Systematic Studies of Jet–medium Interactions in STAR

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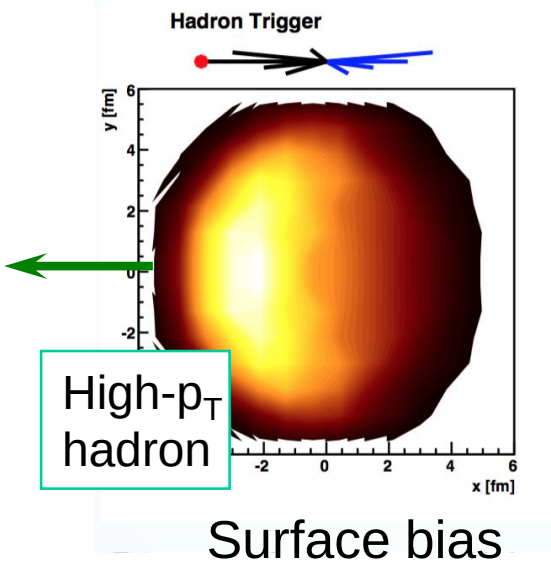
(for the STAR Collaboration)

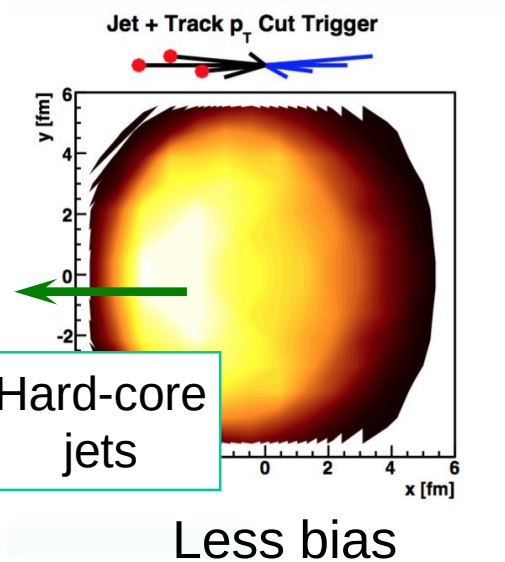
Tomography with Jets

Path-length dependent energy loss

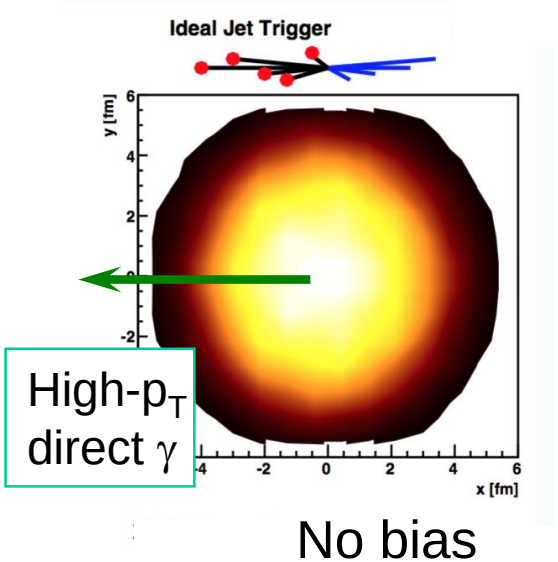
Hard scattering selection



Surface bias



Less bias



No bias

T. Renk PRC 88, 054902 (2013)

- Di-jet momentum imbalance
  →shorter path length? (tangential biased di-jets)
- Di-hadron correlations
  →maximum path length (trigger surface bias)

Method for Di-jet Imbalance Study

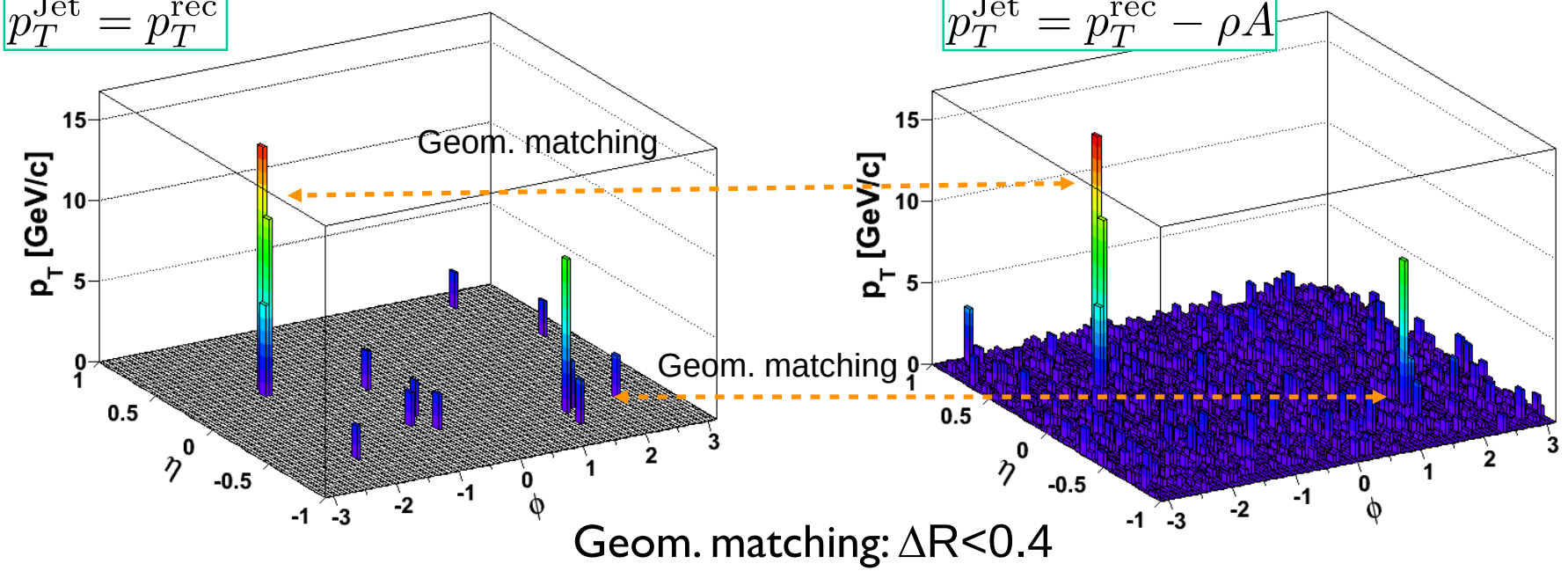
p_T^{Lead}>20 GeV/c, $p_T^{SubLead}$>10 GeV/*c*, $|\Delta\phi-\pi|<0.4$
HT: Neutral particle with p_T>5.4 GeV/*c*

Hard-Core Di-jets
Constituents p_T^{Cut} = 2 GeV/*c*

Matched Di-jets
Constituents p_T^{Cut}=0.2 GeV/*c*

$p_T^{\mathrm{Jet}} = p_T^{\mathrm{rec}}$

$p_T^{\mathrm{Jet}} = p_T^{\mathrm{rec}} - \rho A$

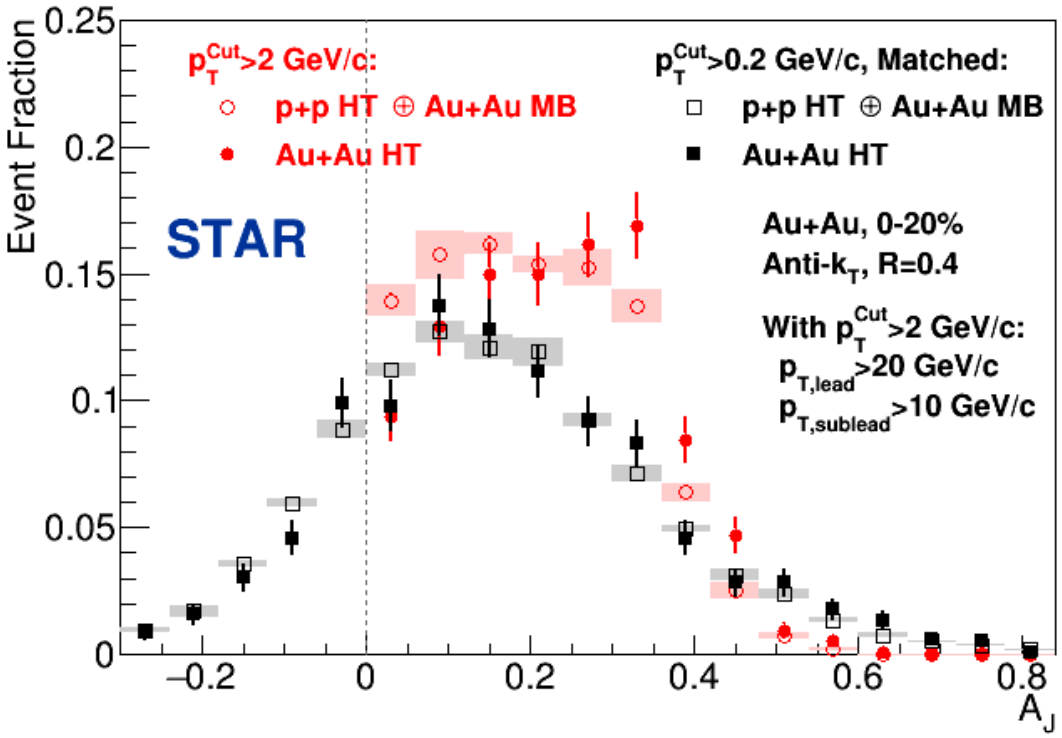


Geom. matching: $\Delta R<0.4$

Keep this jet selection

Calculate "matched" momentum imbalance with constituent p_T^{cut}>0.2 GeV/*c*.

Di-jet Imbalance



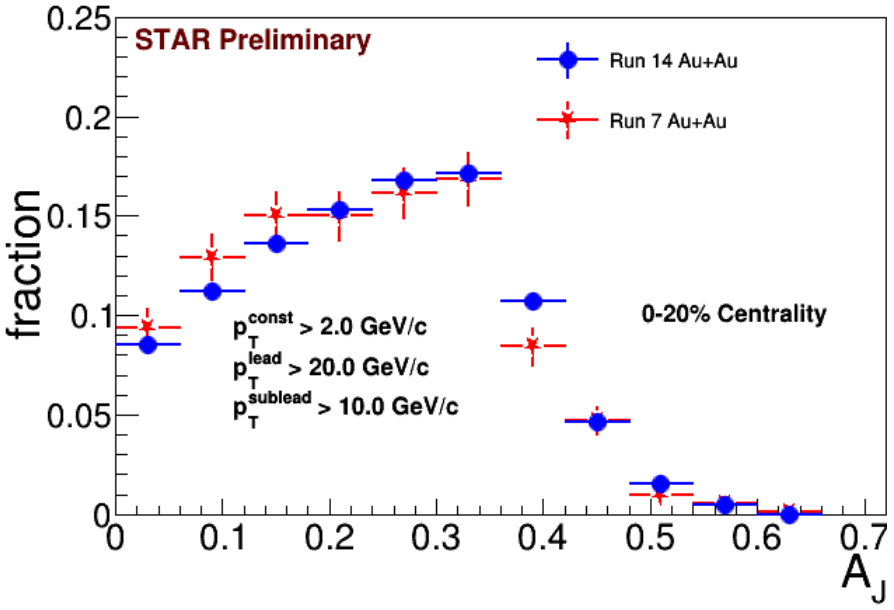
STAR *PRL 119, 062301 (2017)*

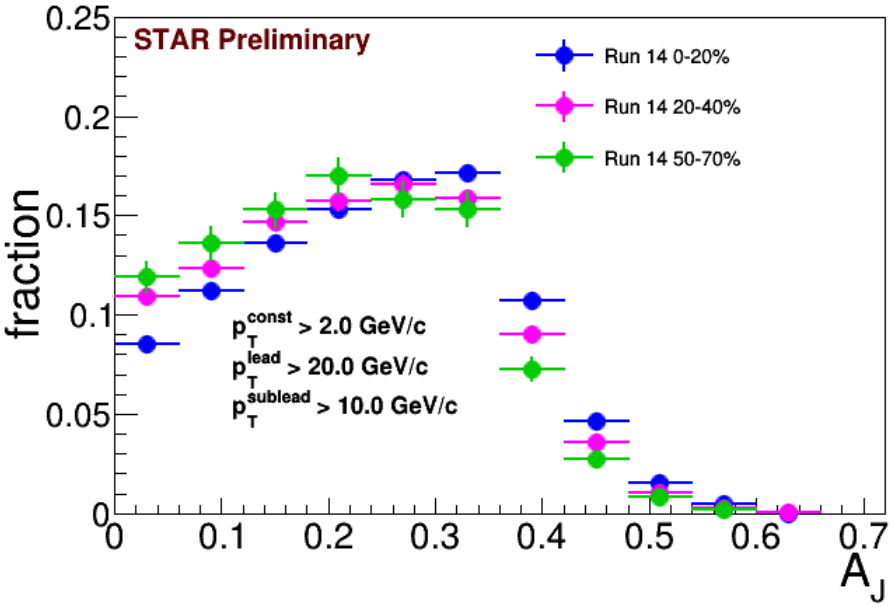
$$A_J = \frac{p_T^{\mathrm{Lead}} - p_T^{\mathrm{SubLead}}}{p_T^{\mathrm{Lead}} + p_T^{\mathrm{SubLead}}}$$

- Hard-core di-jets in central Au+Au significantly more imbalanced than p+p
- Momentum balance restored to p+p baseline for R = 0.4 with soft particles included

Centrality Dependence of A_J

RUN7: STAR *PRL 119, 062301 (2017)*





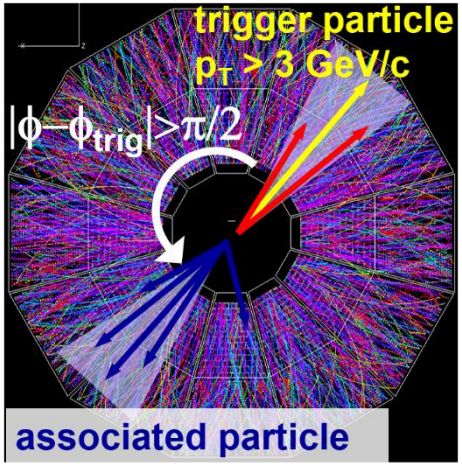
- Comparable between Au+Au Run 14 and Run 7 in 0-20% centrality (detector level)
- Run14: large increase in statistics
  →enable to study centrality dependence
- Apparent evolution of A_J to more balanced jets in peripheral Au+Au collisions

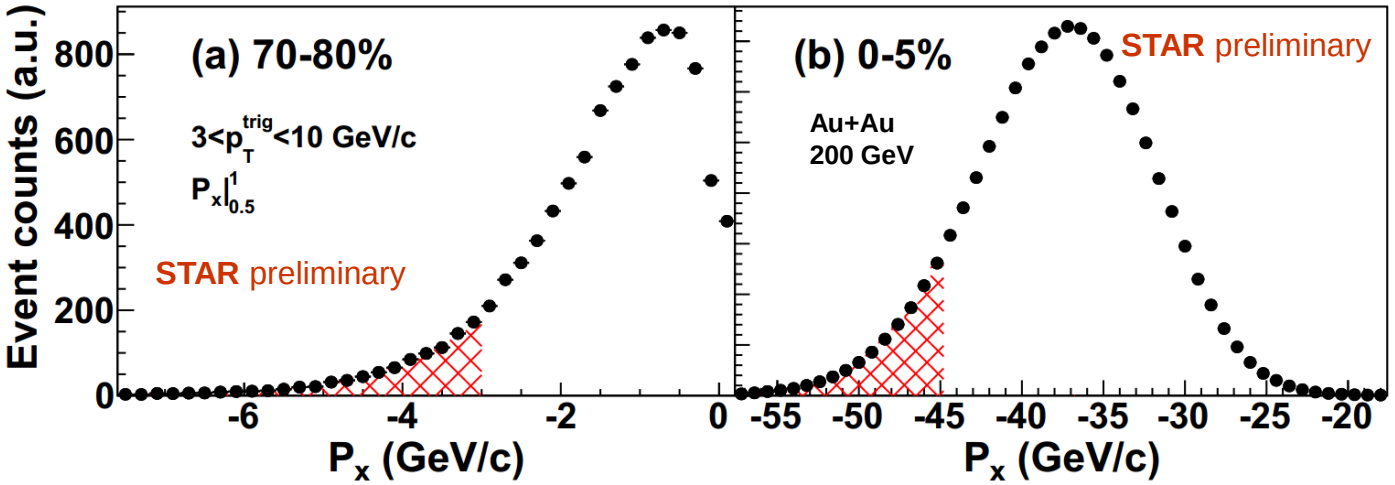
Enhanced Away-side Momentum Flow

Projection of away-side p_T onto trigger axis

$$P_x\Big|_{\eta_1}^{\eta_2} = \sum_{\eta_1<\eta<\eta_2,\,|\phi-\phi_{trig}|>\pi/2} p_T \cdot \cos(\phi-\phi_{trig}) \cdot \frac{1}{\varepsilon}$$

ε: single-particle acceptance $\times$ efficiency

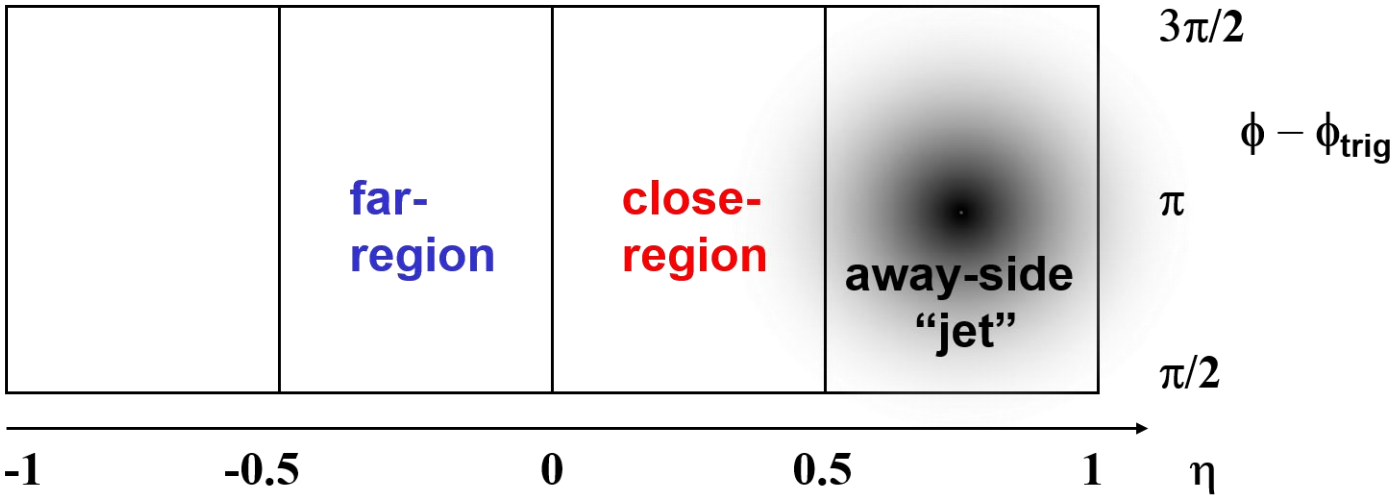




- For each centrality, cut on the lowest 10% of events to enhance **away-side momentum flow → "jet" = jet + jet-like hotspots**

Methodology for Two-particle Correlations

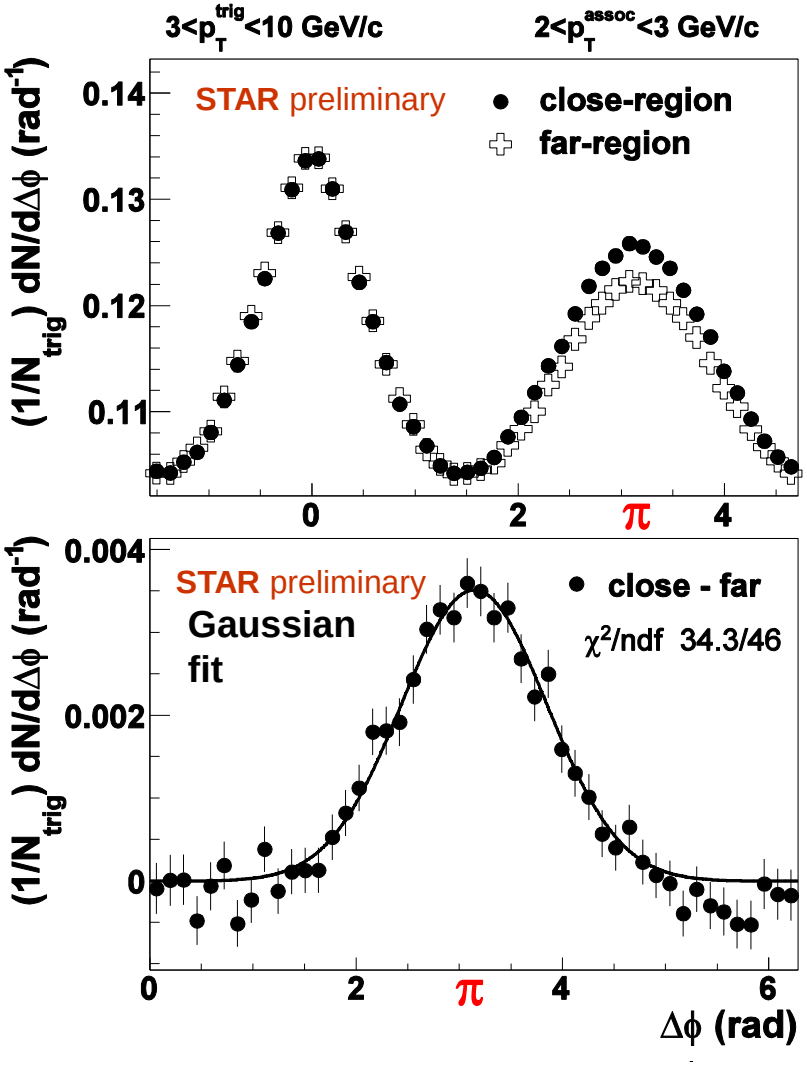
Trigger particle $|\eta| < 1$

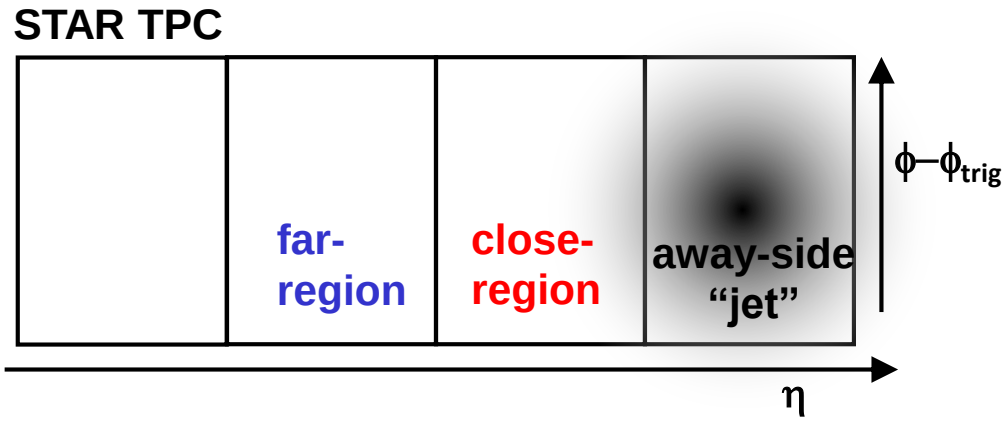


- Away-side: large recoil momentum region opposite to trigger particle
- Analyze correlations in **close-region** and **far-region**, respectively
- Flow contributions to close-region and far-region are equal
  → cancelled in their difference

close-region = flow + near-side "jet" + away-side "jet" ∗ $\text{fraction}_{\text{close}}$
far-region = flow + near-side "jet" + away-side "jet" ∗ $\text{fraction}_{\text{far}}$
diff = away-side "jet" ∗ fraction

Flow Subtracted Away-side Correlation

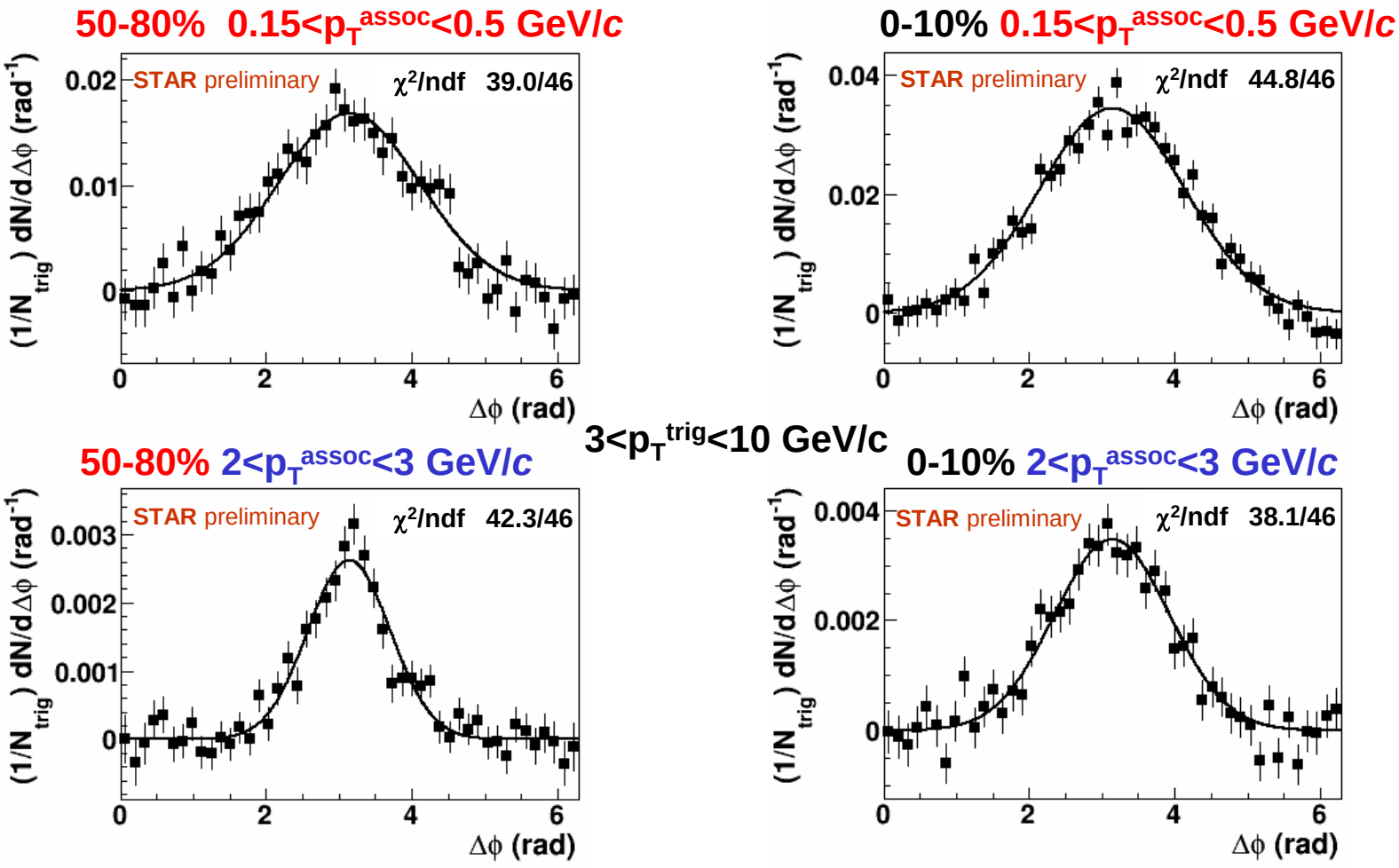




close-region = flow + near-side "jet"
+ away-side "jet" ∗ $fraction_{close}$
far-region = flow + near-side "jet"
+ away-side "jet" ∗ $fraction_{far}$
diff = away-side "jet" ∗ fraction

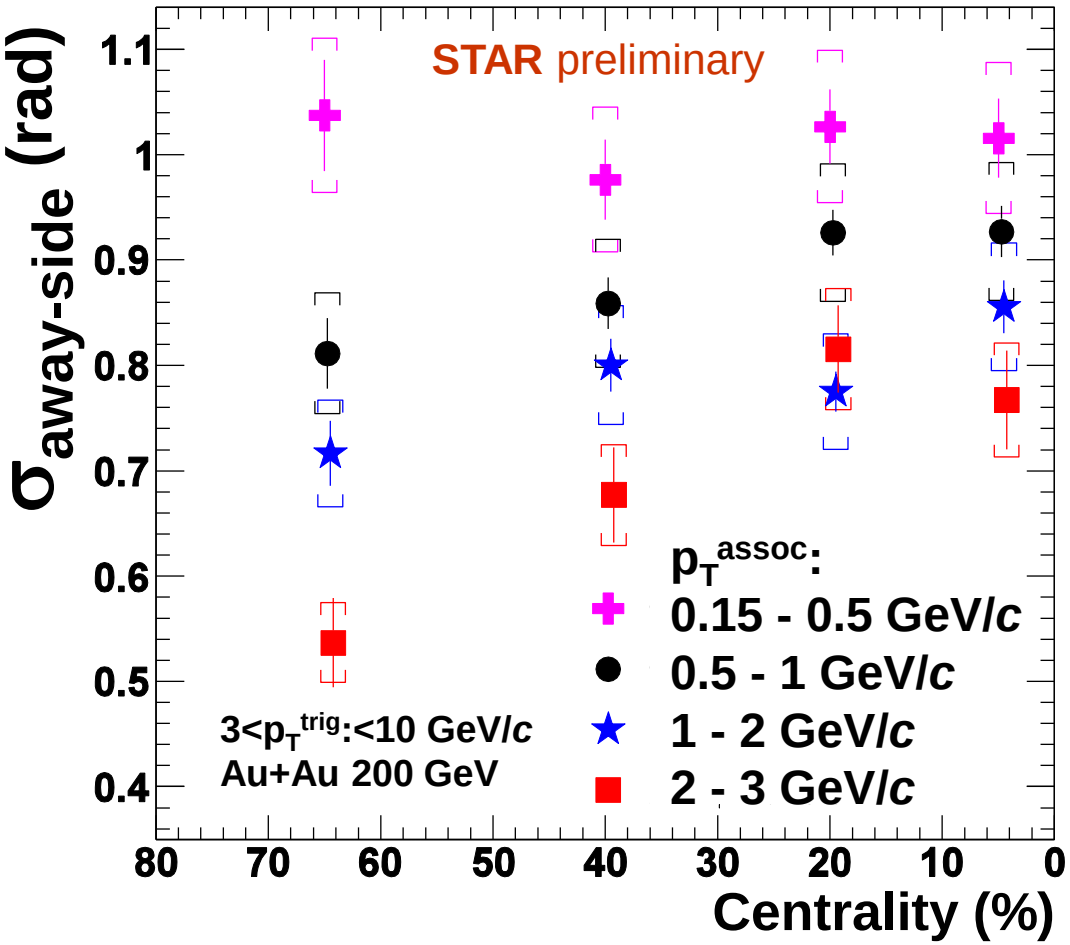
- Near-side equal as expected
- Away-side yield contains unknown "fraction" factor
- Away-side **shape** can be quantified by Gaussian fit width, σ

Away-side Jet-like Correlation Shape



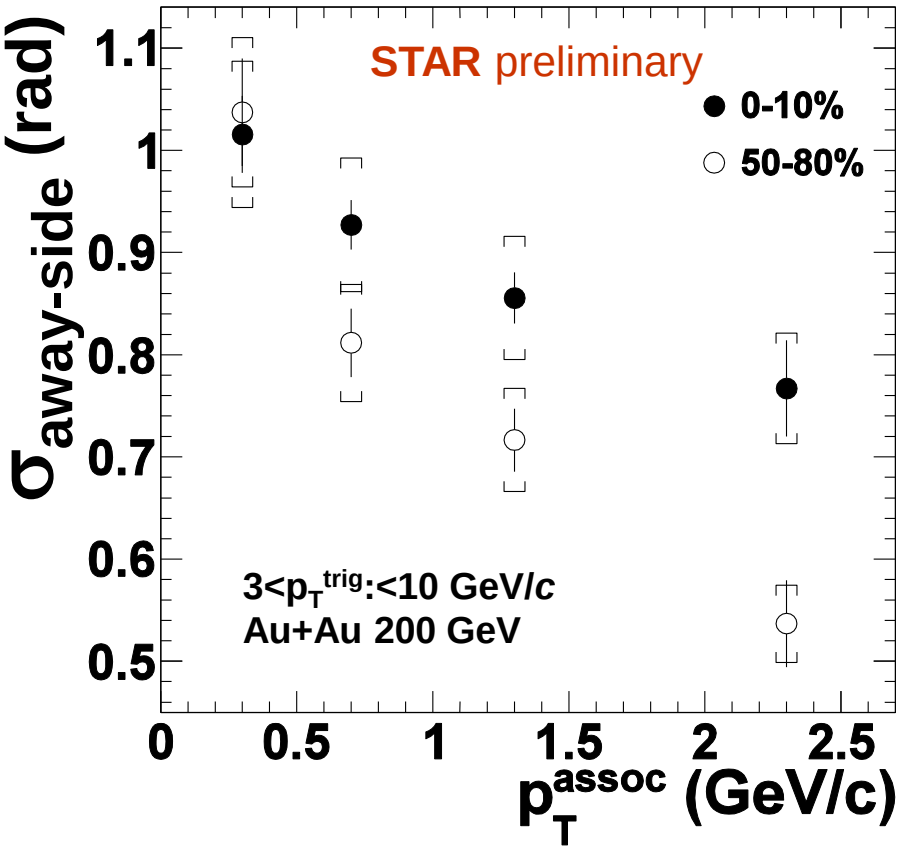
- The away-side correlation shape is consistent with Gaussian for all centrality and p_T bins.

Away-side Jet-like Correlation Widths



- Moderate to high p_T assoc. particles: broadening with increasing centrality
- Shape for all p_T more similar in central than in peripheral collisions

Medium-induced Away-side Broadening



- Width decreases rapidly with increasing p_T^{assoc}
  → expected for jet-like correlations
- In central collisions the decrease is not as large
  → stronger broadening at higher p_T
- Different from jet-hadron correlations:
  - Different "jet" kinematics?
  - Different trigger biases?

STAR *PRL 112, 122301 (2014)*

Conclusions

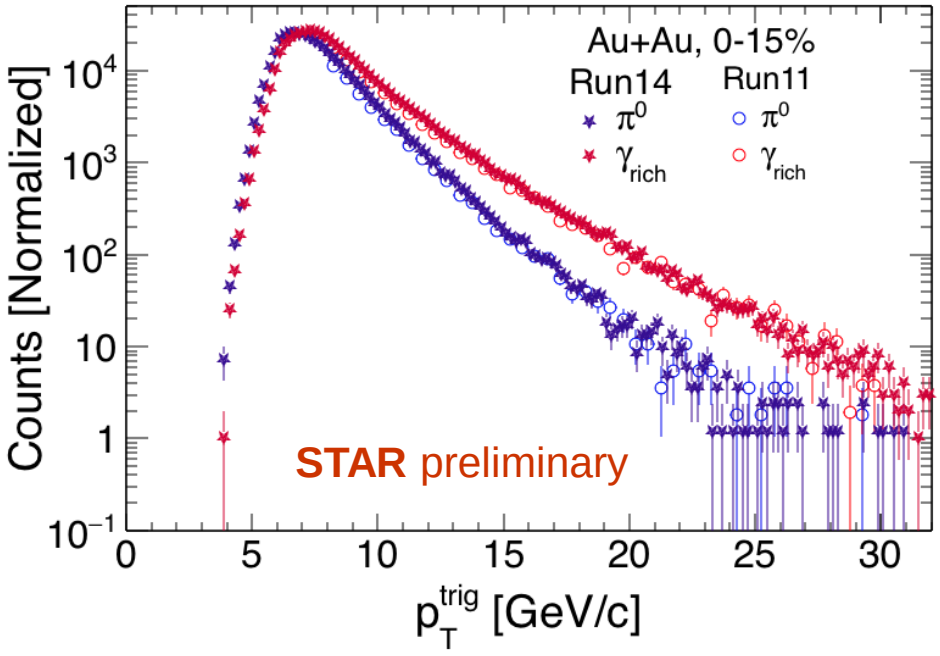
- Di-jet momentum imbalance:
  - Much improved statistics allow first measurement of centrality dependence at RHIC
  - A_J more balanced for peripheral Au+Au data

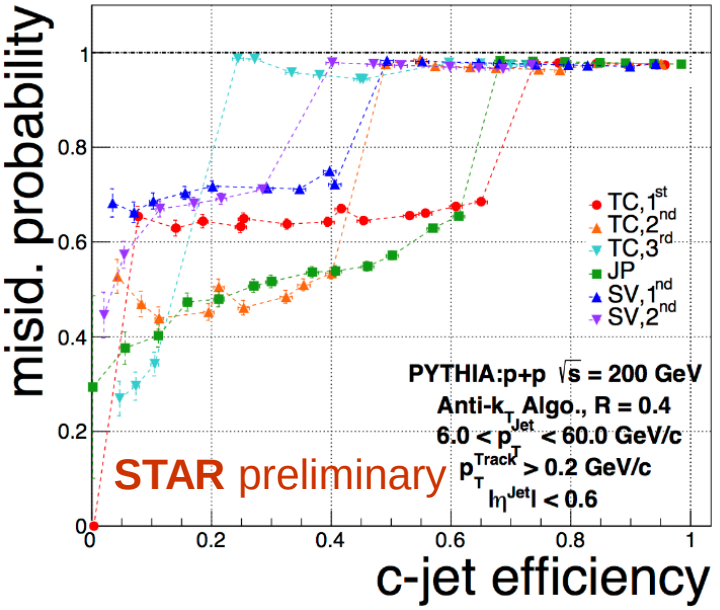
- Away-side jet-like correlations:
  - Away-side shape with robust flow background subtraction
  - Correlation broadens with increasing centrality except low p_T
  - Stronger centrality dependence of broadening at higher p_T

Outlook

- γ-jet and π^0-jet
- p+A hadron-jet

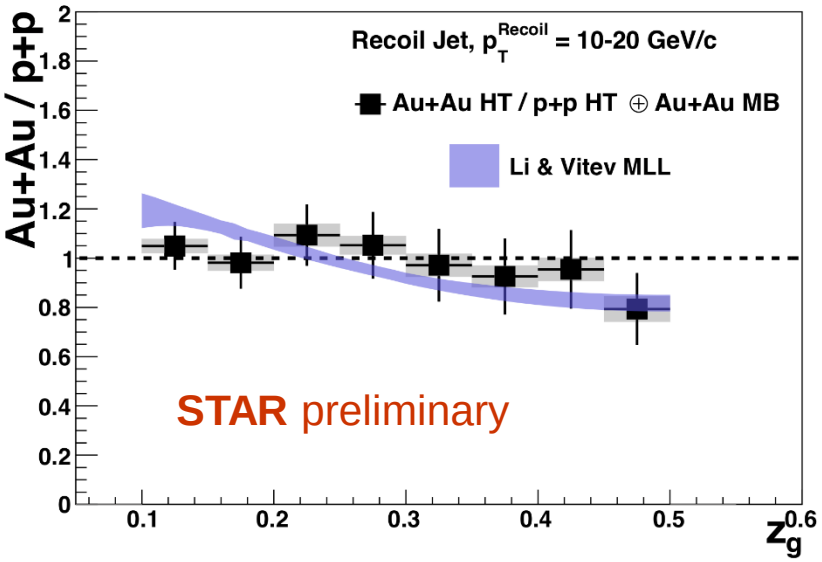
- Heavy-flavor tagged jet (Saehanseul Oh poster #375)



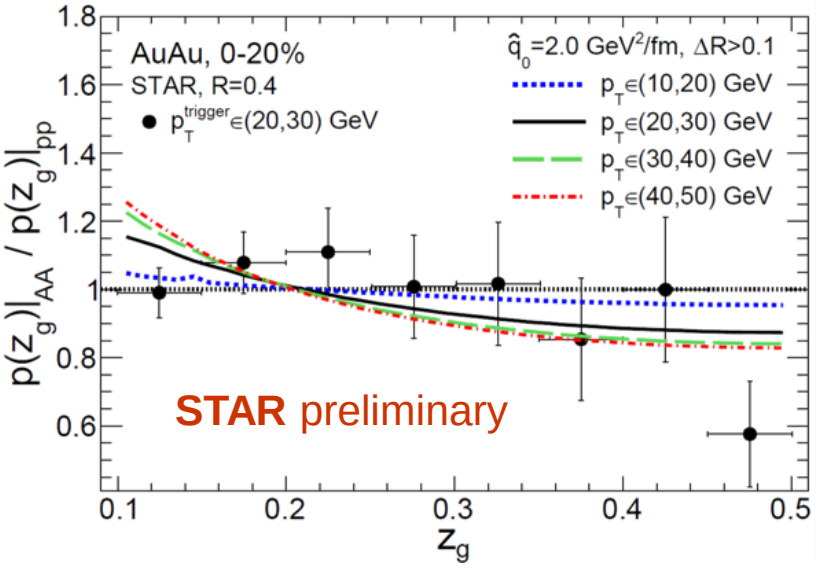


z_g in Au+Au

- Groomed momentum sharing z_g of hard-core di-jets: Theory calculations show good agreement



Li & Vitev arXiv: 1801.00008



Ning-Bo Chang #137 May 15

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- More differential measurements of z_g and jet sub-structure coming soon

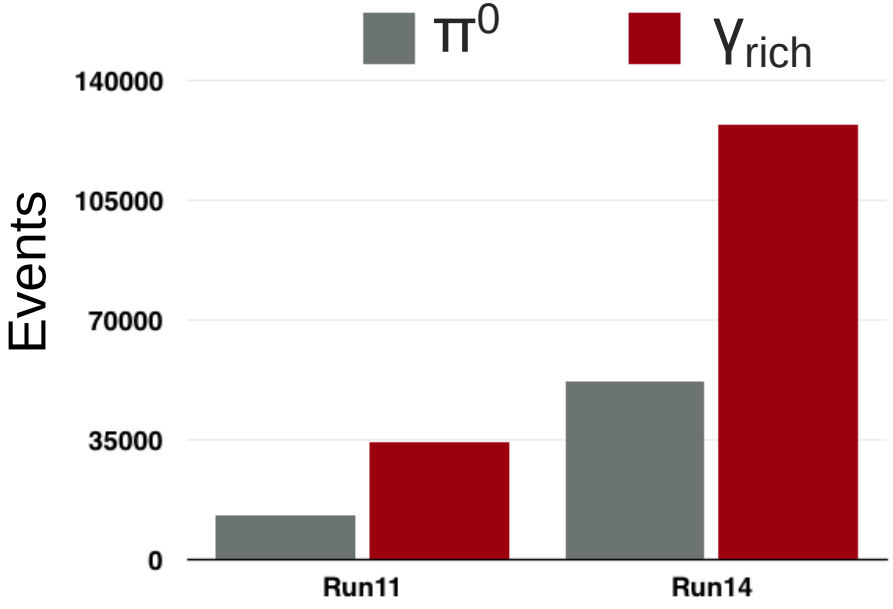
Thank you !

Backup slides

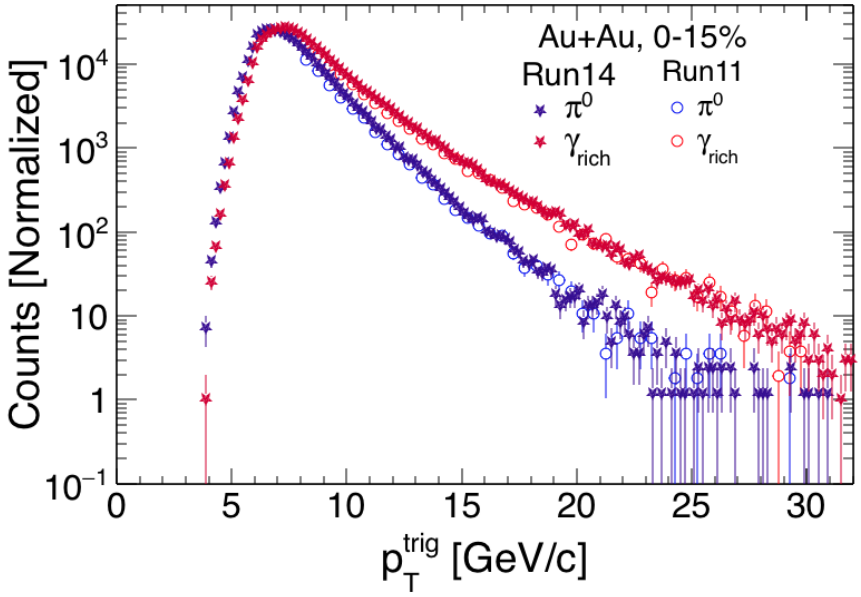
γ+jet and π^0+jet in the STAR Experiment

Au+Au 200 GeV, 0-15% central collisions

Good trigger statistics after QA
($9 < p_T^{trig} < 30$ GeV/c)

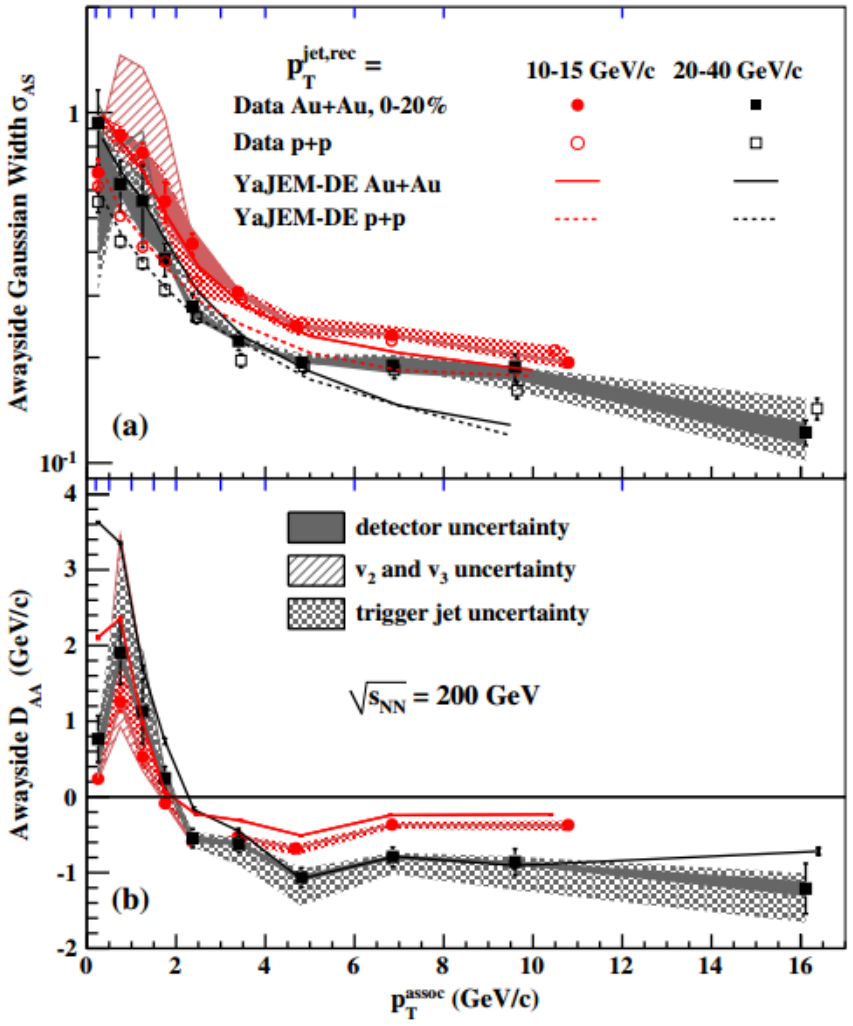


Raw Trigger p_T spectrum



Analysis is underway and will be updated soon.

Jet-hadron



PRL 112, 122301 (2014)