Preliminary figures request: AuAu Event Shape Engineering

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8/15/2024

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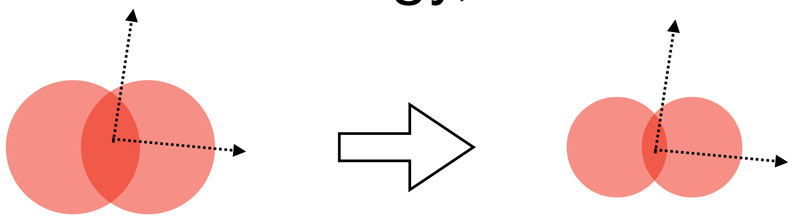
Physics motivation

Constrain path length dependence of energy loss in medium by controlling for both the size and shape of the overlap region → relative contribution of each type of energy loss (e.g. radiative vs. collisional)

Lower statistics and less clean than isobar data, but larger system means better determination of q_2 ($Q_2 = (\sum_{i=1}^{M} w_i \cos(2\phi_i), \sum_{i=1}^{M} w_i \sin(2\phi_i)), q_2 = |Q_2|/\sqrt{M}$)

Has been done at ALICE! See e.g. https://arxiv.org/abs/2307.14097

STAR has smaller systems at lower energy, for different medium path length: complementarity



Dataset

- Dataset: Au+Au, $\sqrt{s} = 200\ \mathrm{GeV}$
- Year: 2019
- Production tag: production_AuAu200_2019,
- Triggers used: ZDCMB: 700001 [138.382M events, of which ~93% on DD → ~32M after all cuts (lose the most due to v_r cut)]
- **Caveat**: Still getting the ‘3011’ error codes, but when resubmitting, no improvement. Either that server is down persistently, or the errors are a red herring and I do actually have the full dataset. Think the former is more likely.

Bad runs

20191005, 20191015, 20192001, 20193001, 20193019

Event level cuts

$-30 < v_z < 20$ cm

$v_r < 2$ cm

$|v_z - v_{z,VPD}| < 3$ cm

Track level cuts

Primary tracks

$0.2 < p_T < 30$ GeV/c

$-1 < |\eta| < 1$

DCA < 1 cm

nHitsFit > 15

nHitsFit/nHitsMax > 0.52

From QM’23:

Analysis procedure

The event plane angles determined by the EPD are flattened by ϕ-weighting and Ψ -shifting [https://drupal.star.bnl.gov/STAR/blog/lisa/using-epd-event-plane-finder] in two iterations of the code.

On the third iteration, we have weighted q-vectors (from the west EPD), and save our track information. Multiplicity for q_2 determination is from truncated nMIPs signal sum.

We determine event-plane angles from one half (east) of the EPD and q_2 from the other half (west). The track measurement for analysis is made with all tracks in the TPC.

After running, we take quantiles of the q_2 distribution for a given centrality and compare the track spectra between the classes.

A systematic uncertainty for the q_2 resolution is applied as well.

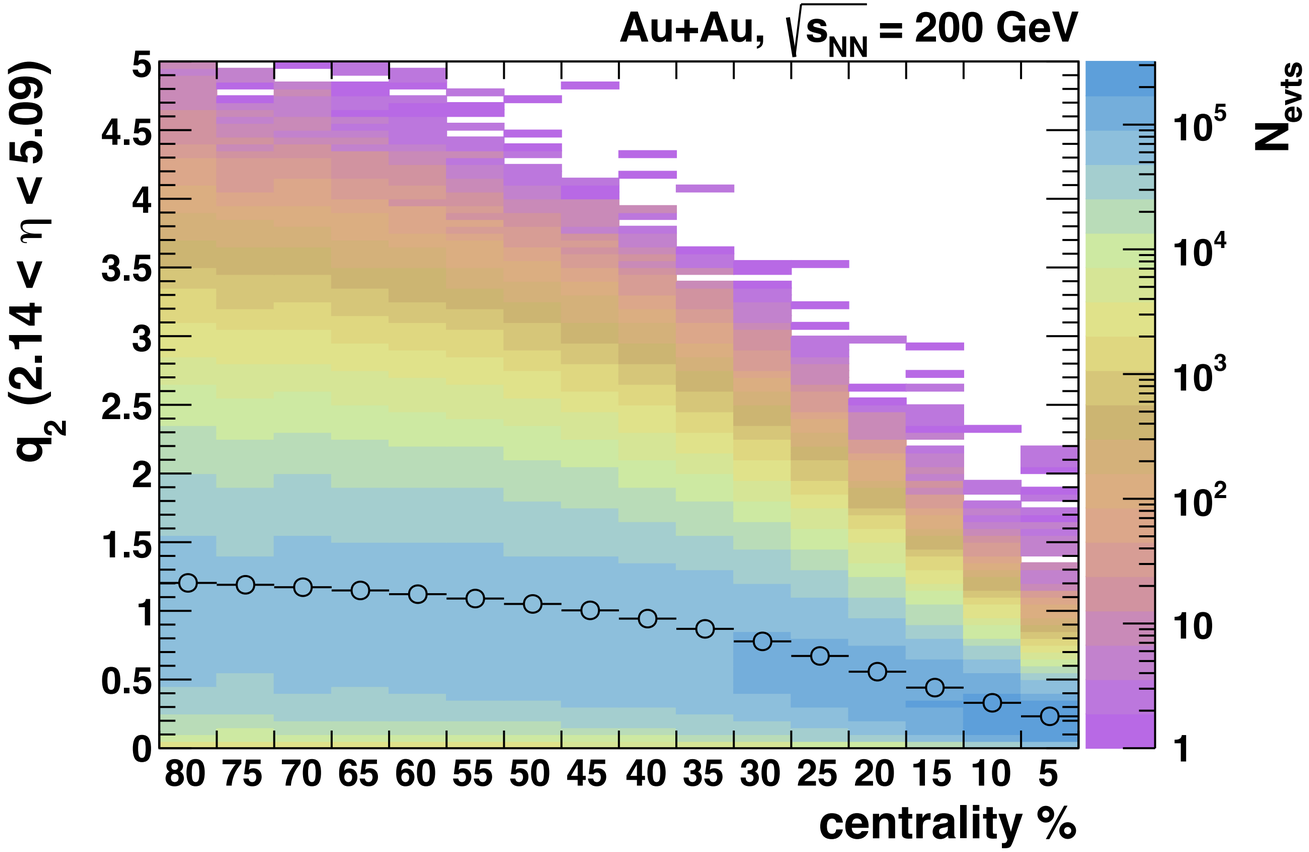
Systematic uncertainties

Imperfect q_2 resolution can cause a misclassification of the event as more/less elliptical than it actually is. Account for this by switching between q_2 of the west and east as a systematic uncertainty

Not applying tracking efficiency correction/uncertainty because it would cancel in the ratio

Figure 1 (performance)

q_2 vs centrality

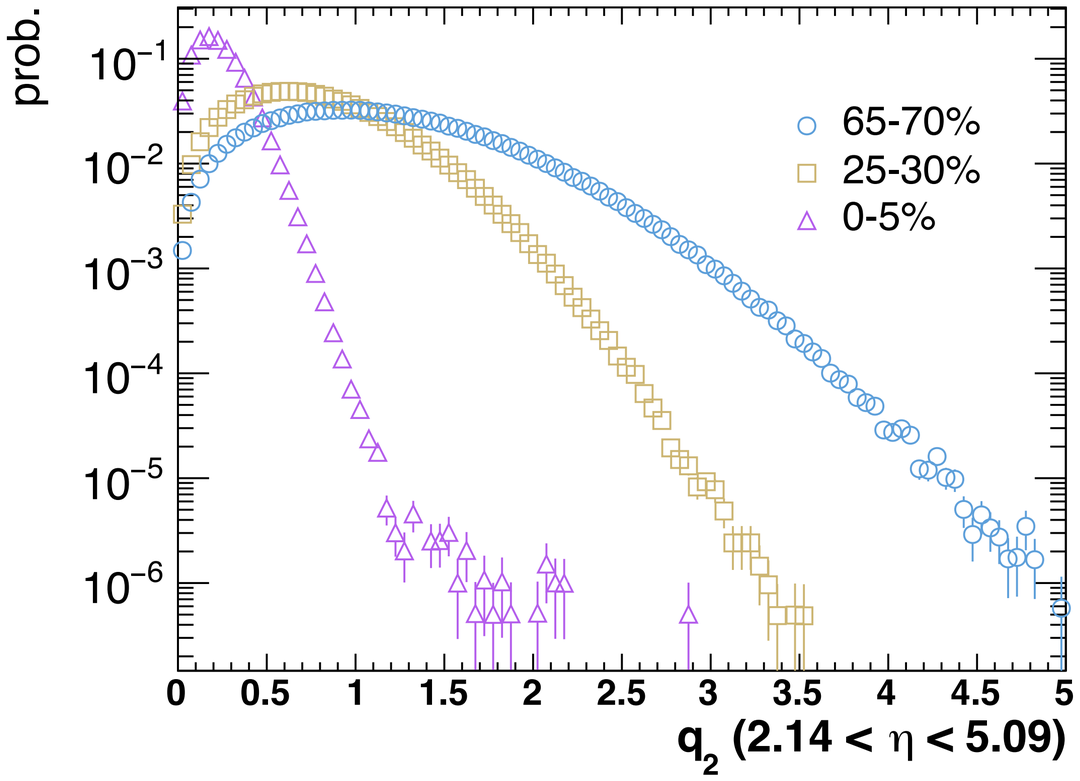


Shows that there is a relation between q_2 and centrality, but that for a given centrality, there is a broad distribution of event shapes

Note: looks different from ALICE V0 distribution, but we looked into this for the isobars — when I don't truncate nMIPs, the distribution becomes qualitatively consistent with theirs. However, should be correct to truncate for EPD.

Figure 2 (performance)

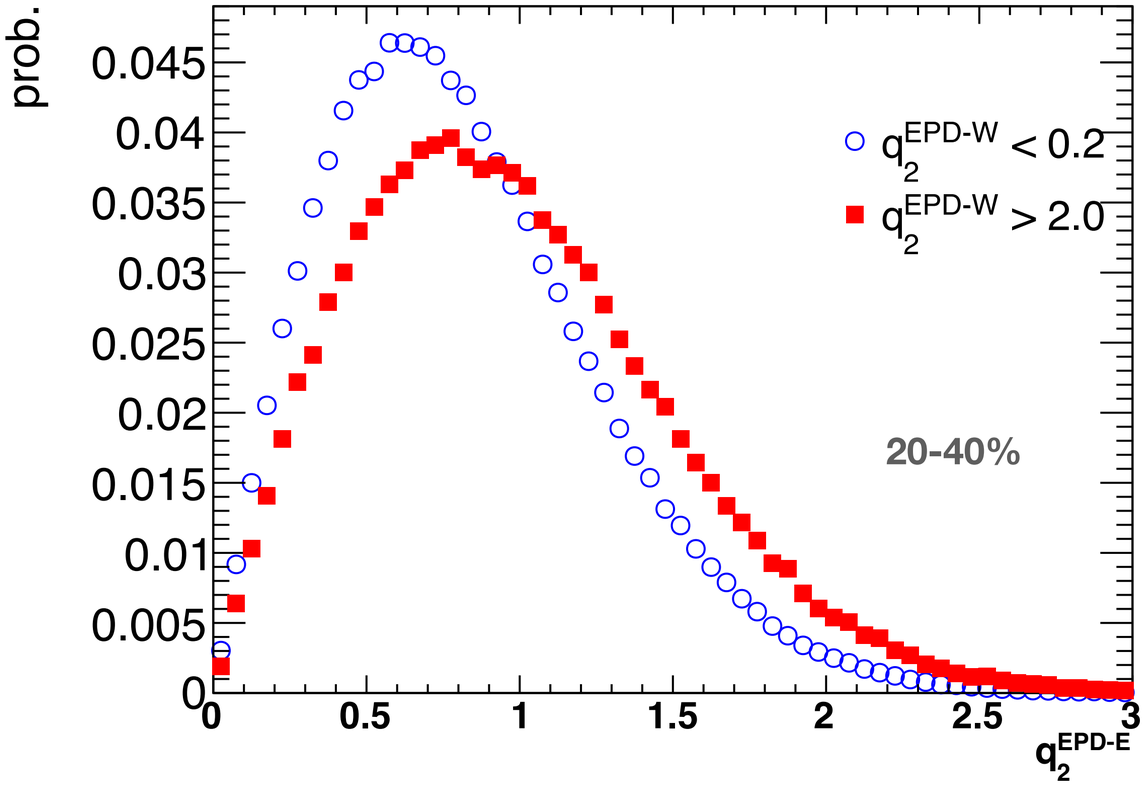
q_2 vs centrality



Projection of the previous figure for different centrality ranges to show that the accentuate the centrality-dependent behavior from the 2D plot

Figure 3 (performance)

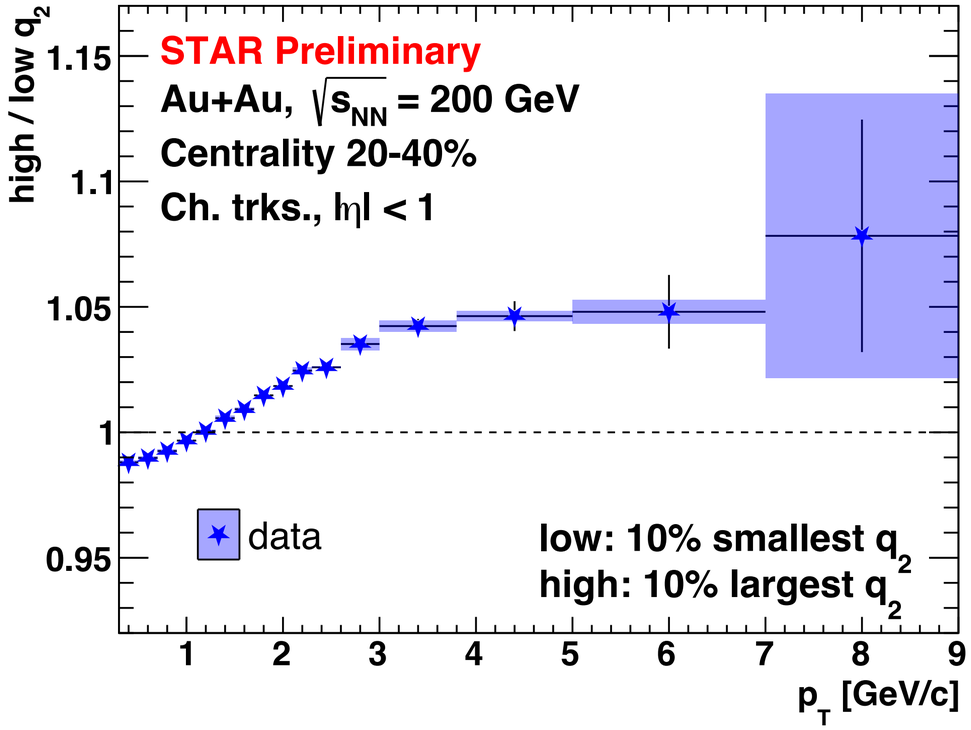
q_2 in east and west halves of EPD



In AuAu, unlike in isobar, we have a correlation between east and west halves of the EPD for q_2 → has physical meaning for this dataset

Figure 4 (preliminary)

Track spectra in q_2 classes

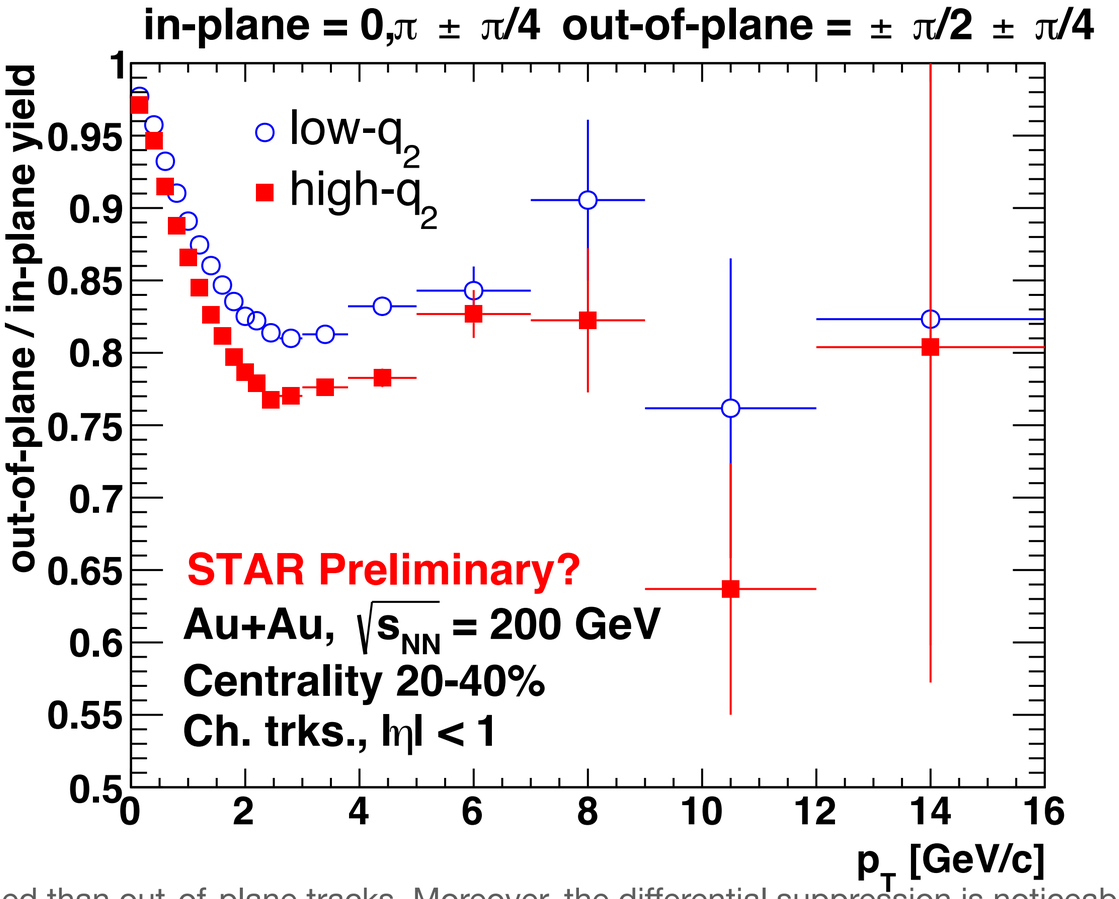


Enhancement at lower p_T for high q_2 consistent with ALICE (https://arxiv.org/pdf/1507.06194.pdf) which they explain with an interplay between elliptic and radial flow. Note: suppression at lowest p_T qualitatively consistent with their results for V0-classified q_2 although slightly stronger effect (mitigated a bit when making high/unbiased comparison as they do). At higher p_T, ratio is flat, so separating by q_2 without selecting on angle from EP doesn't result in a jet quenching difference since average path length is still the same.

Analysis procedure and systematics cont.

- Divide spectra into in-plane and out-of-plane using the EP angles as determined from the procedure mentioned earlier, and take the ratio for both low-q_2 and high-q_2 events
- Systematics:
  - Event plane resolution correction + variation
  - Variation in DCA, nHitsFit, nHitsFitMax, …

Figure 5 (*request for preliminary*)



In-plane tracks are more suppressed than out-of-plane tracks. Moreover, the differential suppression is noticeably larger in high-q_2 than low-q_2 events.
This is suggestive of a path-length dependent mechanism.
Also, consistent with ALICE where largest relative suppression was seen at lowest p_T for R = 0.2 jets, but overall suppression was seen across the p_T domain (regardless of R).

BACKUP