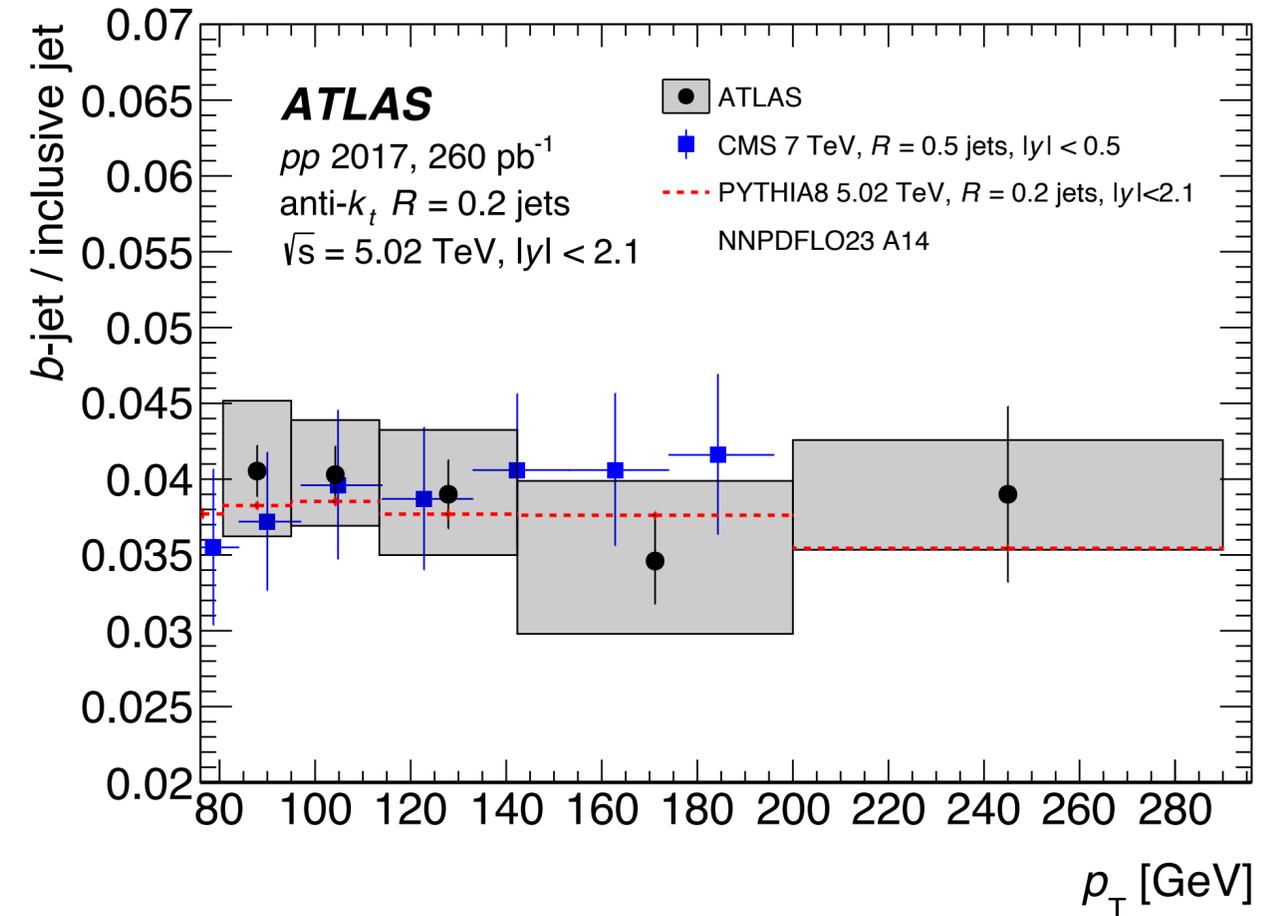
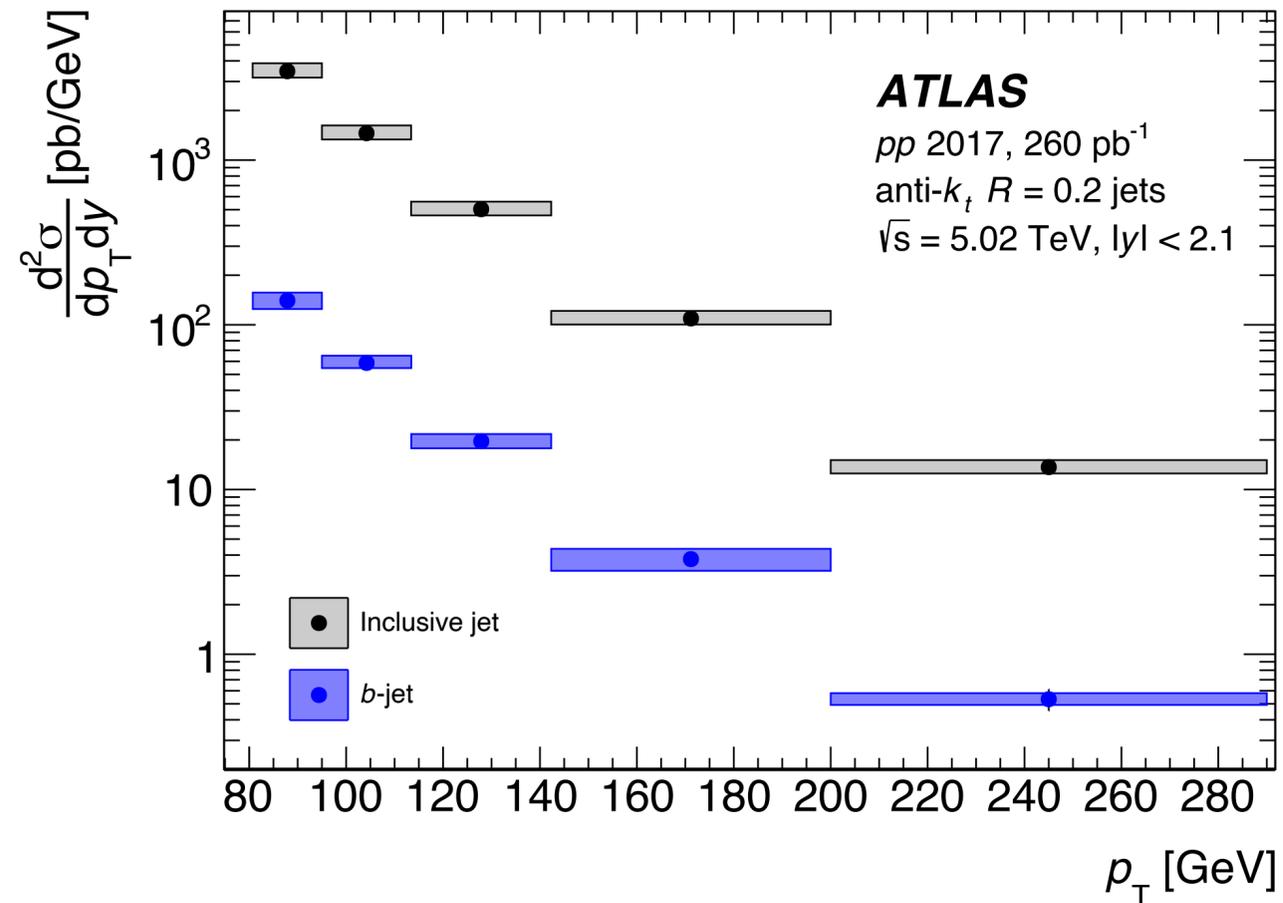
charged hadrons in
inclusive jets (PDG)



b-hadrons in b-jets (PDG)

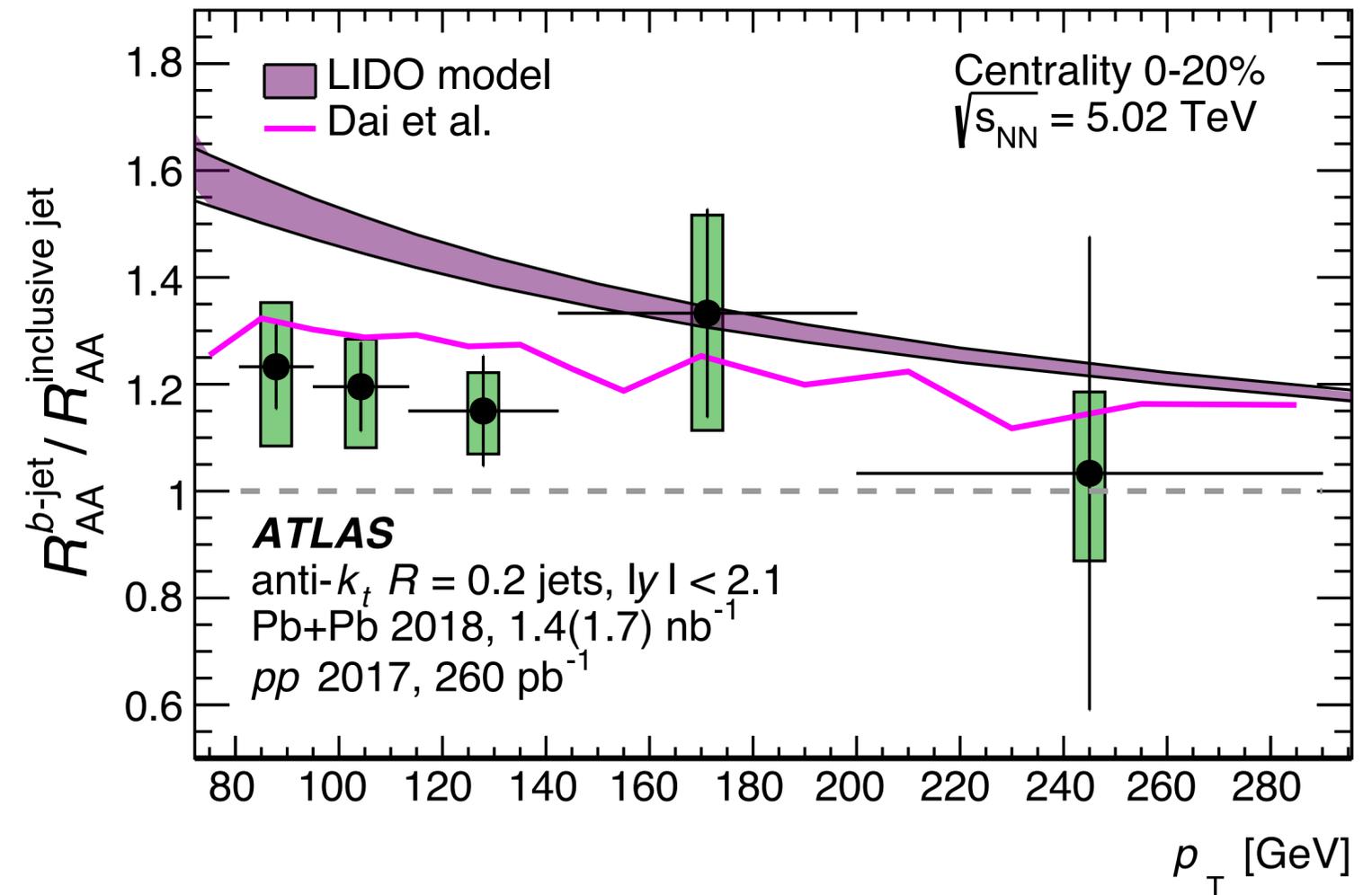
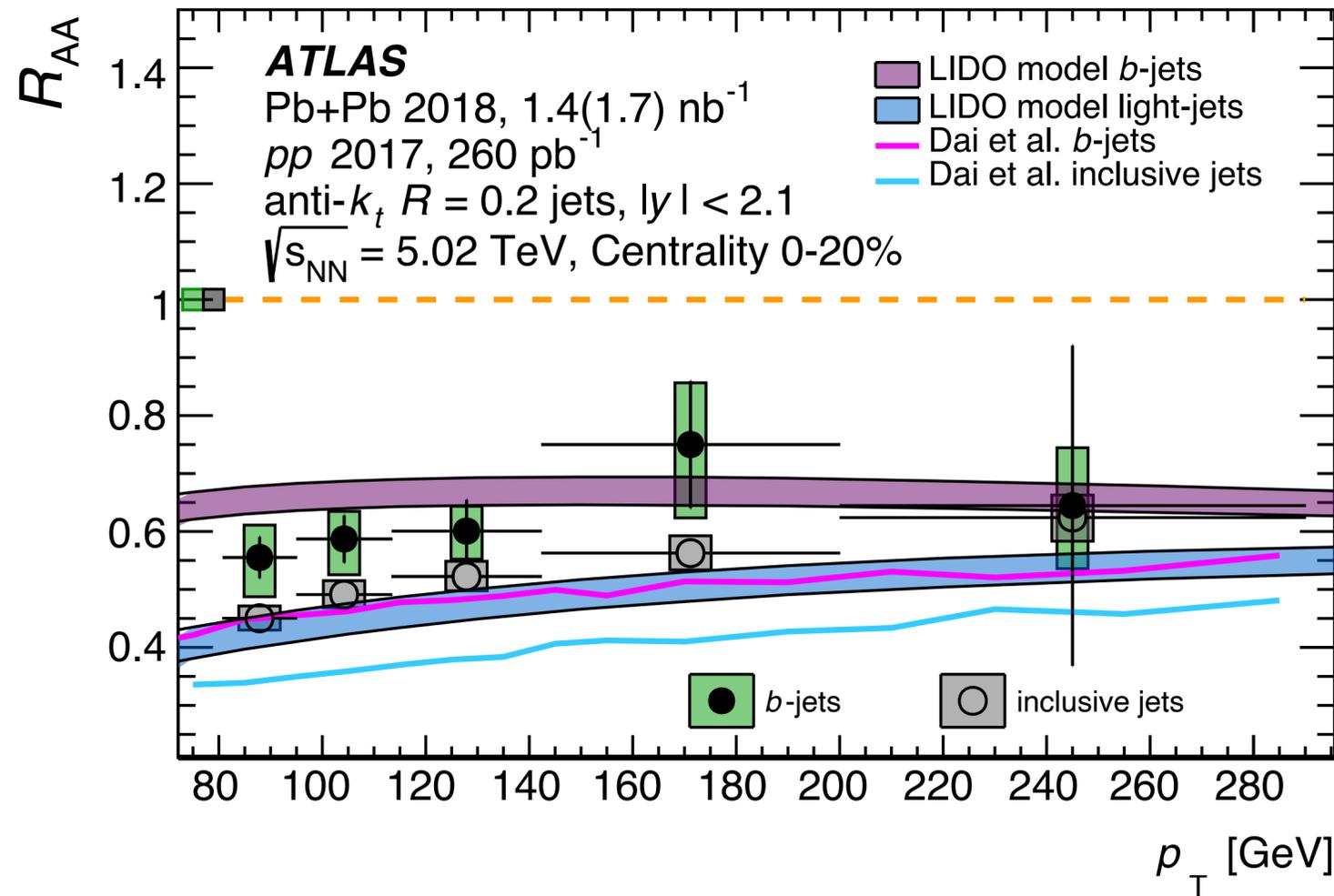


b-jets in pp collisions



- b -jets around 4% of the inclusive jet yield, independent of p_T from 80-280 GeV
- measurement consistent with previous measurements from CMS @ 7 TeV and PYTHIA8

comparison of b- & inclusive-jet R_{AA}

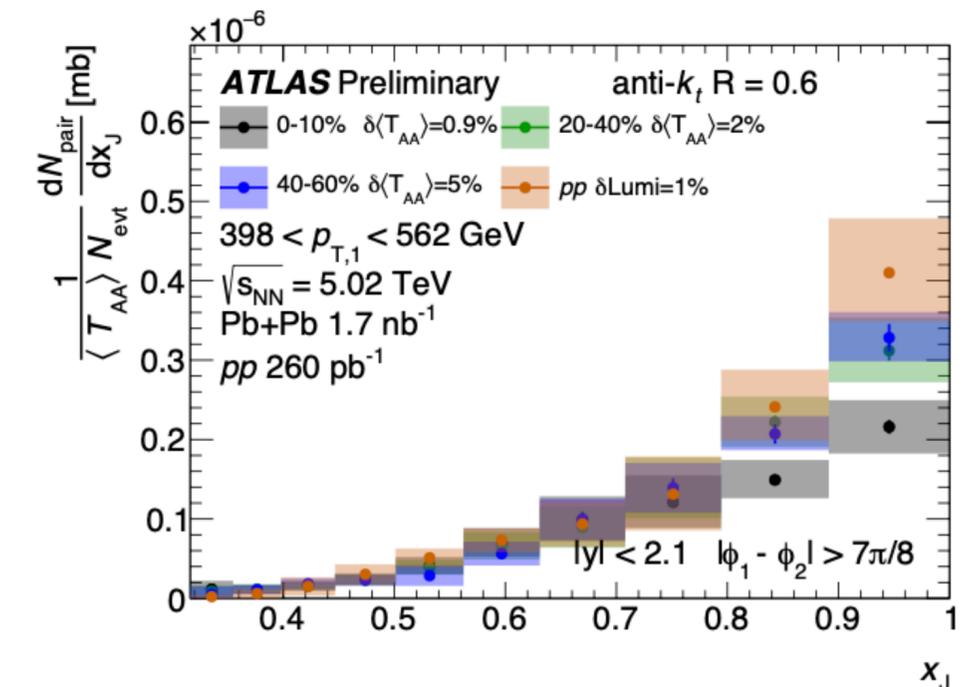
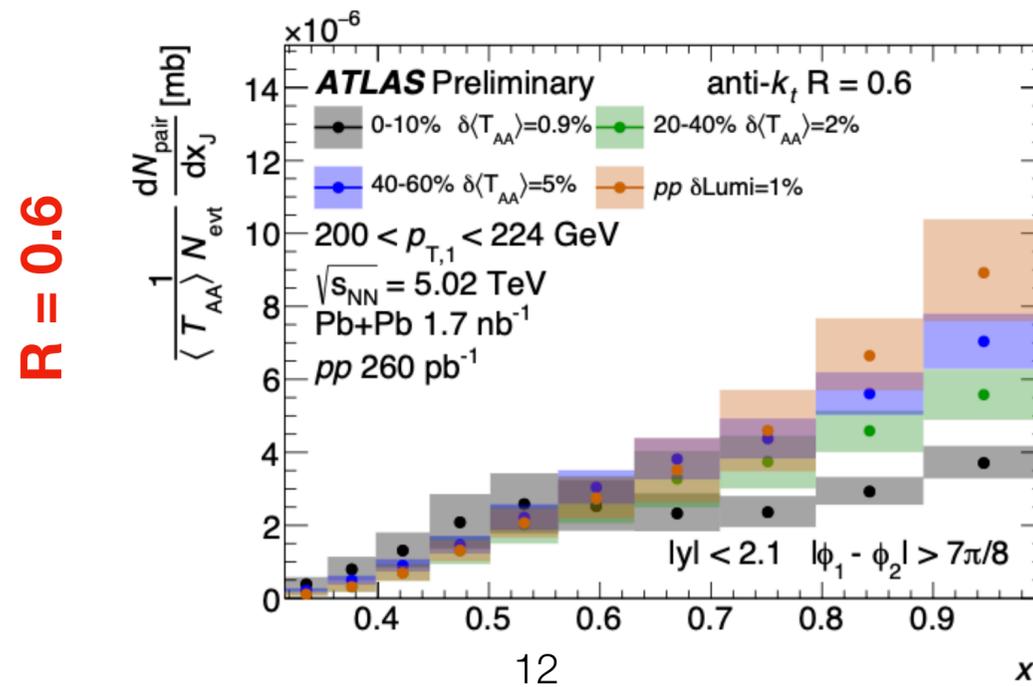
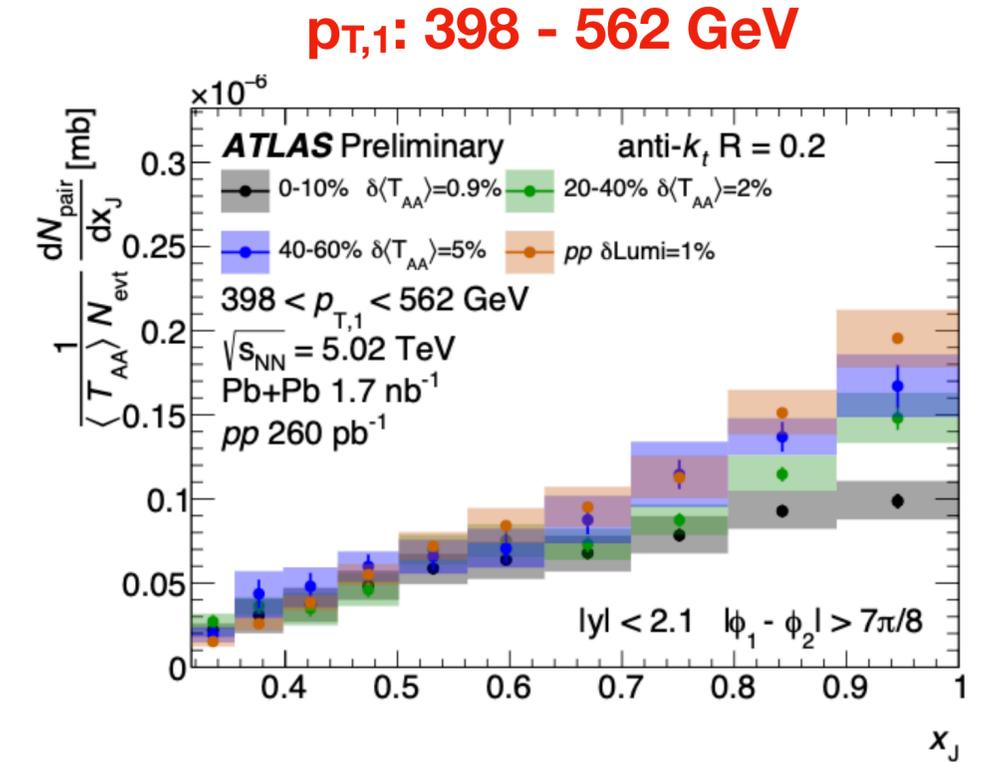
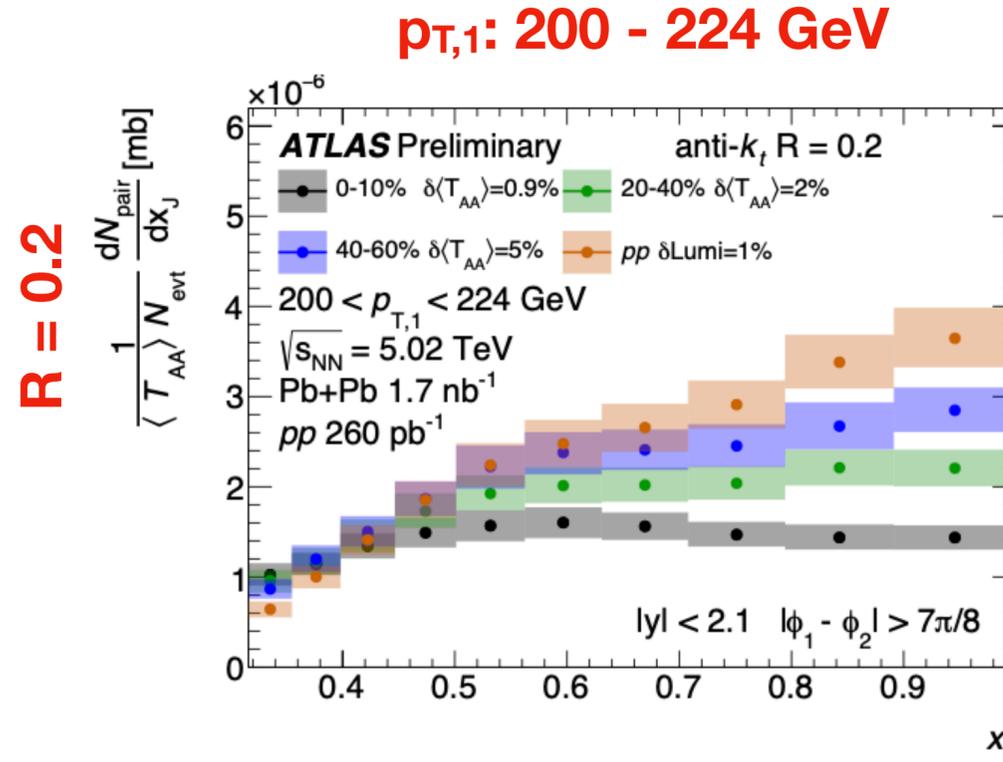


first observation of a difference between b - & inclusive-jet R_{AA} values

R-dep. of dijet imbalance

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

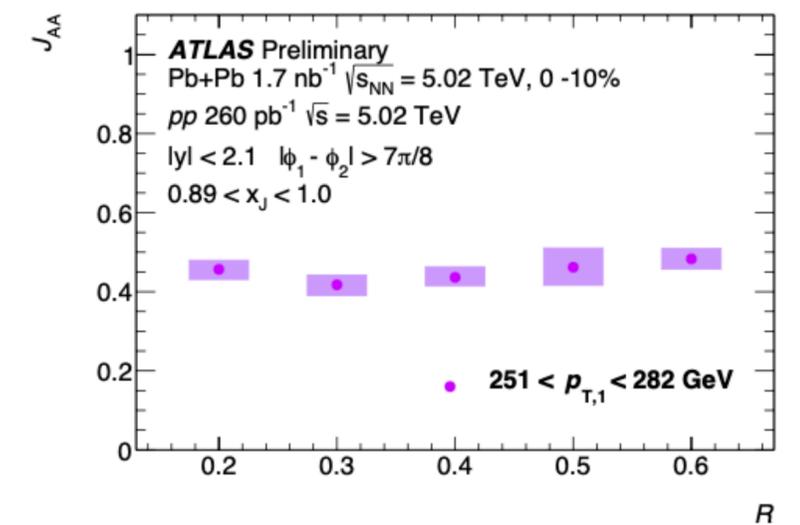
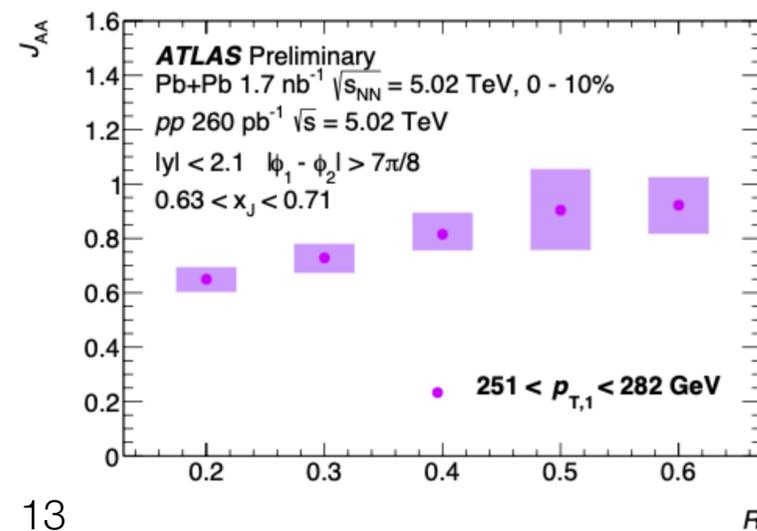
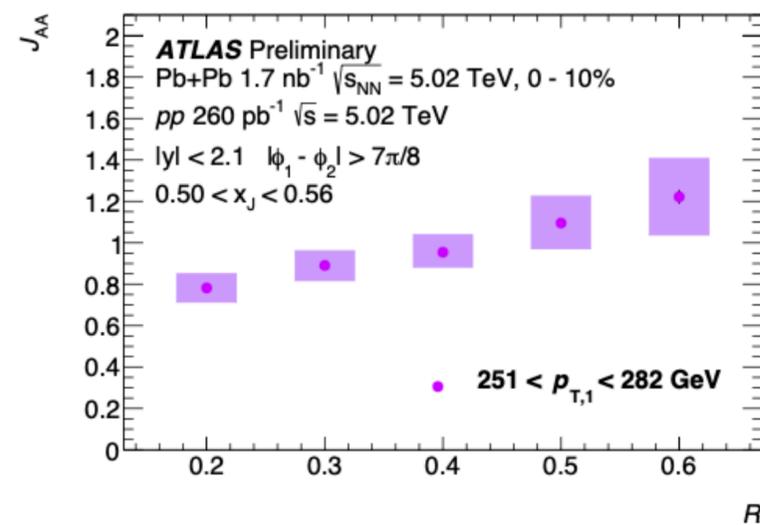
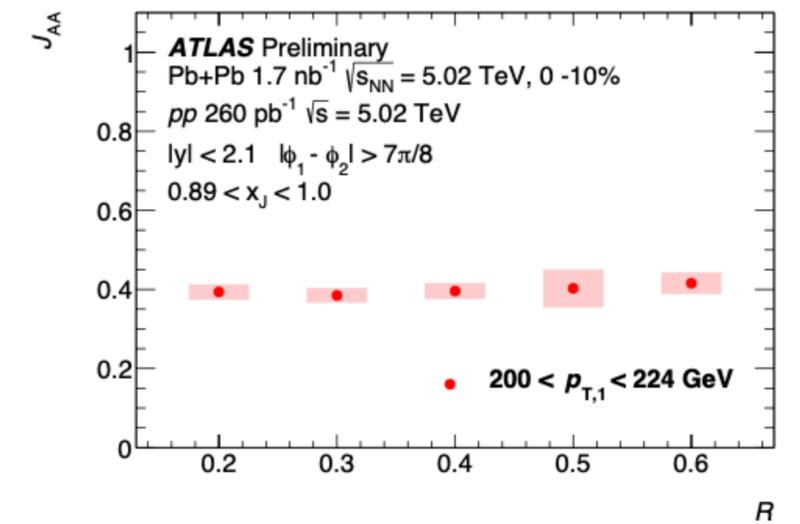
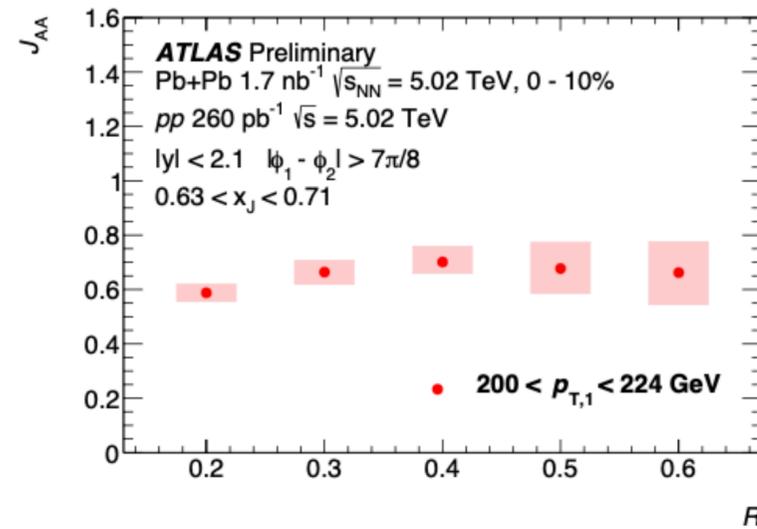
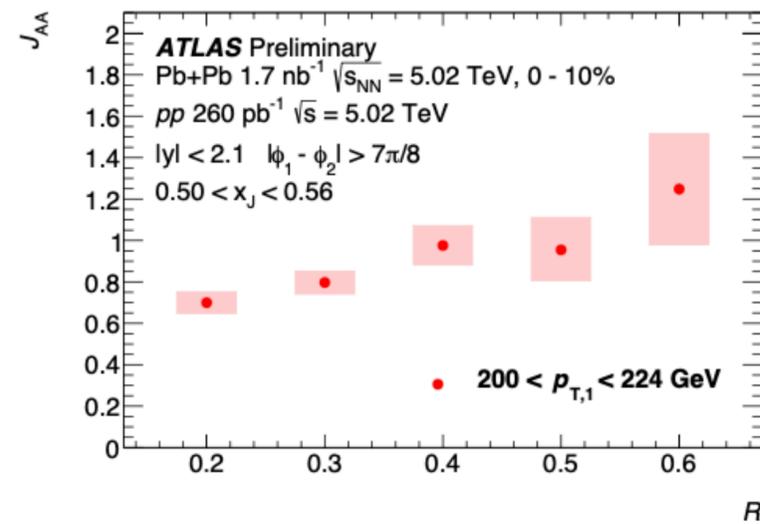
- large kinematic range
- balanced dijets are preferentially suppressed for $0.2 < R < 0.6$ jets
- much smaller modifications for imbalanced jets



x_J dependent dijet suppression

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

R dependent suppression only seen for low- x_J values
balanced jet suppression independent of R



summary

- dimuon correlations & b-jet measurements are complementary probes of heavy flavor interaction with the QGP
 - dimuons provide access to back-to-back heavy quark pairs
 - b-tagged jets are statistics limited but provide a direct way to compare b-jets to inclusive jets
- b-jets are a small fraction of the jets produced at the LHC
 - big improvements expected from the increased Run 3 luminosity coming soon!
- R-dependent suppression of dijet pairs seen for imbalanced dijets

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

backups

POWHEG for charge sign combinations

