



Systematic Studies of Jet–medium Interactions in STAR

Kun Jiang (江琨)

University of Science and Technology of China (USTC)



U.S. DEPARTMENT OF
ENERGY

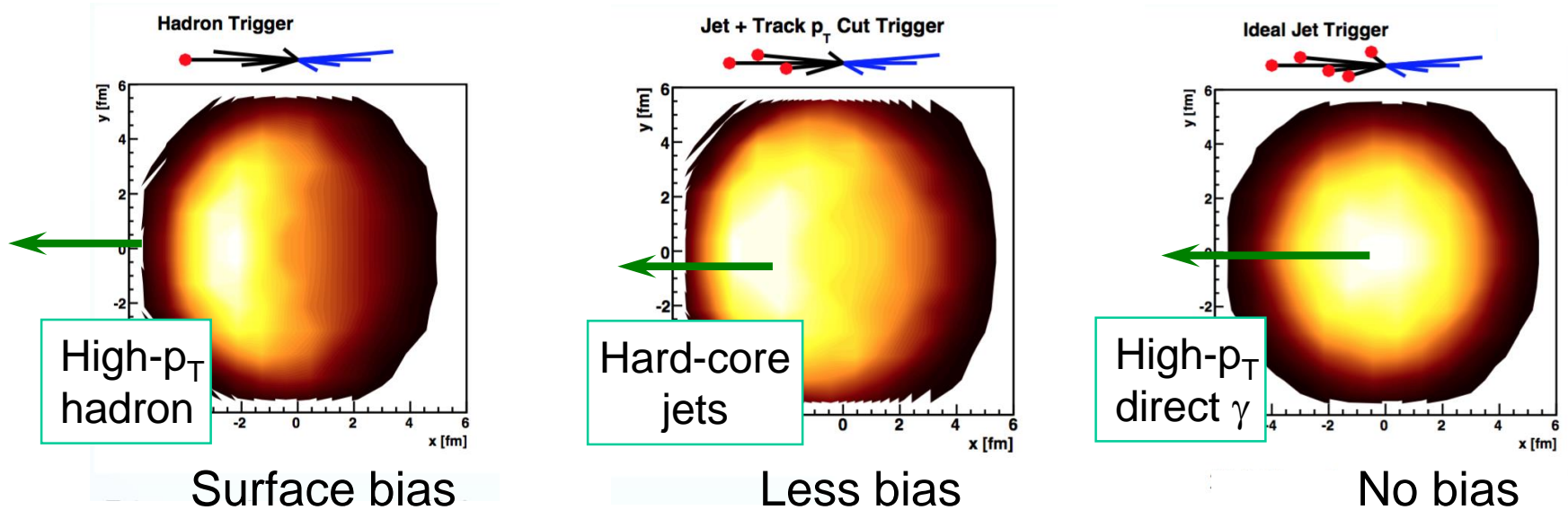


PURDUE
UNIVERSITY

Tomography with Jets

Path-length dependent energy loss

Hard scattering selection



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)

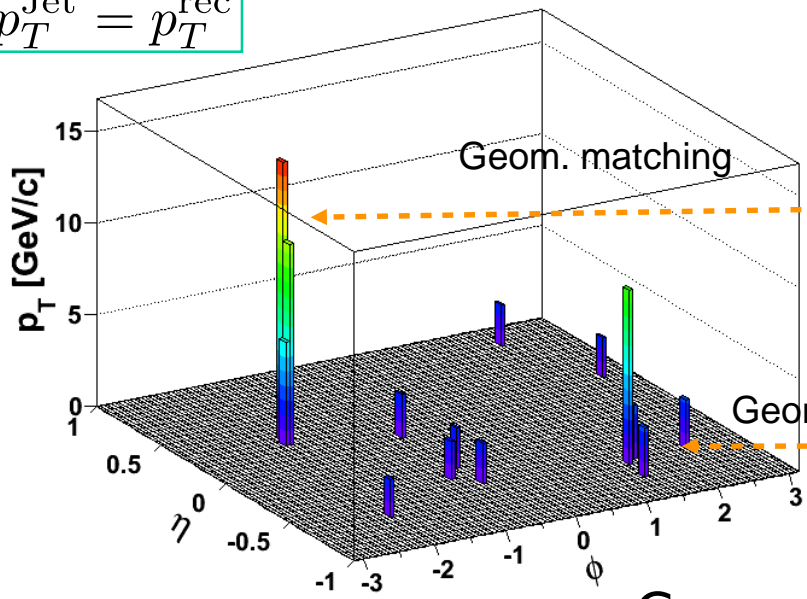
Method for Di-jet Imbalance Study

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

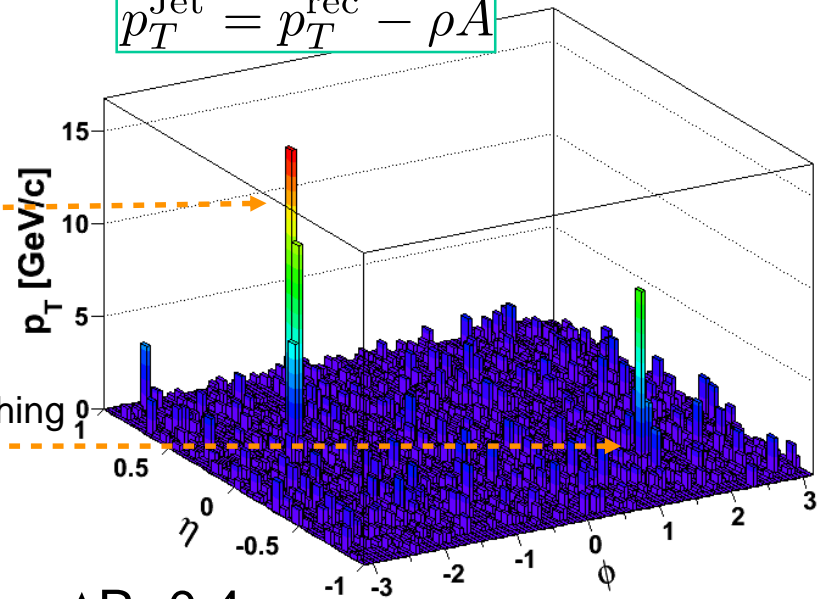
Hard-Core Di-jets
 Constituents $p_T^{\text{cut}} = 2 \text{ GeV}/c$

Matched Di-jets
 Constituents $p_T^{\text{cut}} = 0.2 \text{ GeV}/c$

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



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

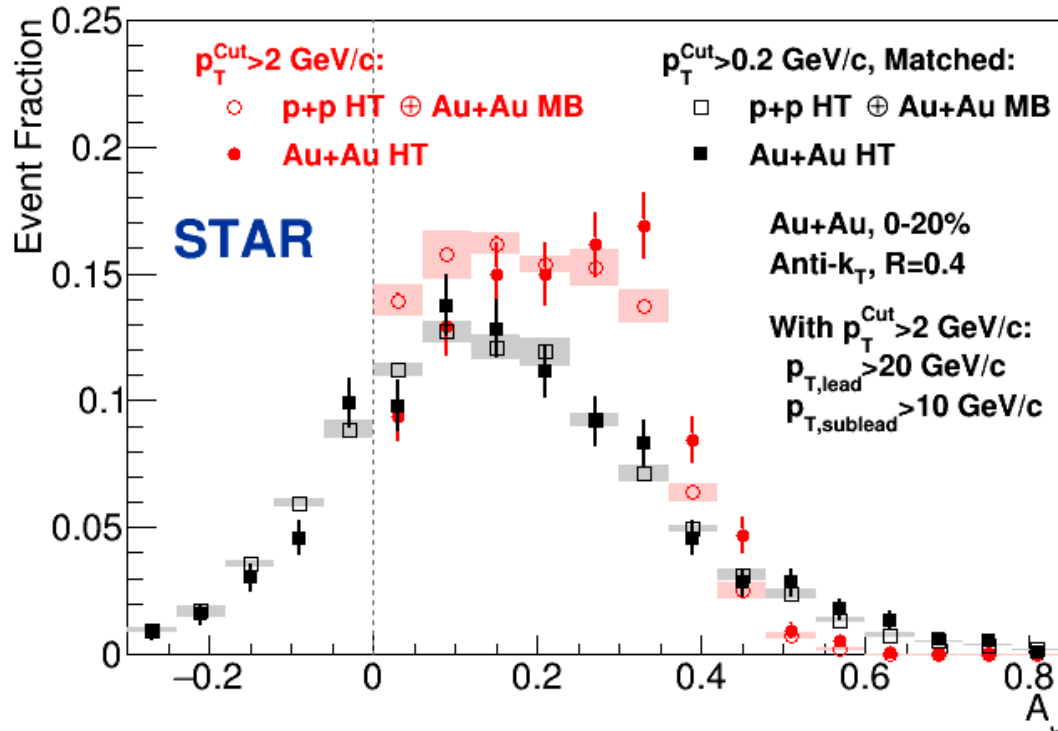


Geom. matching: $\Delta R < 0.4$

Keep this jet selection

**Calculate “matched”
 momentum imbalance with
 constituent $p_T^{\text{cut}} > 0.2 \text{ GeV}/c$.**

Di-jet Imbalance



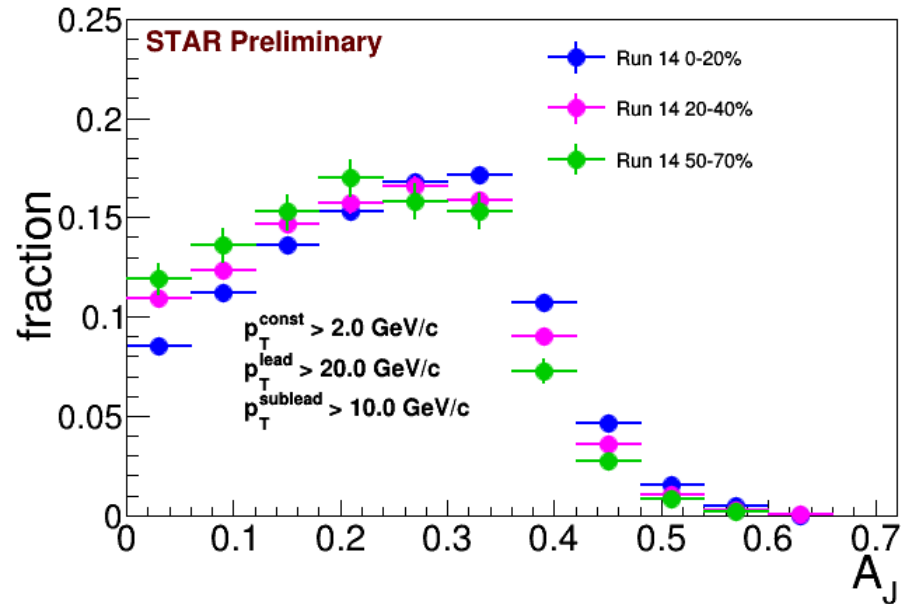
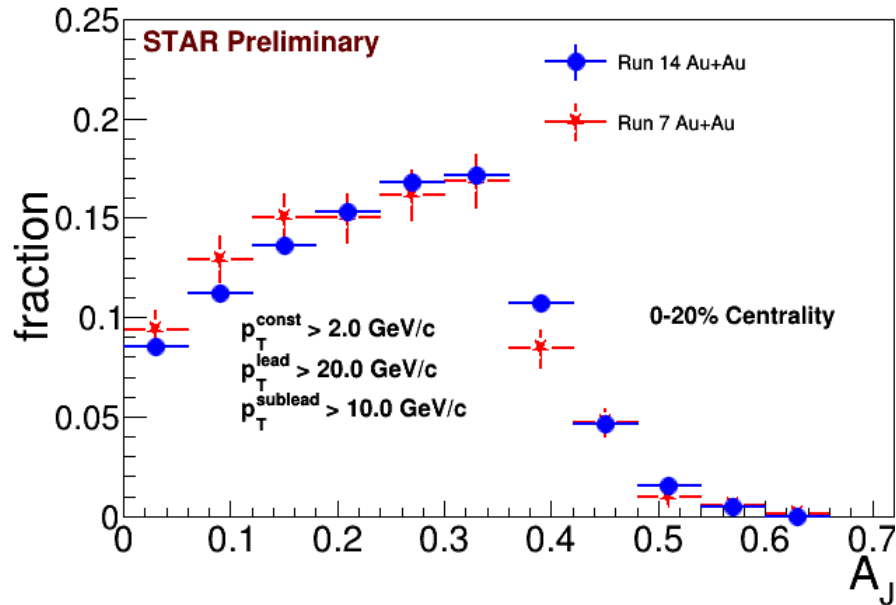
STAR PRL 119, 062301 (2017)

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

- 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)



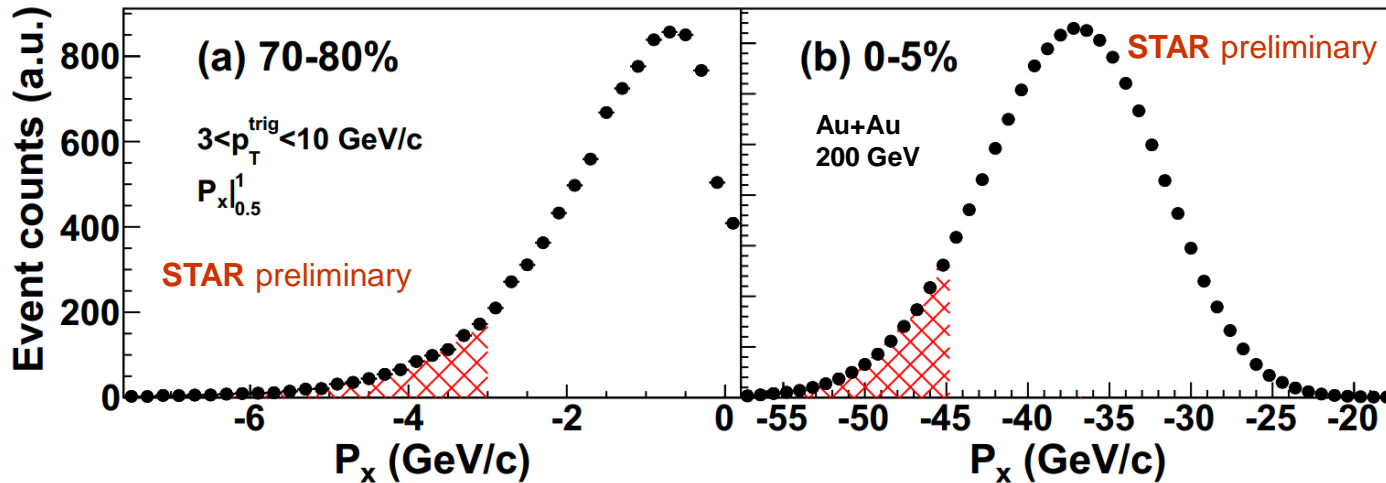
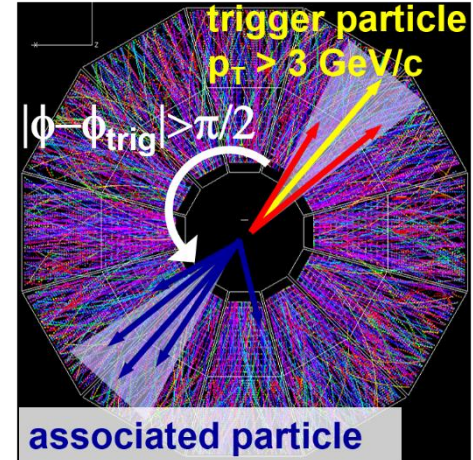
- Comparable between Au+Au Run 14 and Run 7 in 0-20% centrality (detector level)
- Run14: large increase in statistics
 → enable to study centrality dependence
- Apparent evolution of A_J to more balanced jets in peripheral Au+Au collisions

Enhanced Away-side Momentum Flow

Projection of away-side p_T onto trigger axis

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

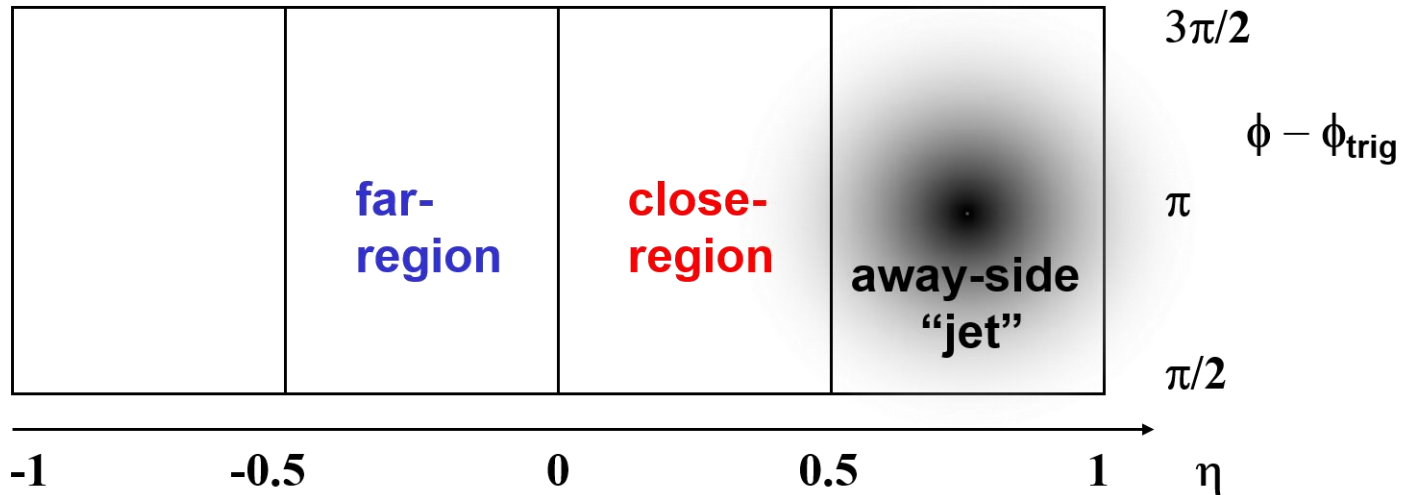
ε : single-particle acceptance \times efficiency



- For each centrality, cut on the lowest 10% of events to enhance away-side momentum flow \rightarrow “jet” = jet + jet-like hotspots

Methodology for Two-particle Correlations

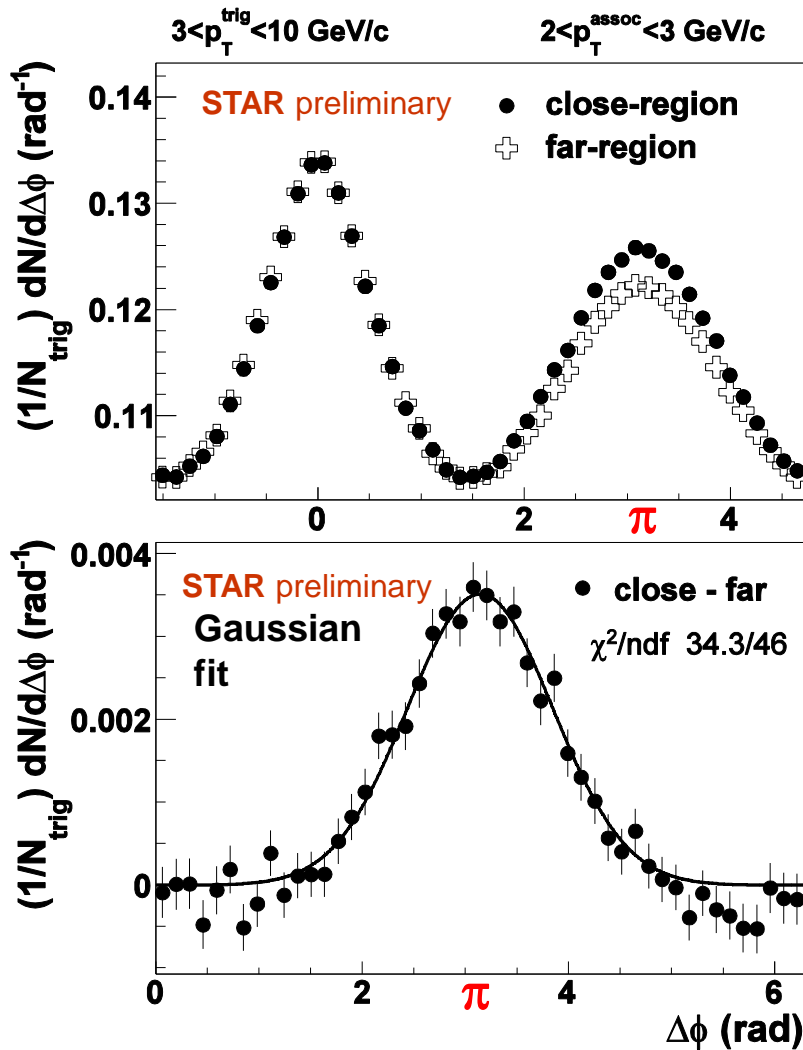
Trigger particle $|\eta| < 1$



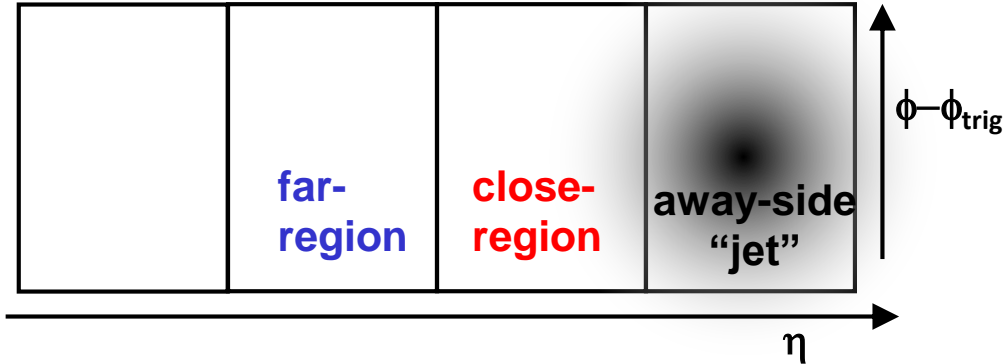
- Away-side: large recoil momentum region opposite to trigger particle
- Analyze correlations in **close-region** and **far-region**, respectively
- Flow contributions to close-region and far-region are equal
→ cancelled in their difference

$$\begin{aligned}
 \text{close-region} &= \text{flow} + \text{near-side "jet"} + \text{away-side "jet"} * \text{fraction}_{\text{close}} \\
 \text{far-region} &= \text{flow} + \text{near-side "jet"} + \text{away-side "jet"} * \text{fraction}_{\text{far}} \\
 \text{diff} &= \text{away-side "jet"} * \text{fraction}
 \end{aligned}$$

Flow Subtracted Away-side Correlation



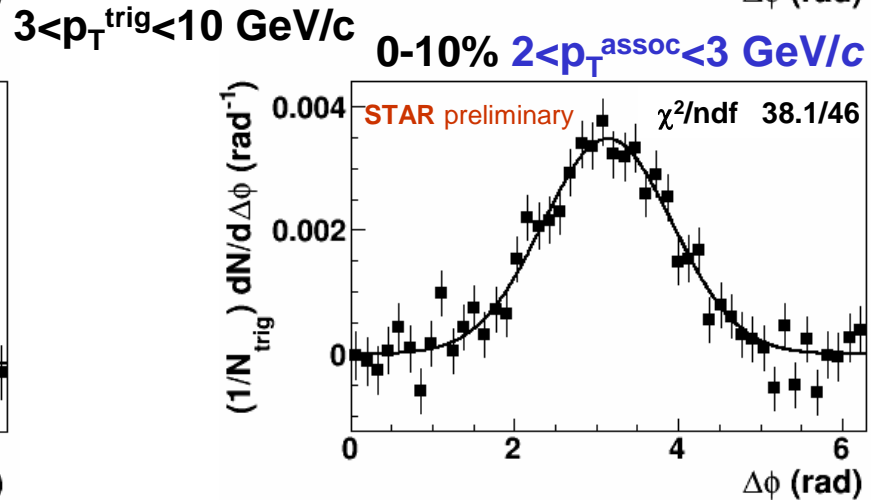
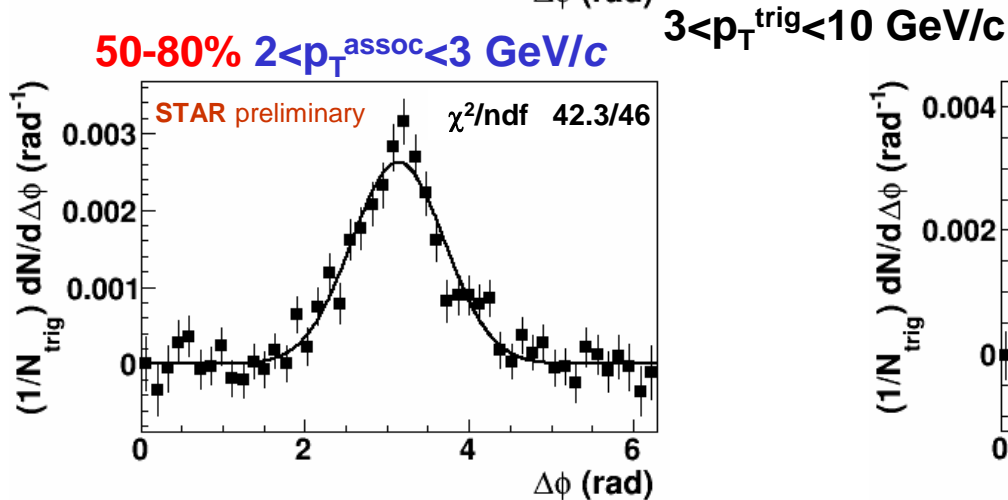
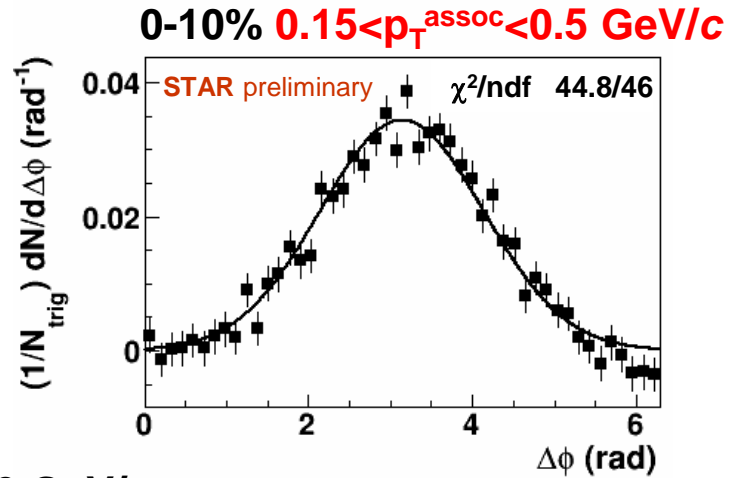
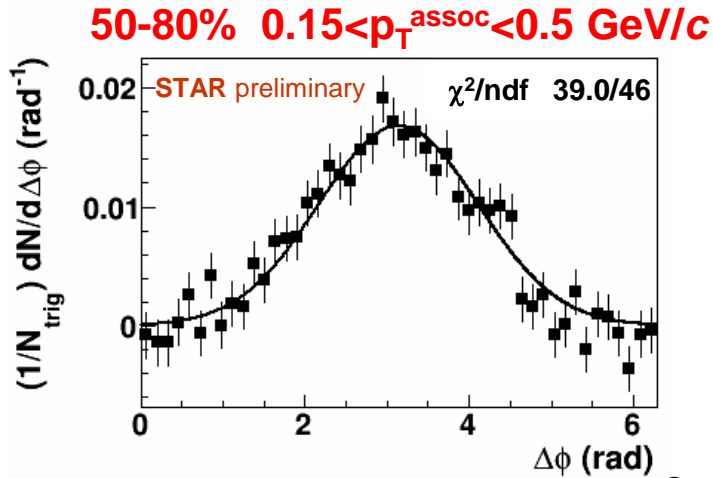
STAR TPC



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

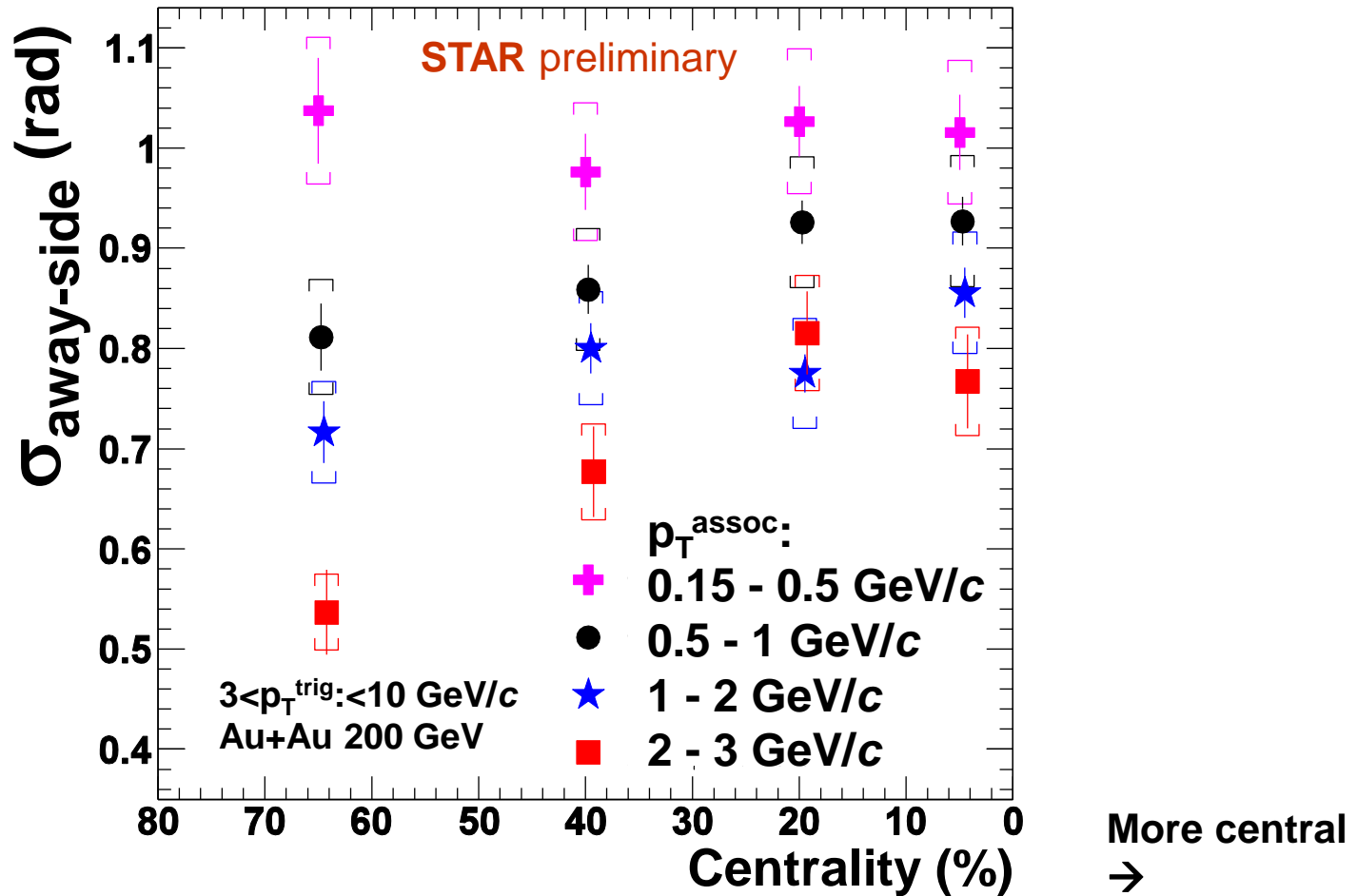
- Near-side equal as expected
- Away-side **yield** contains unknown "fraction" factor
- Away-side **shape** can be quantified by Gaussian fit width, σ

Away-side Jet-like Correlation Shape



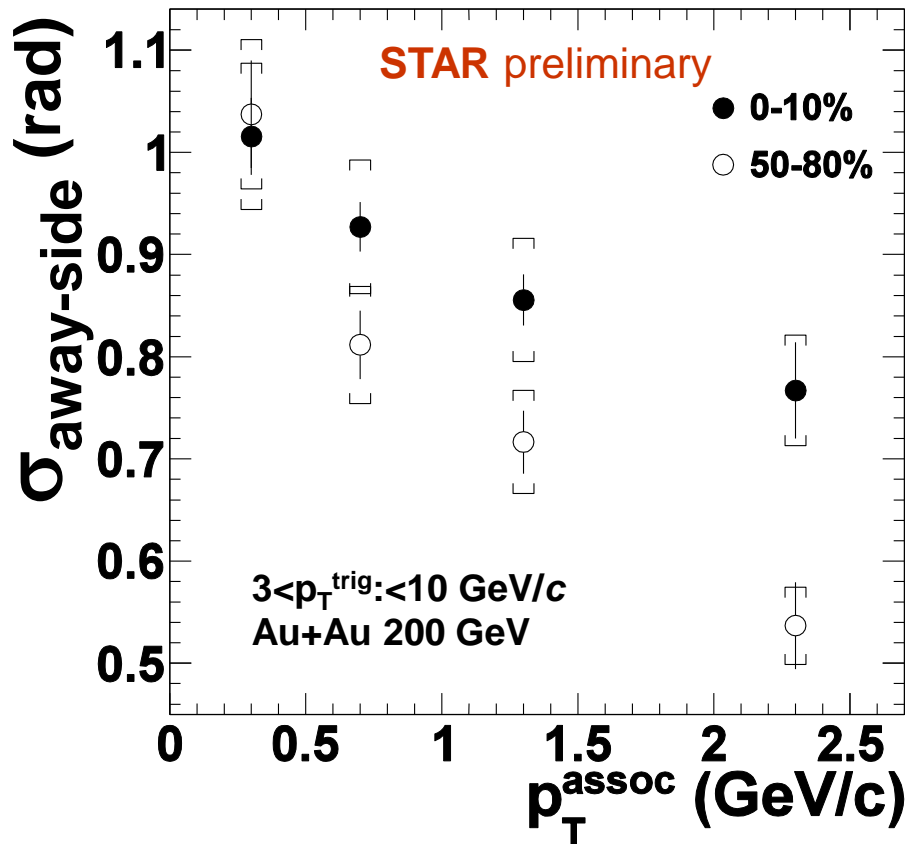
- The away-side correlation shape is consistent with Gaussian for all centrality and p_T bins.

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 $p_{\text{T}}^{\text{assoc}}$
→ 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?

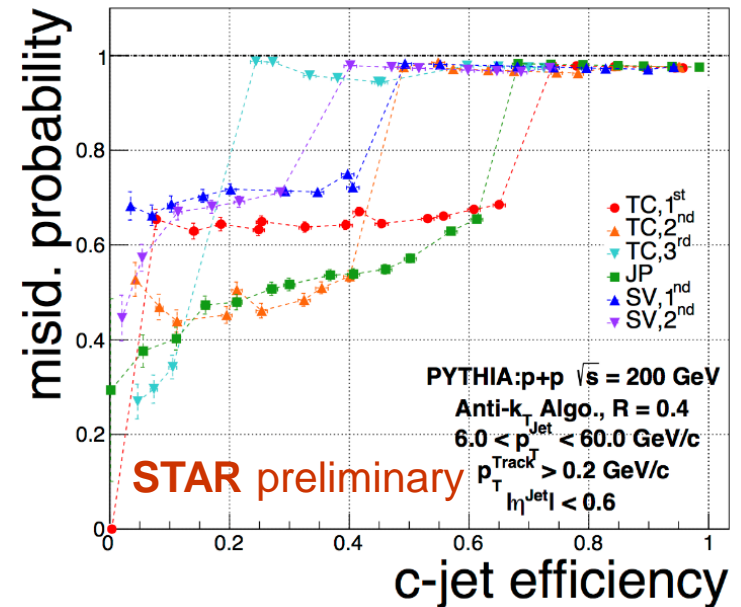
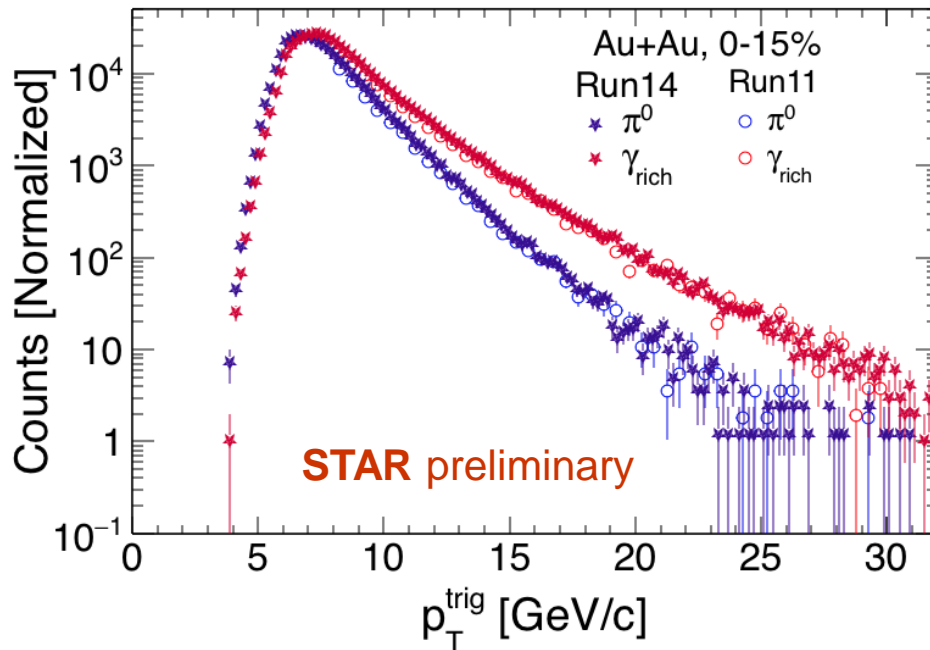
STAR PRL 112, 122301 (2014)

- 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

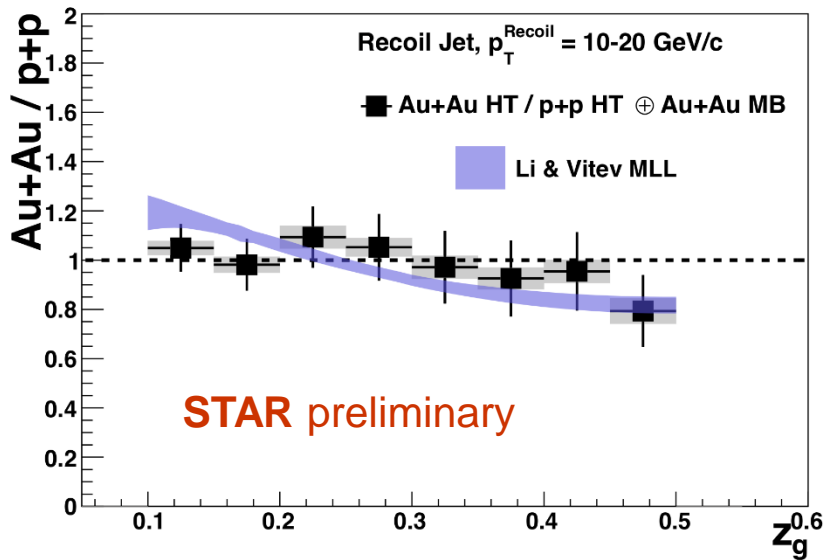
- γ -jet and π^0 -jet
- p+A hadron-jet

- Heavy-flavor tagged jet

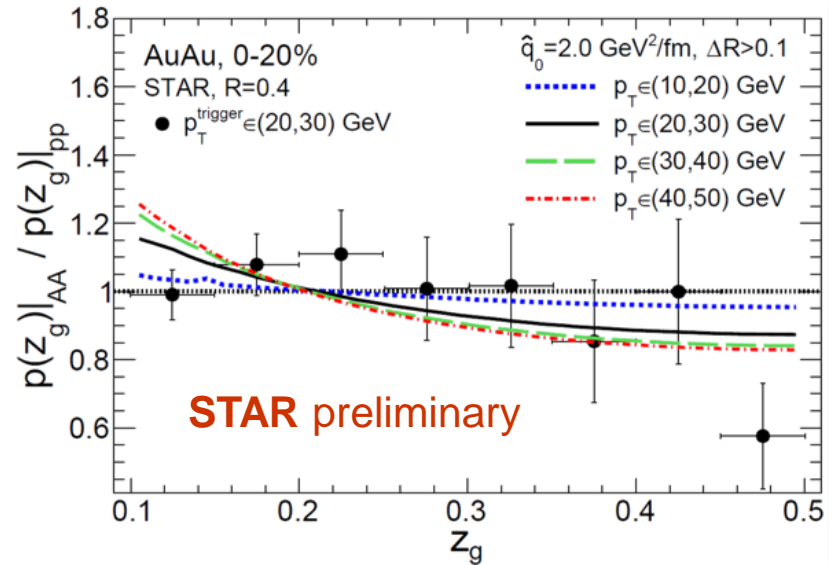


z_g in Au+Au

- 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

N.-B. Chang et al. PLB 781 (2018) 423

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

Thank you!

Backup slides

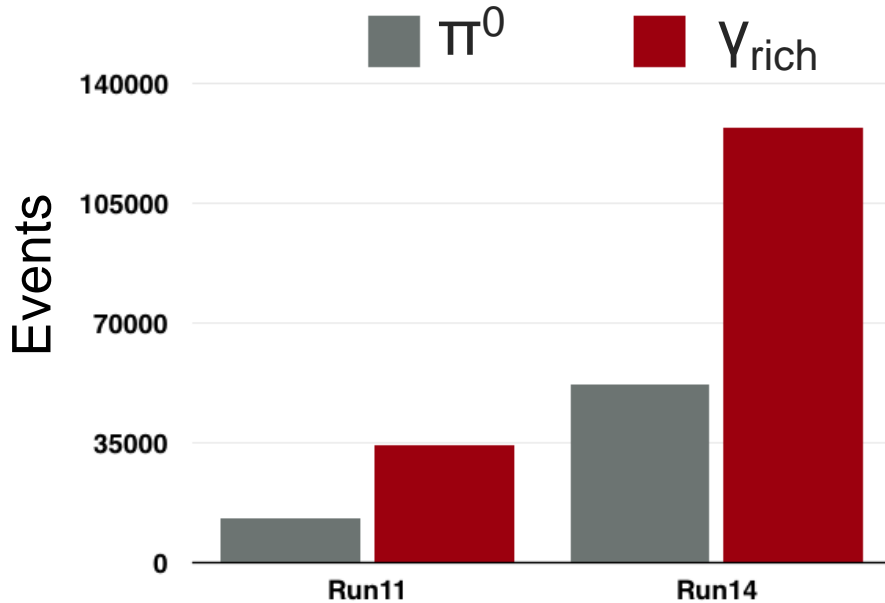


γ +jet and π^0 +jet in the STAR Experiment

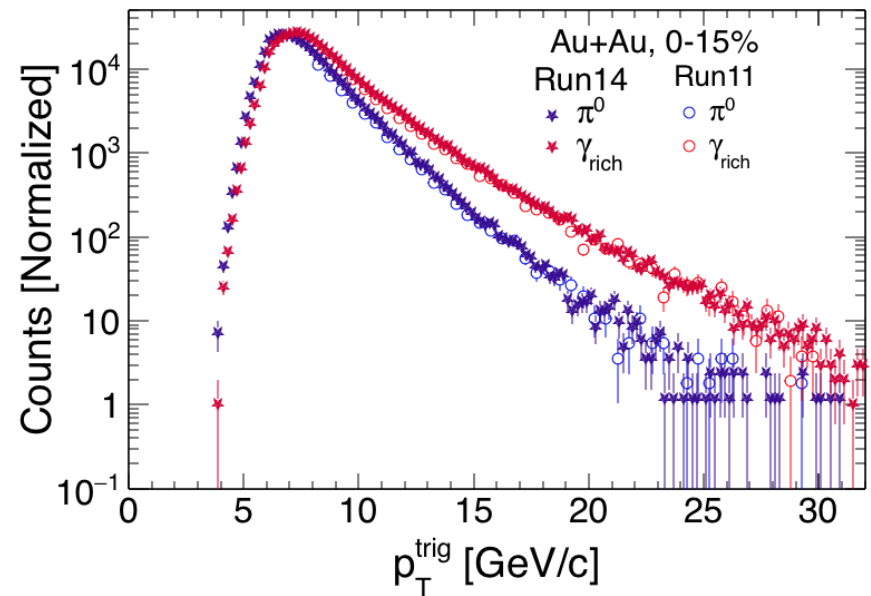


Au+Au 200 GeV, 0-15% central collisions

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

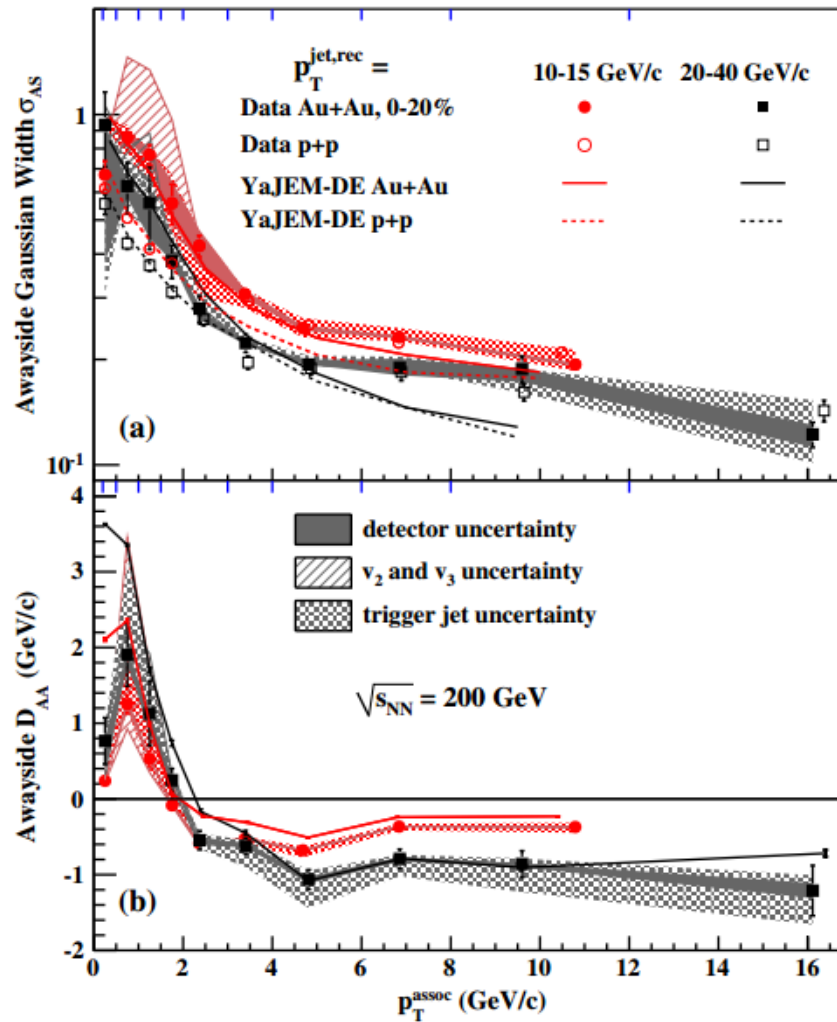


Raw Trigger p_T spectrum



Analysis is underway and will be updated soon.

Jet-hadron



PRL 112, 122301 (2014)