Control study of surface bias emission in 2-particle correlations in Au+Au at $\sqrt{s_{NN}}$ = 200 GeV in PHENIX

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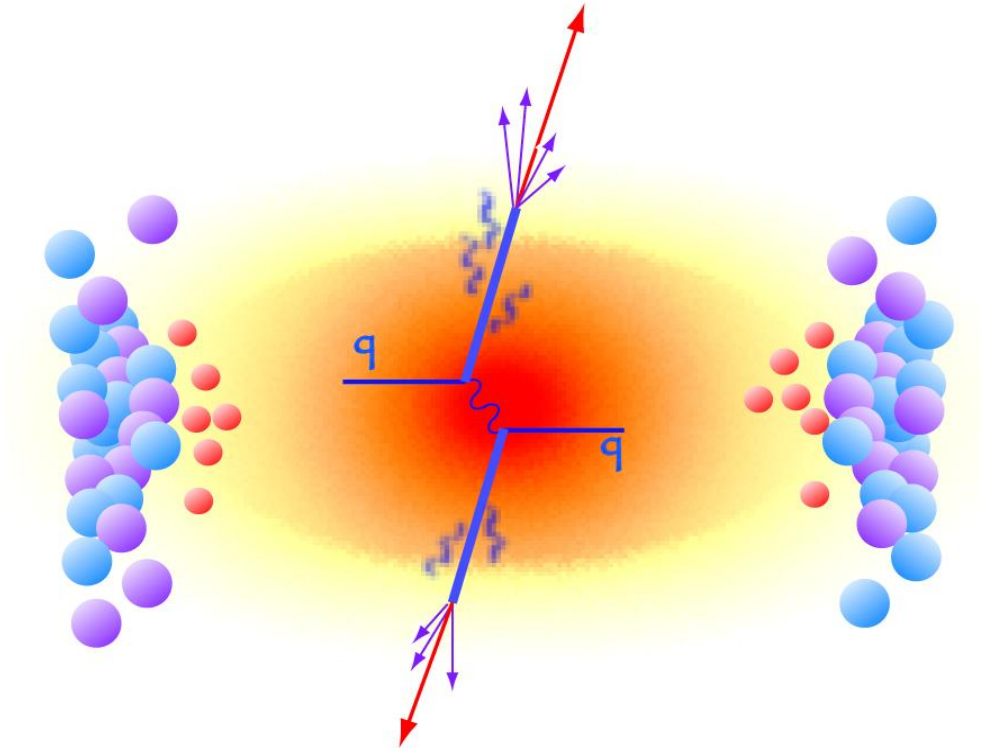
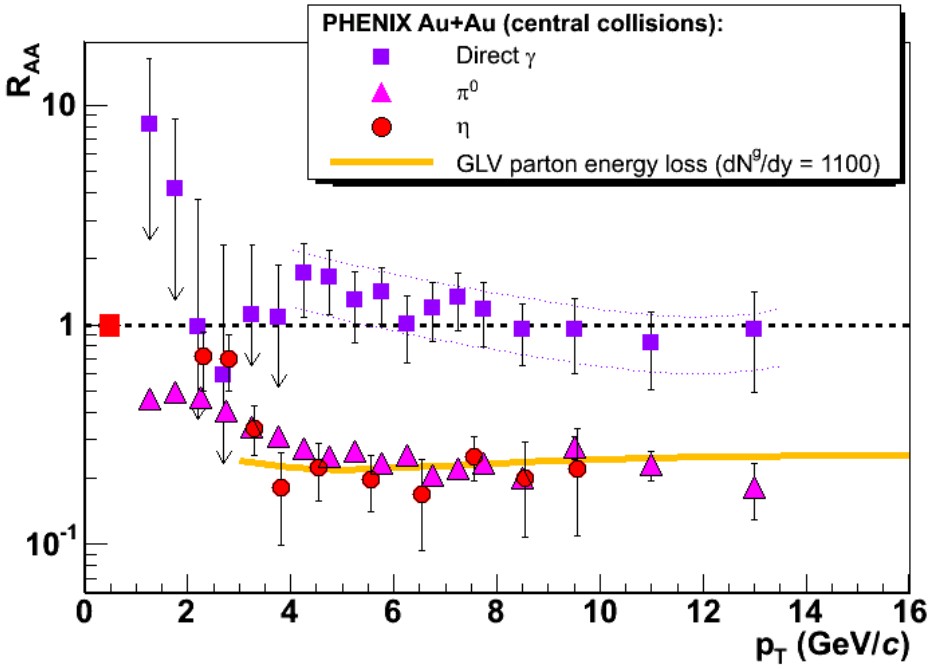
Probing the quark gluon plasma

- RHIC: Heavy-ion collisions at $\sqrt{s_{NN}}$ = 200 GeV:
  - Evidence of strongly interacting colored medium
  - Strongly interacting medium induces parton energy loss



PROBING THE QUARK GLUON PLASMA

- Nuclear modification factor (R_{AA}) was first crude indicator of energy loss.
  - Compare final state particle production with a "control" system (scaled proton-proton collisions)
  - However, little sensitivity to precise energy loss mechanism



Significant energy loss

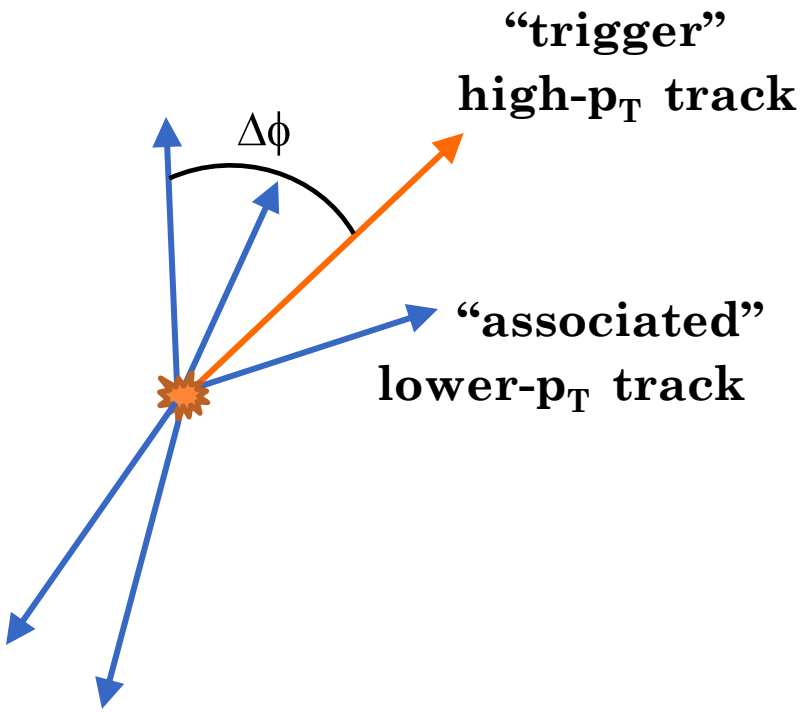
Probing the quark gluon plasma

- Nuclear modification factor (R_{AA}) was first crude indicator of energy loss.
  - Compare final state particle production with a "control" system (scaled proton-proton collisions)
  - However, little sensitivity to precise energy loss mechanism

- 2-particle correlations provide a probe associated with jets that is sensitive to path length traversed in strongly interacting medium.

2-PARTICLE CORRELATIONS AT RHIC

- Triggering on events with high-p_T tracks is an efficient way to probe jet production.



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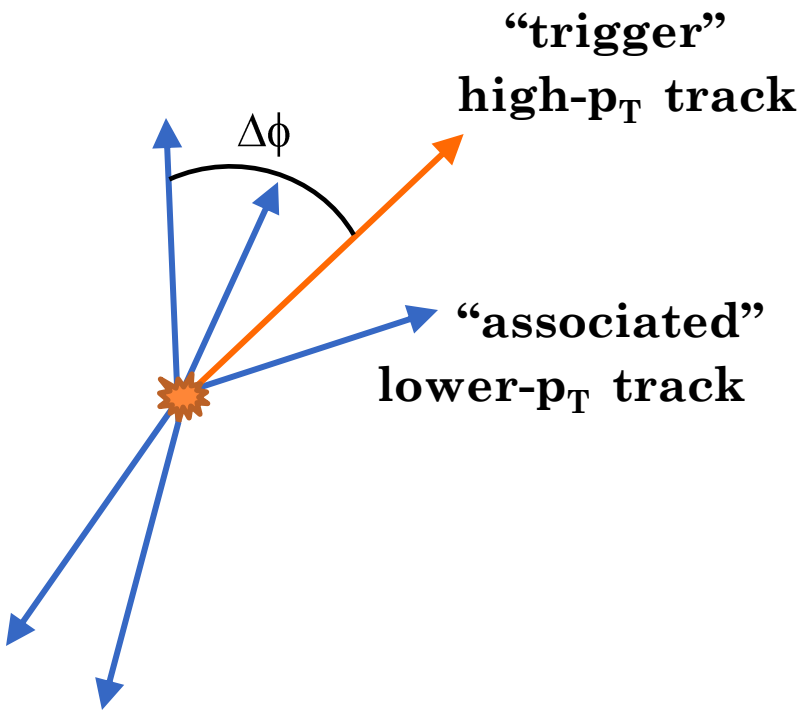
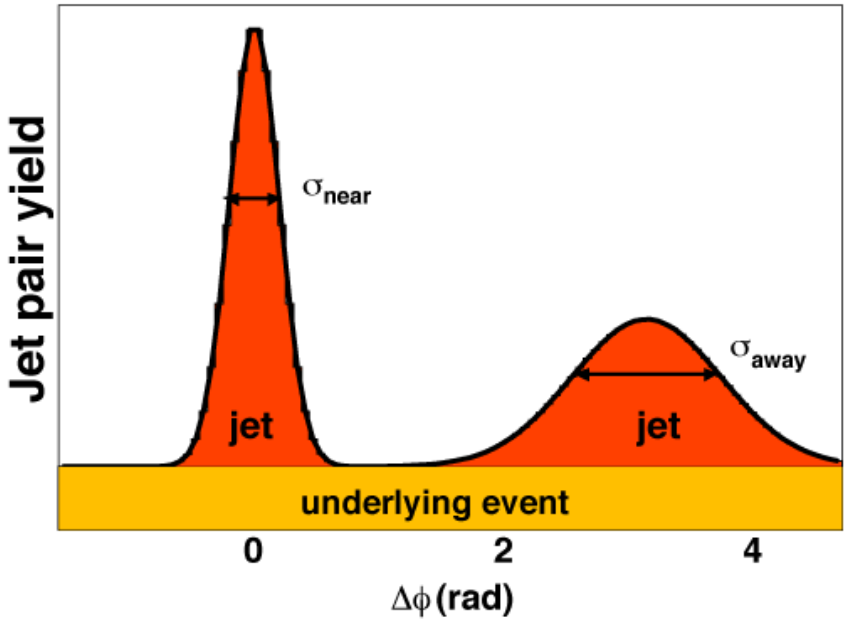
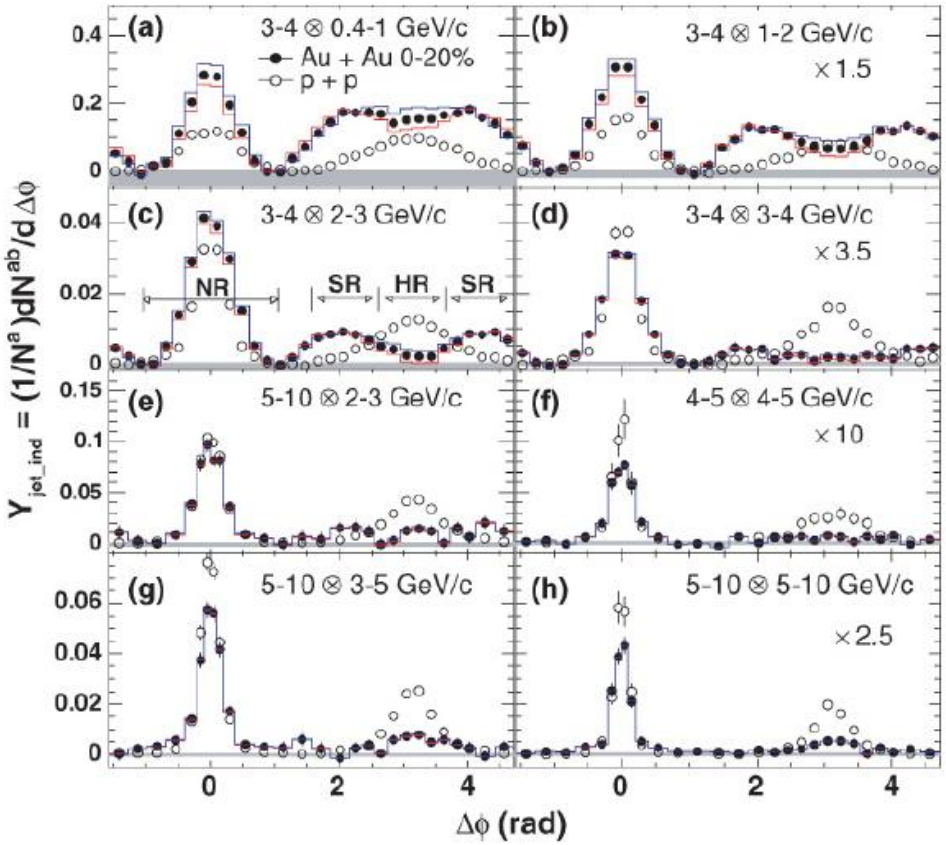




JET MEASUREMENTS AT RHIC

- Both PHENIX and STAR have provided a wealth of measurements providing insight into jet-quenching at RHIC.



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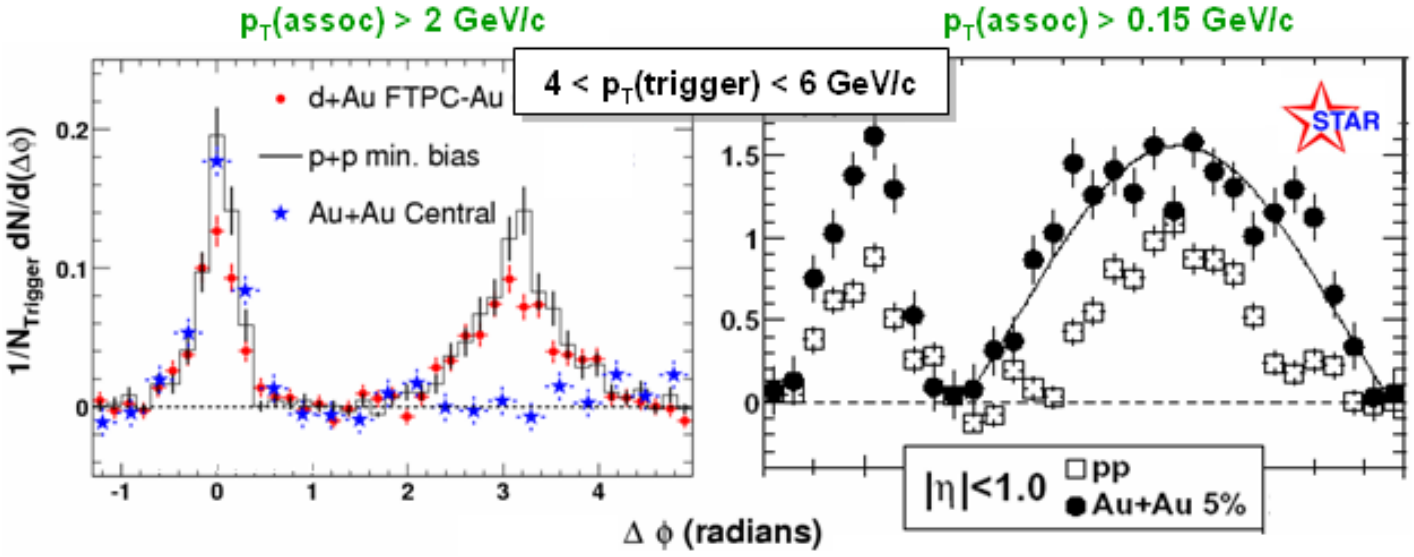
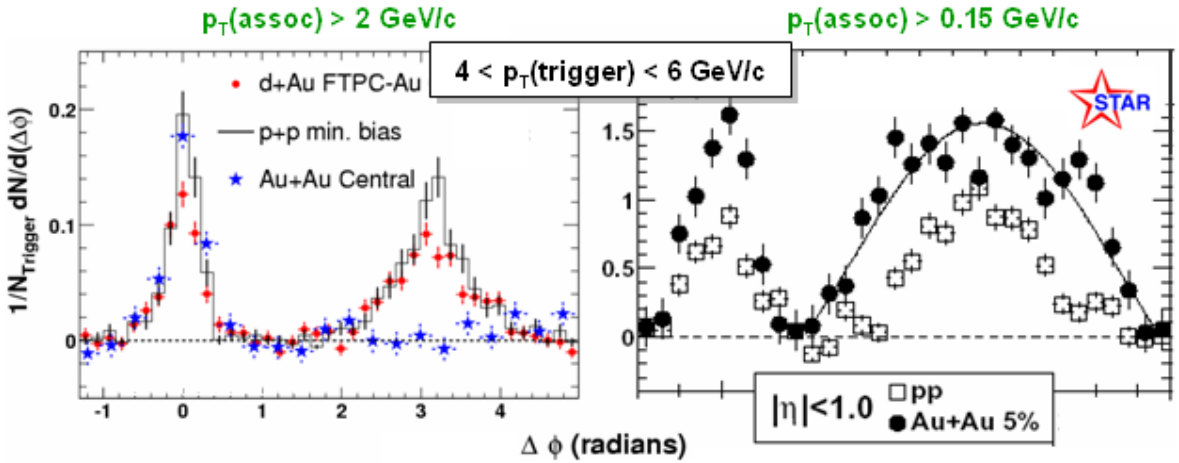


Both experiments observe jet-quenching for away-side pairs!!

Surface bias emission

- However….
  - Why is the away-side jet quenched while the near-side jet is not?



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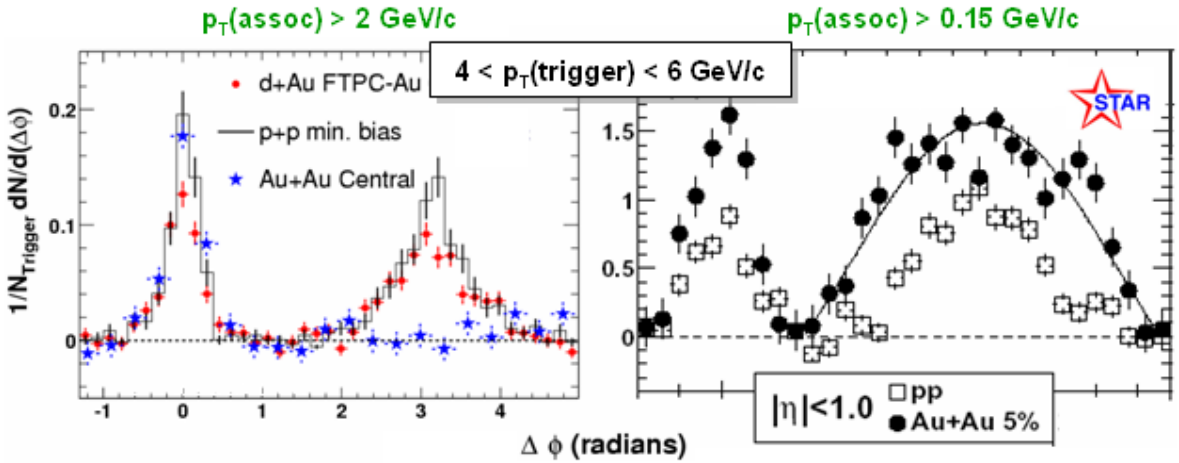

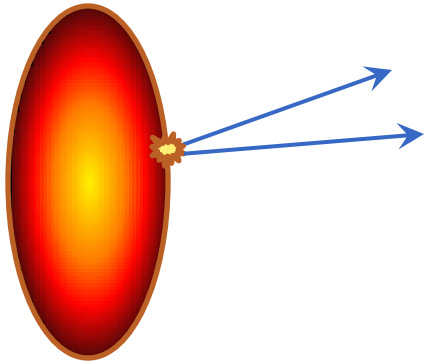

Unmodified
pair production

Strongly interacting medium

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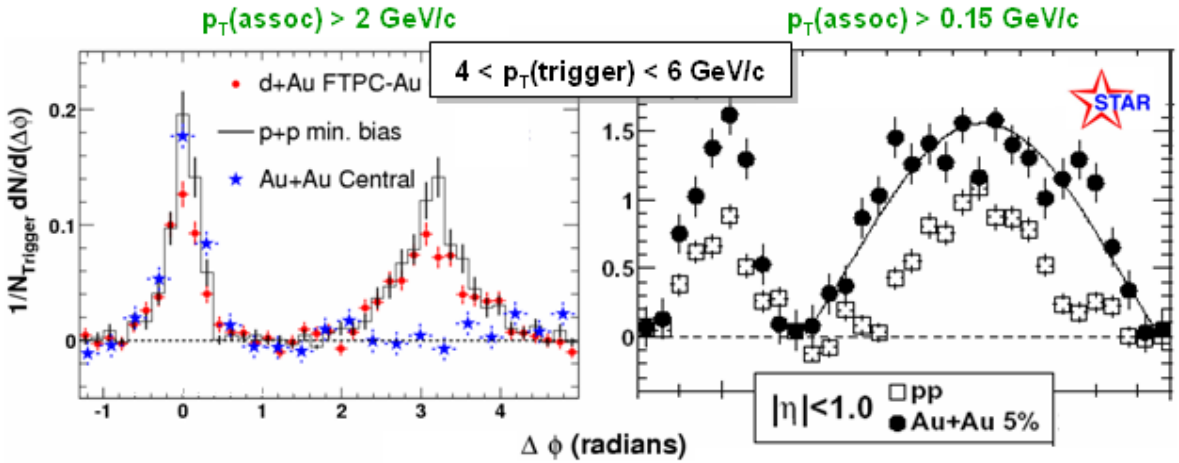

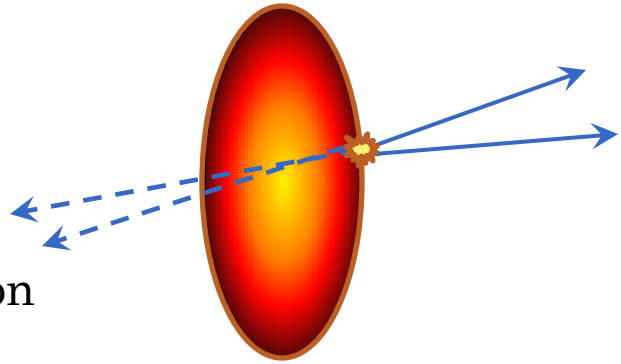

Unmodified
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Modified
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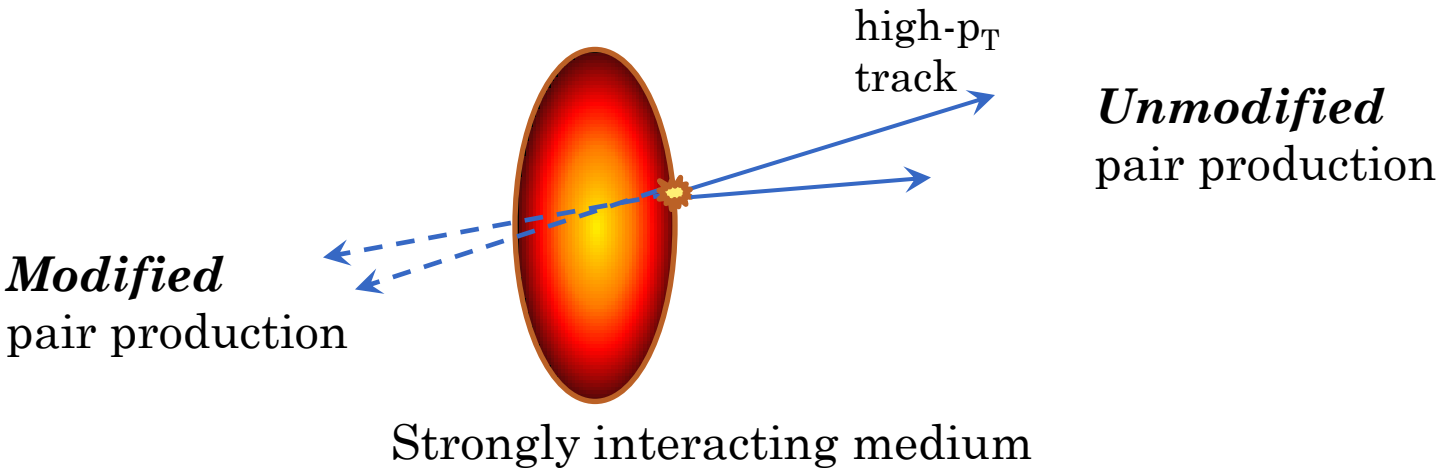
Strongly interacting medium

Surface bias emission

- Can we reduce the "surface bias"?
- Some proposals to reduce "surface bias"
  - 2+1 correlations: require two high-p_T "triggers"



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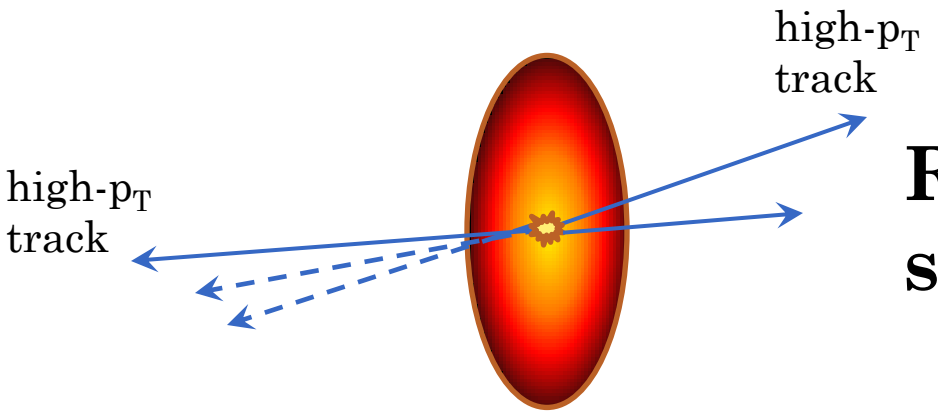

Reduction surface bias

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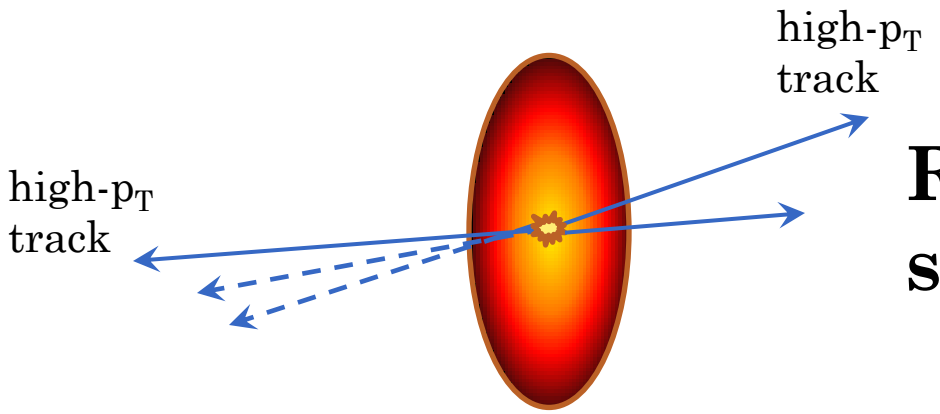
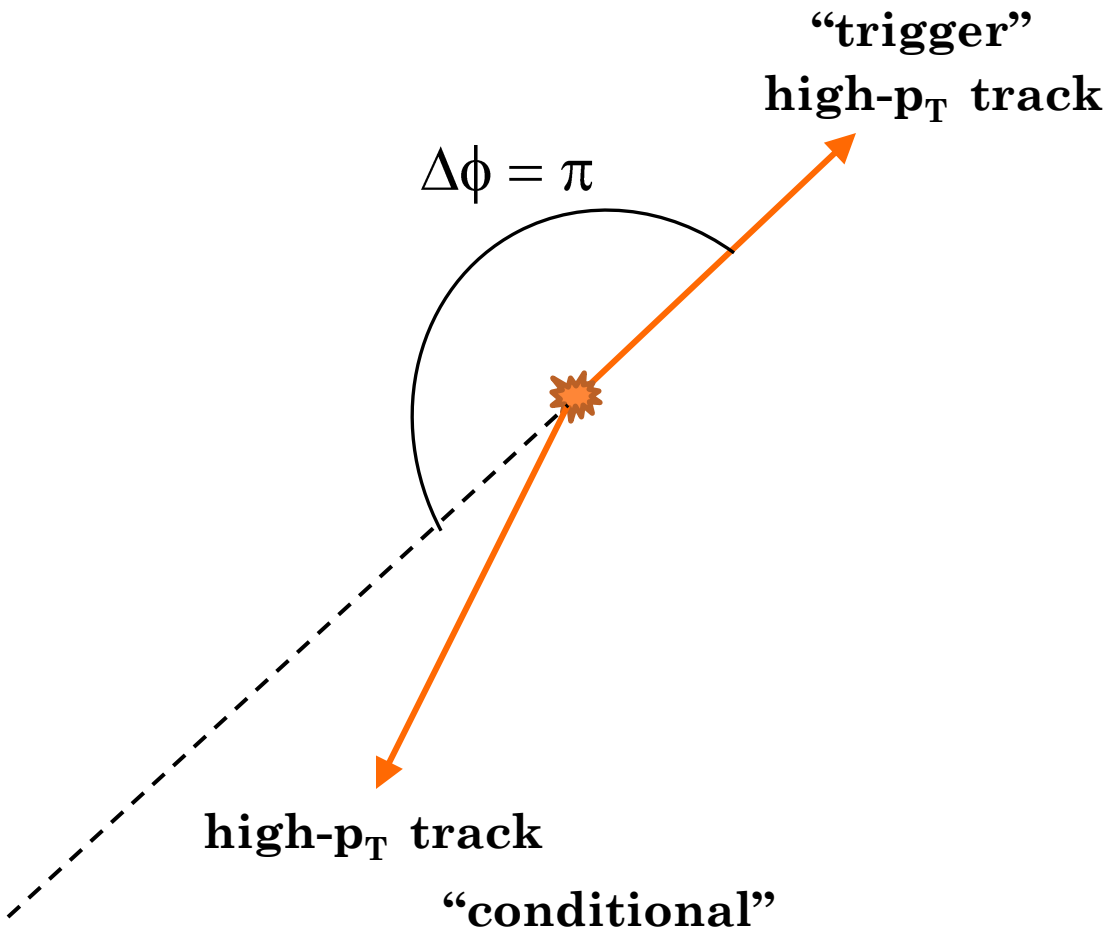


Reduction surface bias

  - γ-h correlations: Colorless probe

2+1 DI-HADRON CORRELATIONS

Conditionally triggered events



- 2 high-p_T track requirement

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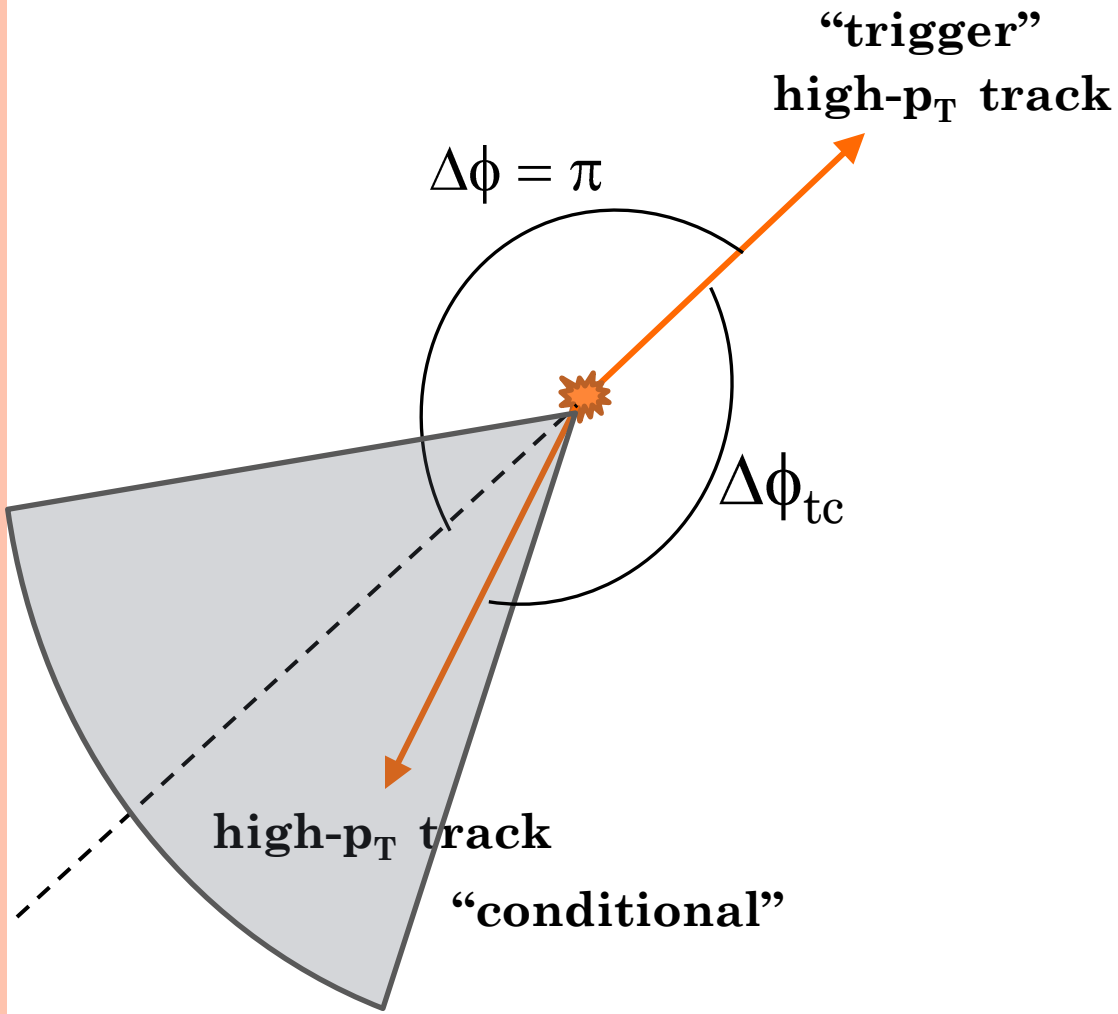
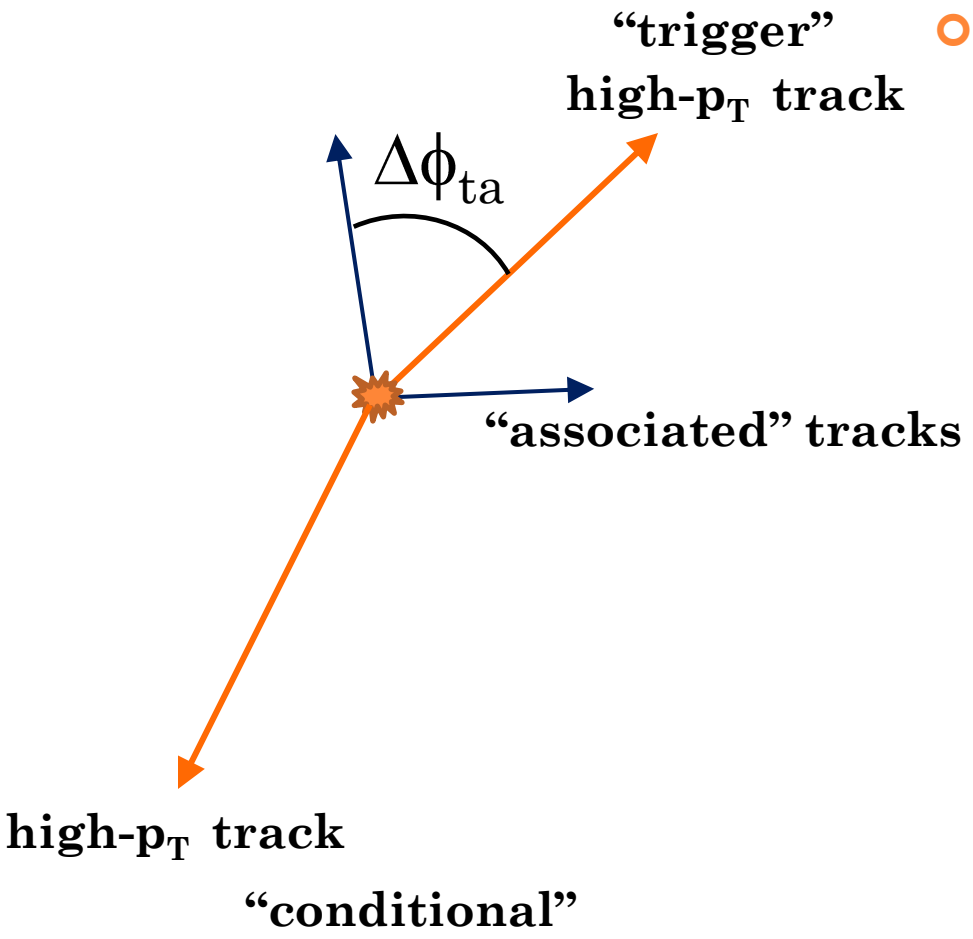


- 2 high-p_T track requirement
- Both high-p_T tracks separated in azimuth by:

$$\frac{7}{8}\pi < |\Delta\phi_{tc}| < \pi$$

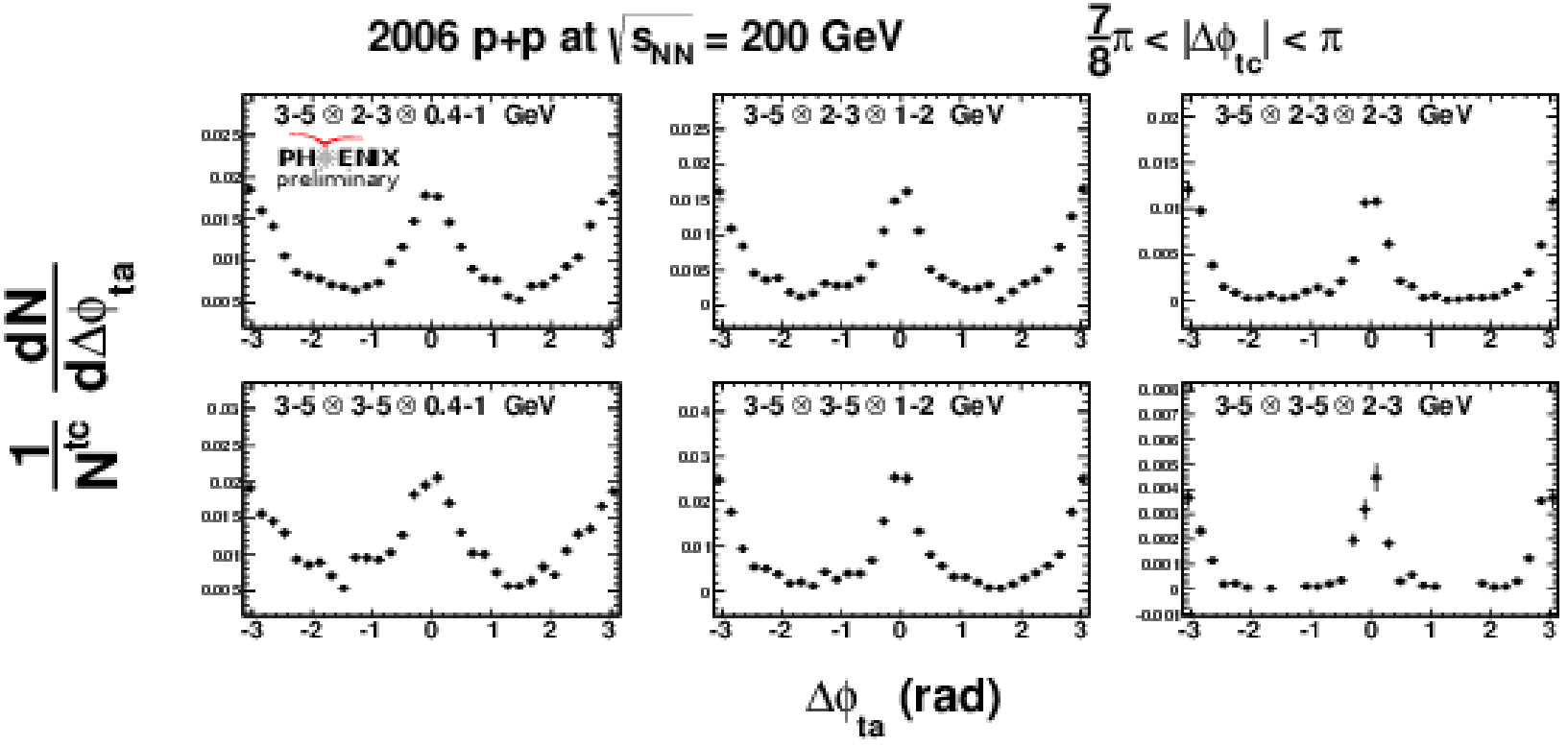
2+1 CORRELATIONS PAIR DISTRIBUTION



- Pair distribution is constructed from a high-p_T trigger relative to other lower p_T fragments

2+1 DI-HADRON CORRELATIONS

- 2006 p+p at $\sqrt{s_{NN}}$ = 200 GeV



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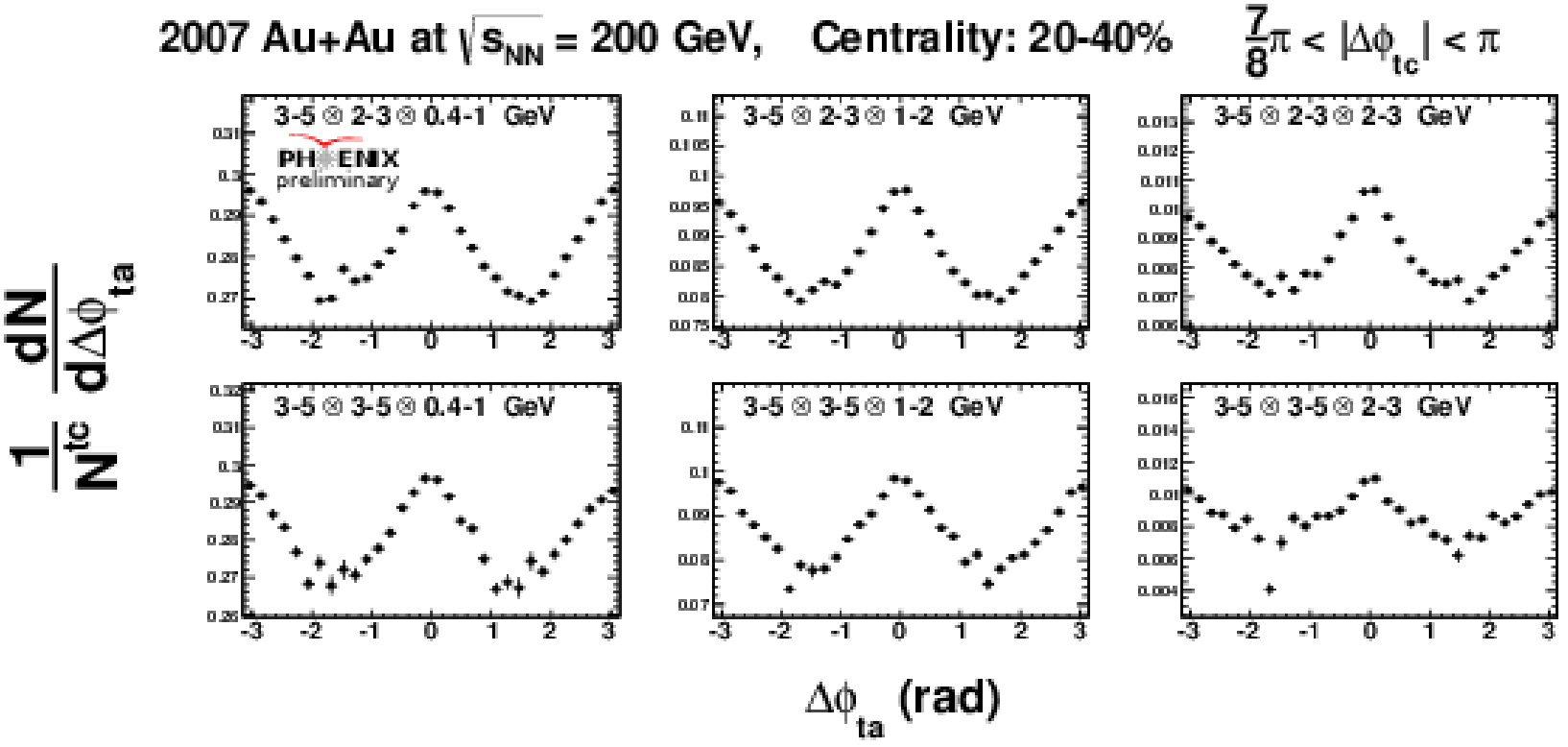


Background subtraction

- Subtraction is done under the ***<u>two-source model</u>*** assumption:

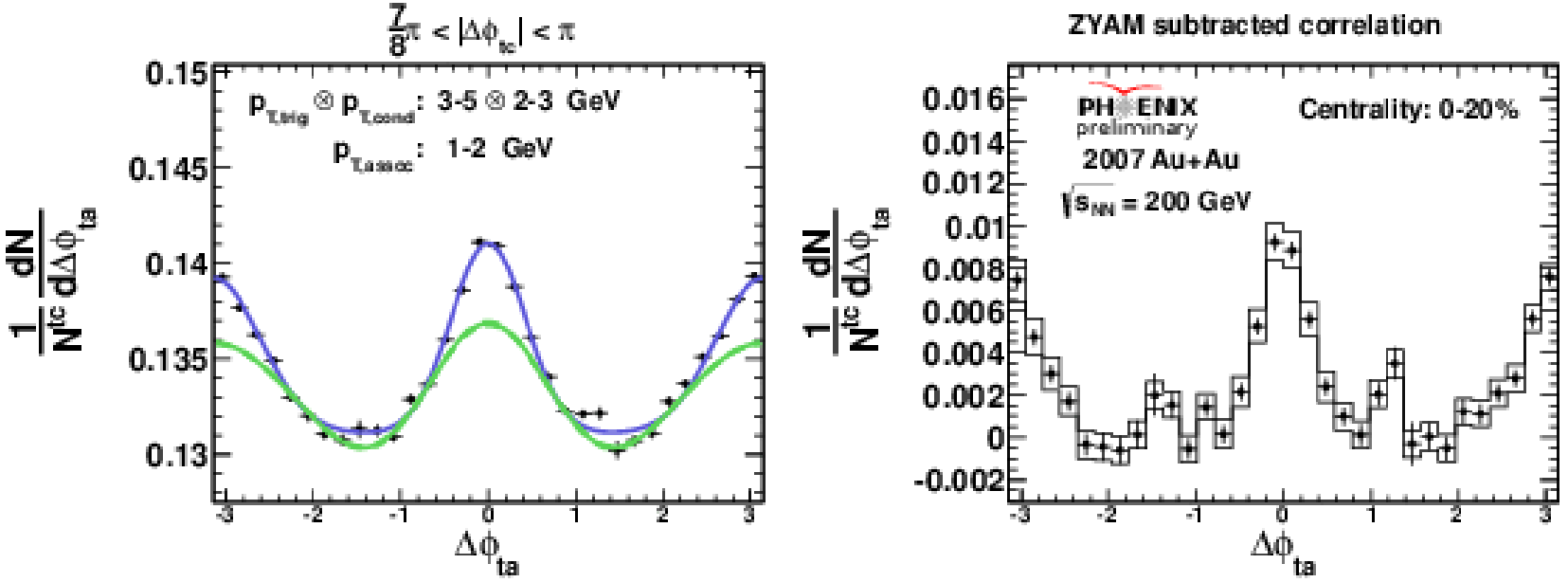
"correlation" "jet" "background"

$$C(\Delta\phi_{ta}, \Delta\phi_{tc}) = J(\Delta\phi_{ta}, \Delta\phi_{tc}) + B(\Delta\phi_{ta}, \Delta\phi_{tc})$$

- Flow modulated background is modeled by convoluting three single particle flow distributions

ZYAM PROCEDURE

- To determine background level, the Zero Yield at Minimum (ZYAM) procedure is employed.



$$C(\Delta\phi_{ta}, \Delta\phi_{tc}) - B(\Delta\phi_{ta}, \Delta\phi_{tc}) = J(\Delta\phi_{ta}, \Delta\phi_{tc})$$

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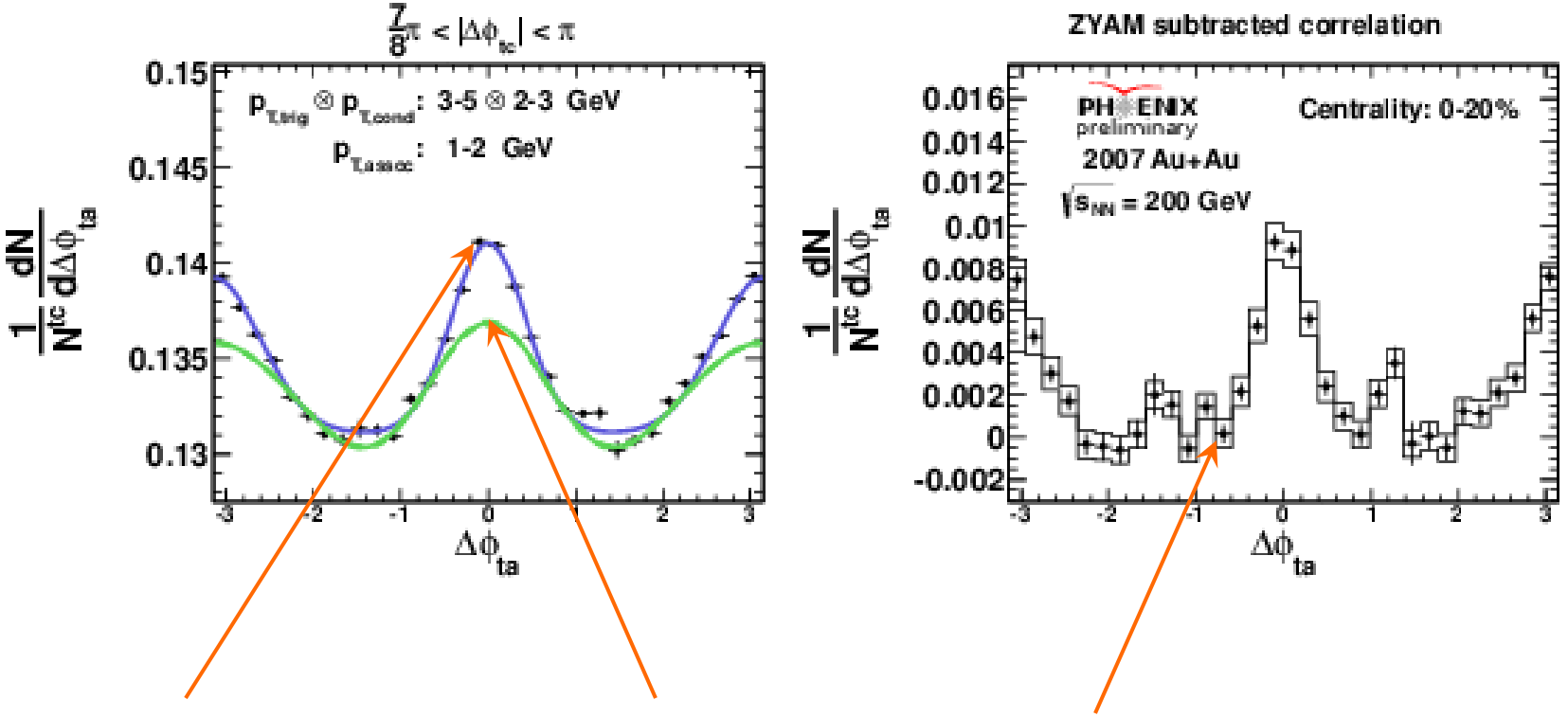

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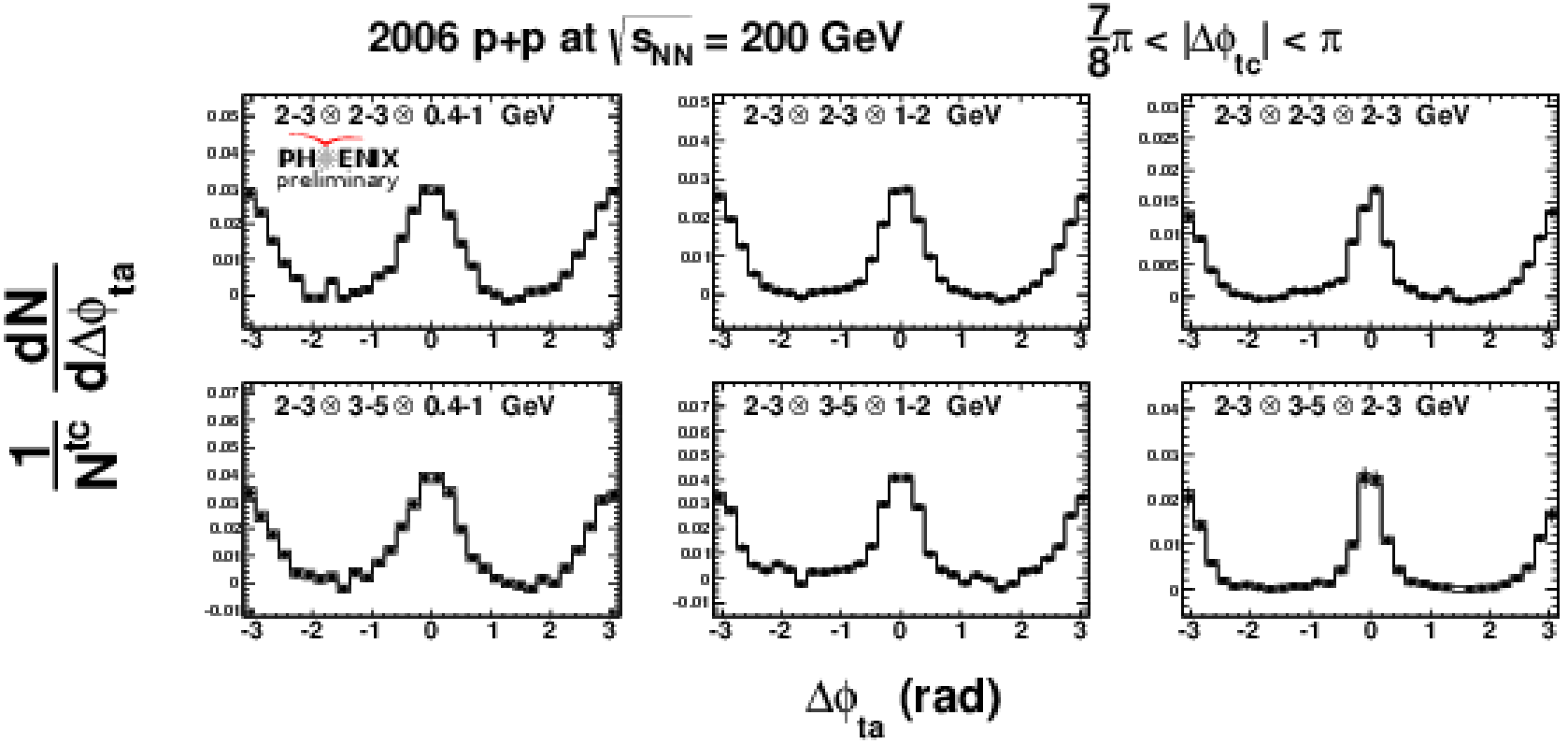

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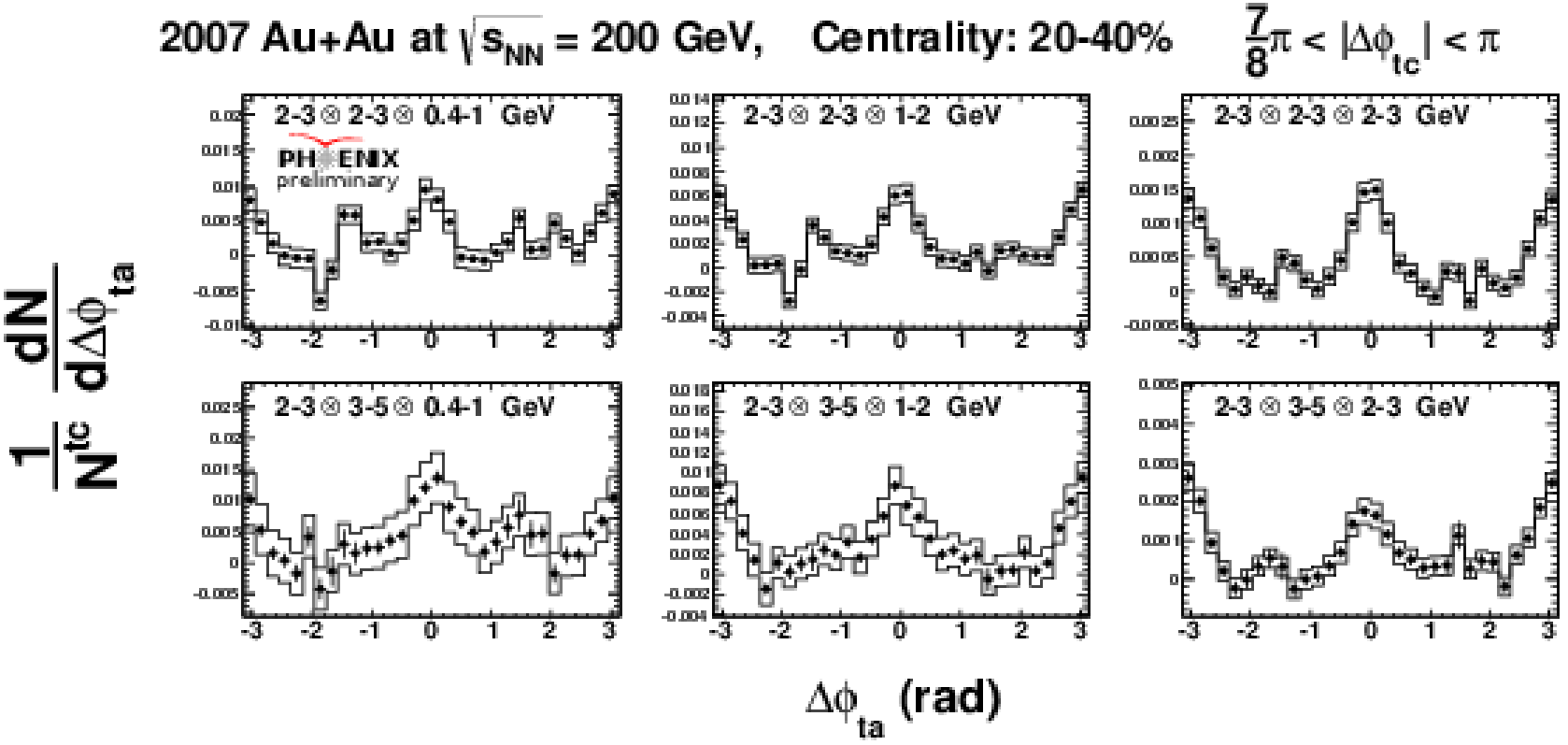

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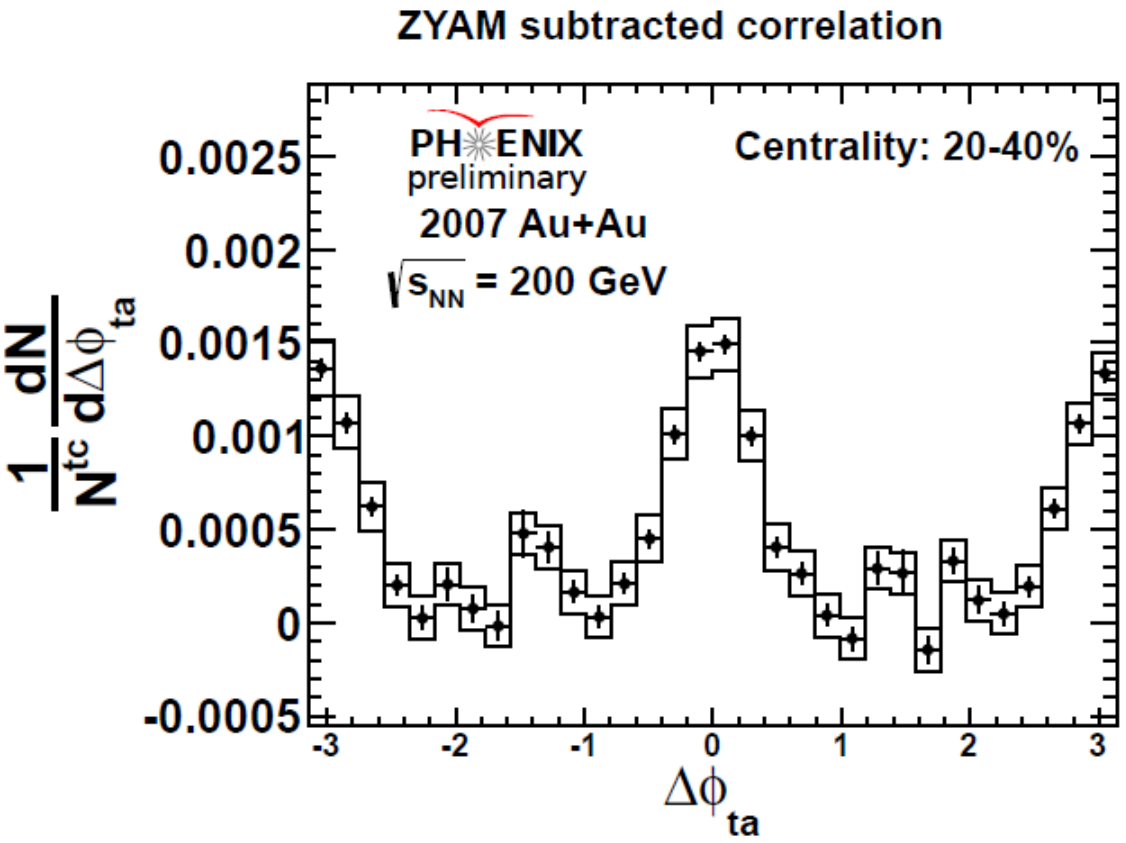

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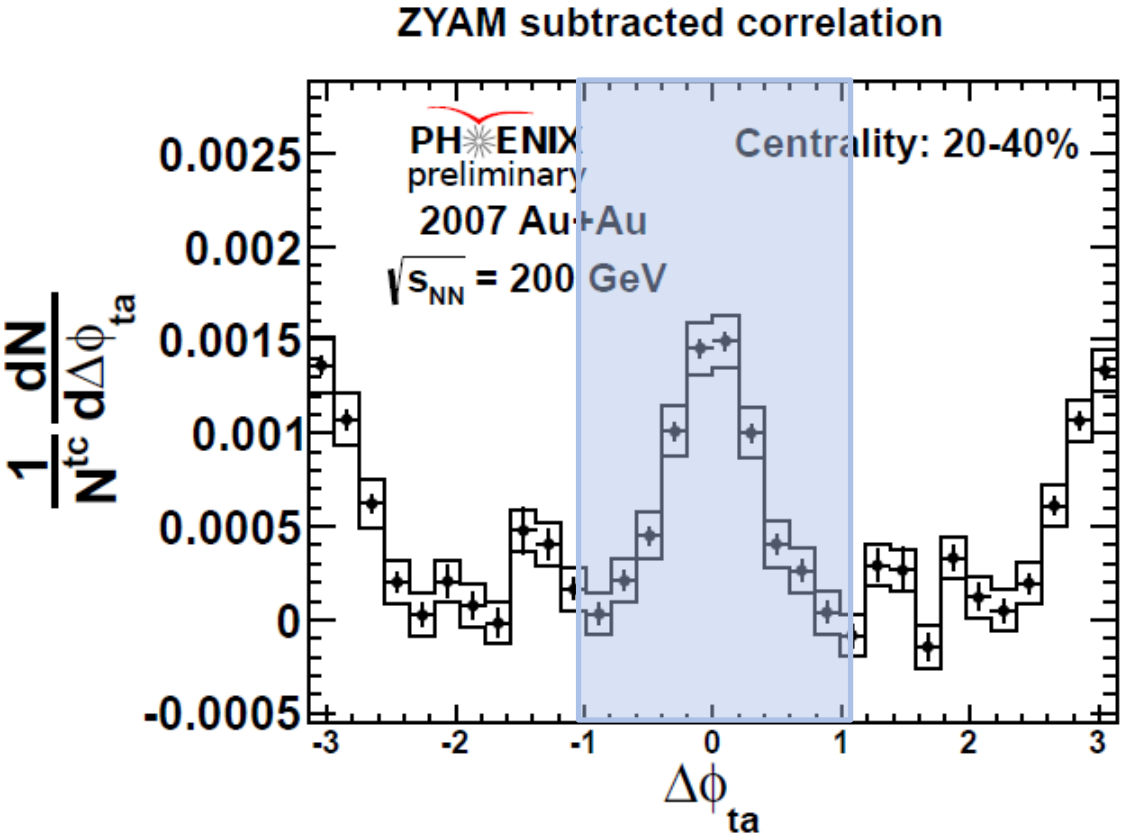

Integrate near-side from $-\pi/3$ to $\pi/3$

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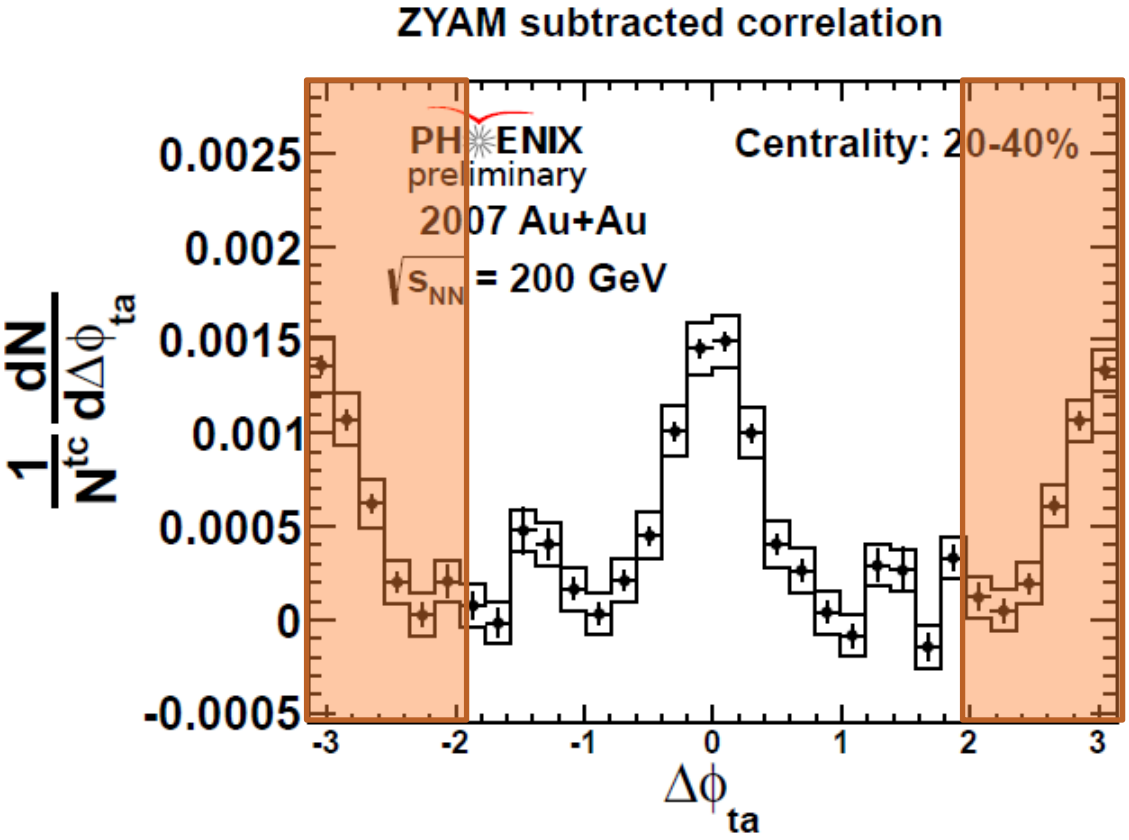
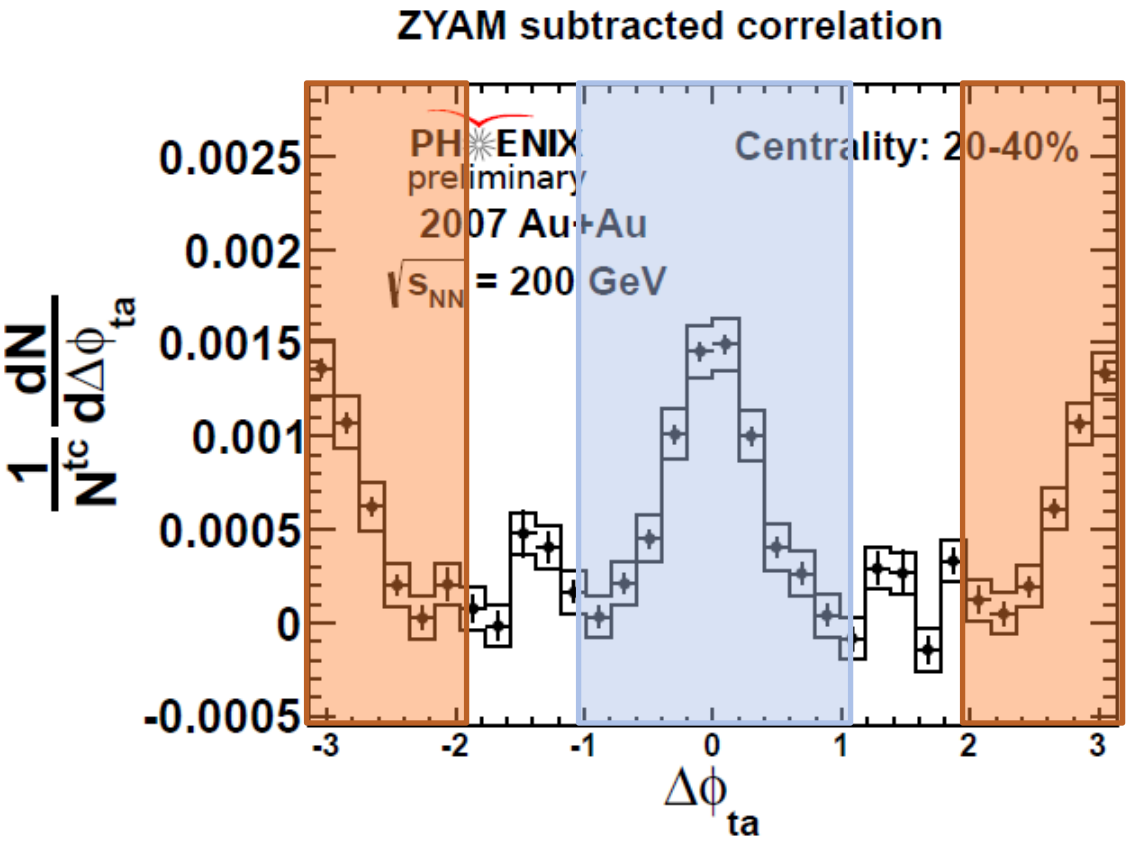


Integrate away-side from $2\pi/3$ to π

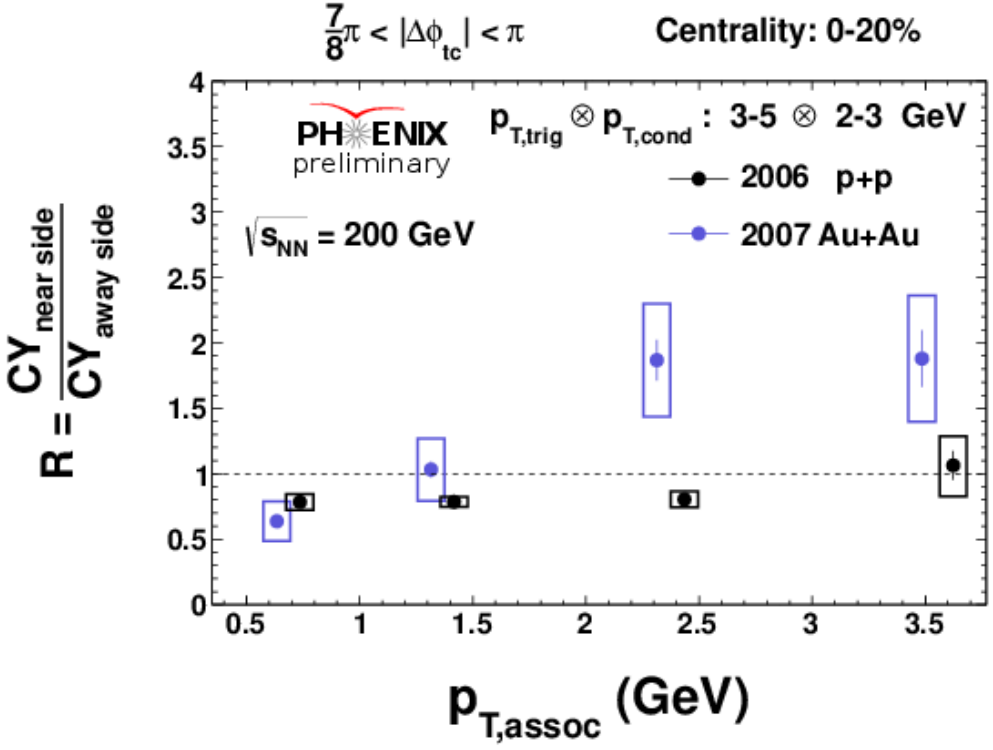
Ratio: near-side to away-side

- Define ratio: $R = \frac{CY_{near-side}}{CY_{away-side}}$



Ratio of Integrated Yields (Near-side to Away-side)

- Ratio of near-side to away-side integrated yields



$$R = \frac{CY_{near-side}}{CY_{away-side}}$$

Harder fragments in the direction of higher p_T track

Ratio of Integrated Yields (Near-side to Away-side)

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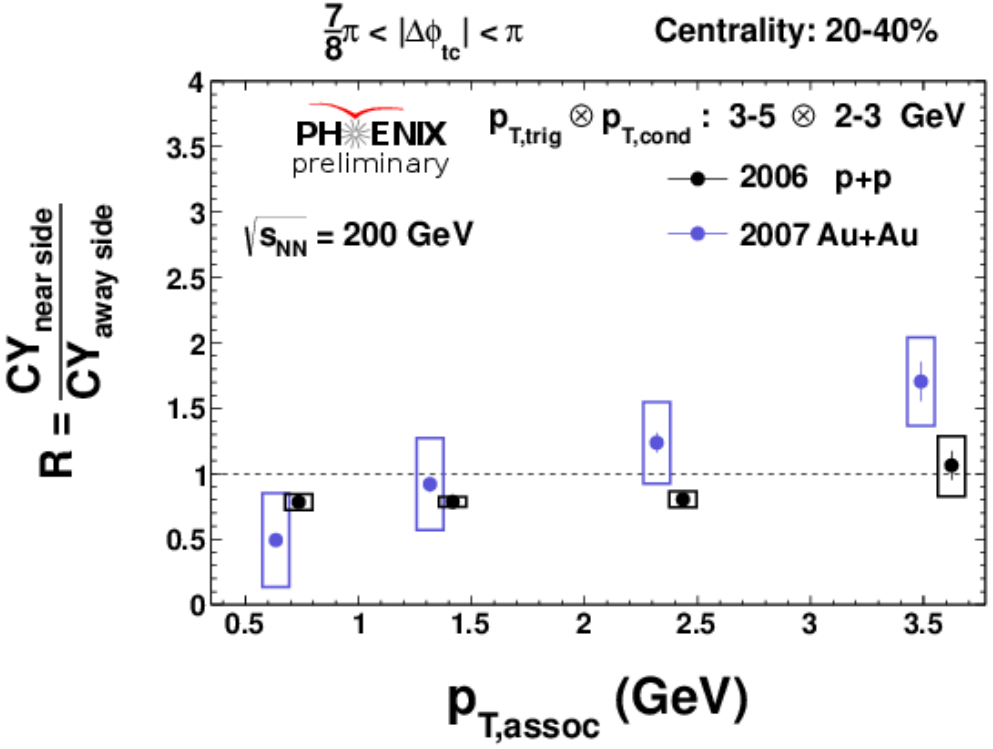

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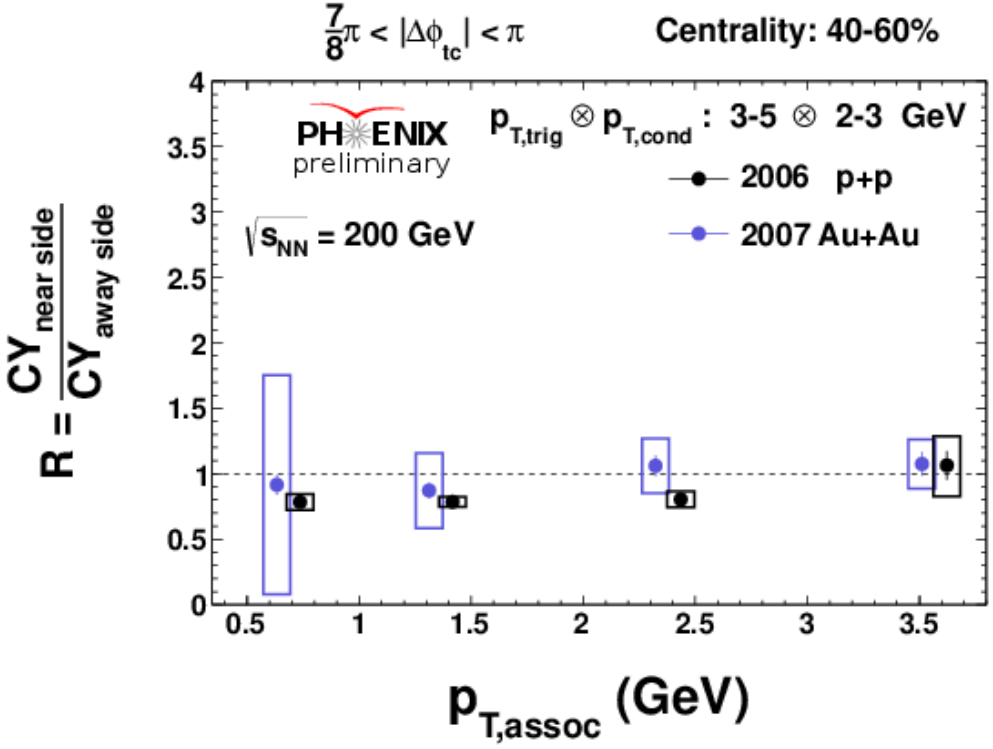
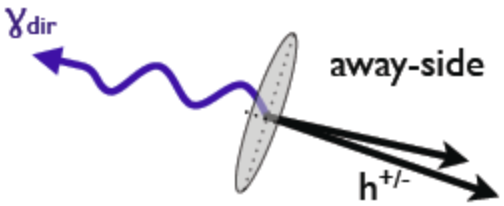


$$R = \frac{CY_{near-side}}{CY_{away-side}}$$

γ-h CORRELATIONS

The "golden channel"

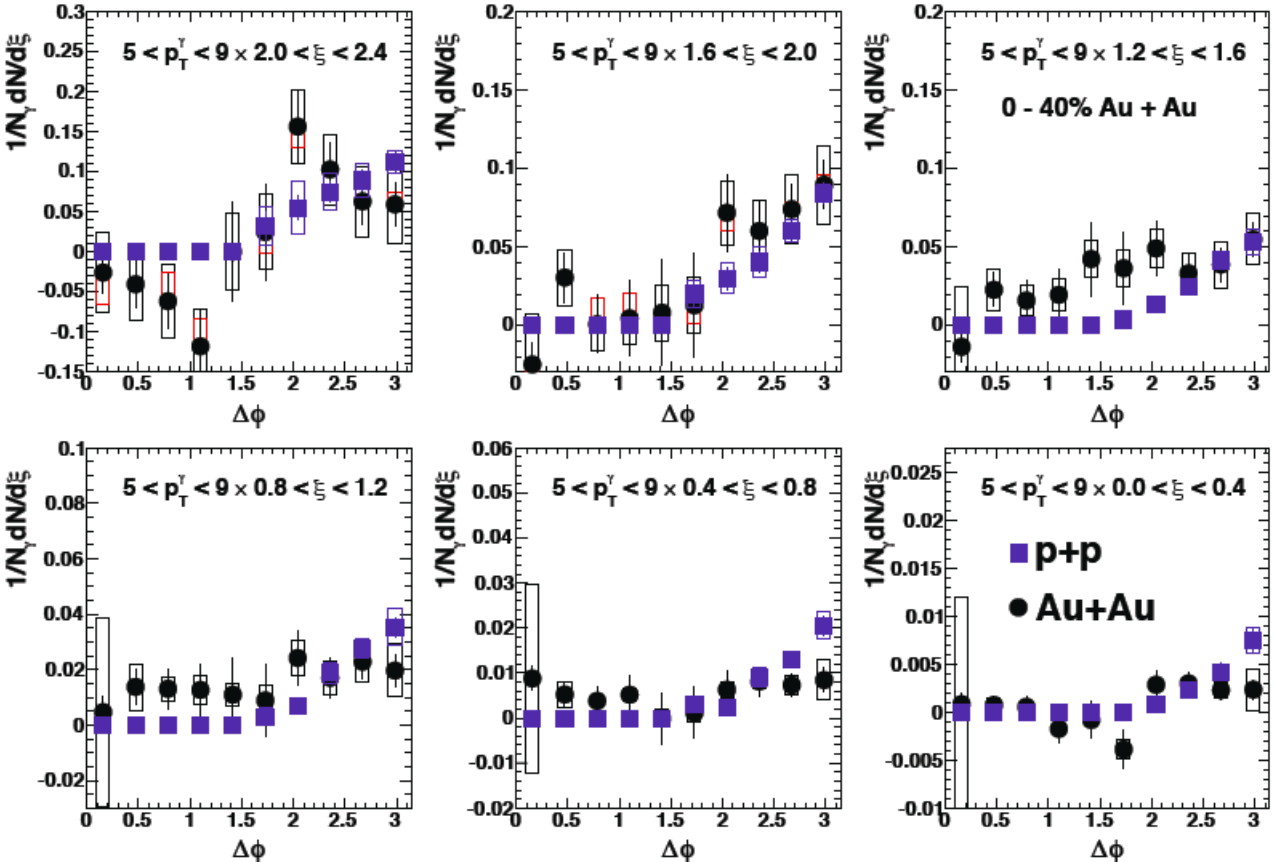
- ***Photons are "colorless" probes:*** (i.e. DO NOT interact with strongly interacting colored medium)



- Use as photon as calibration for modified away-side jet

γ-h CORRELATIONS

- Comparison of Au+Au to p+p correlations
- Extract yields by integrating away-side correlation.



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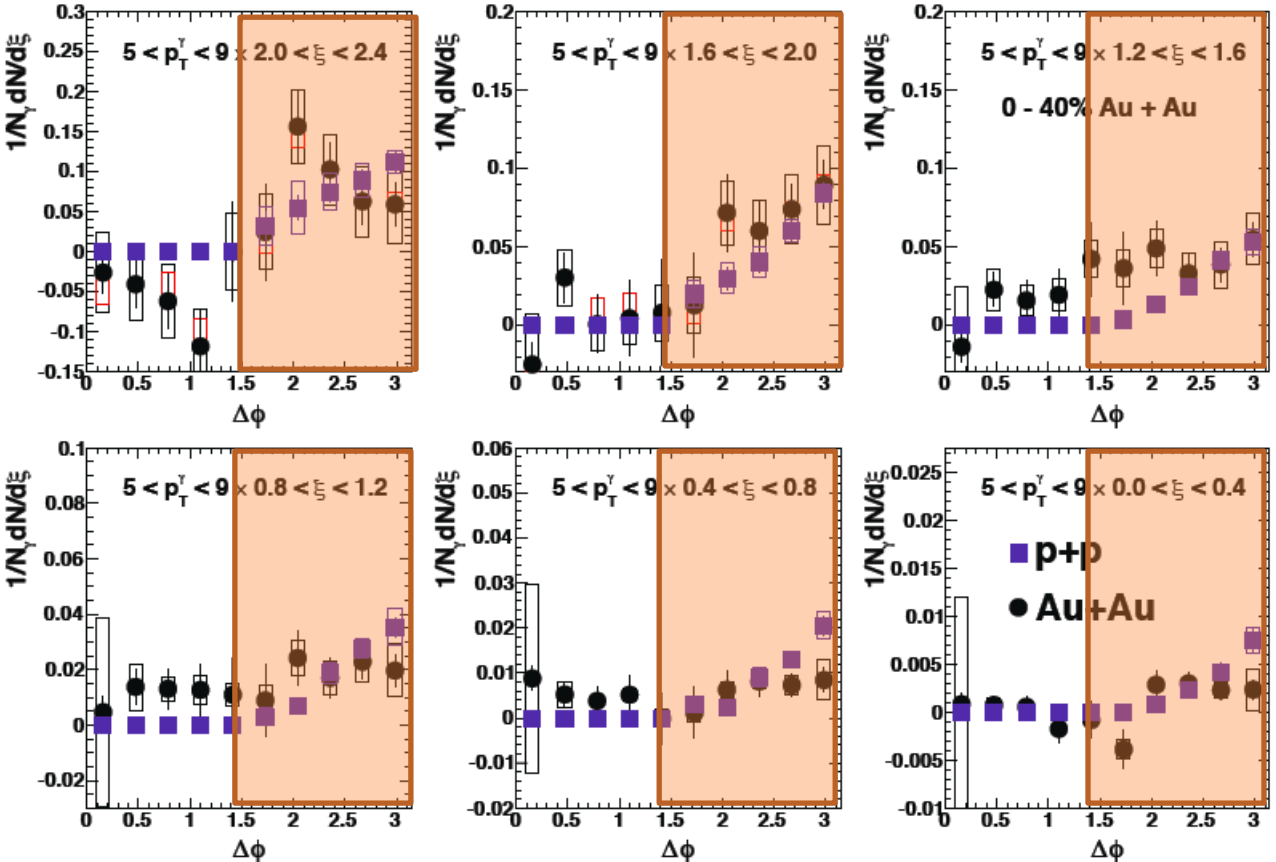
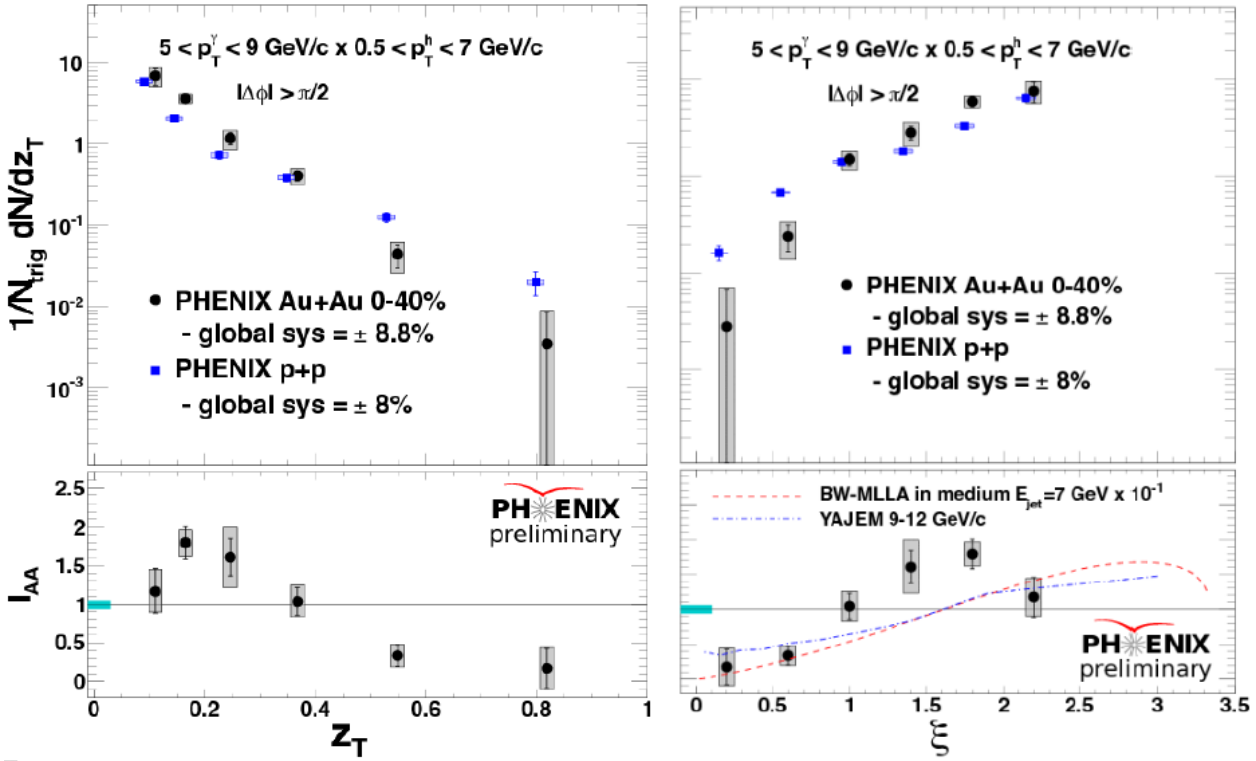


Fragmentation yields vs. z_T

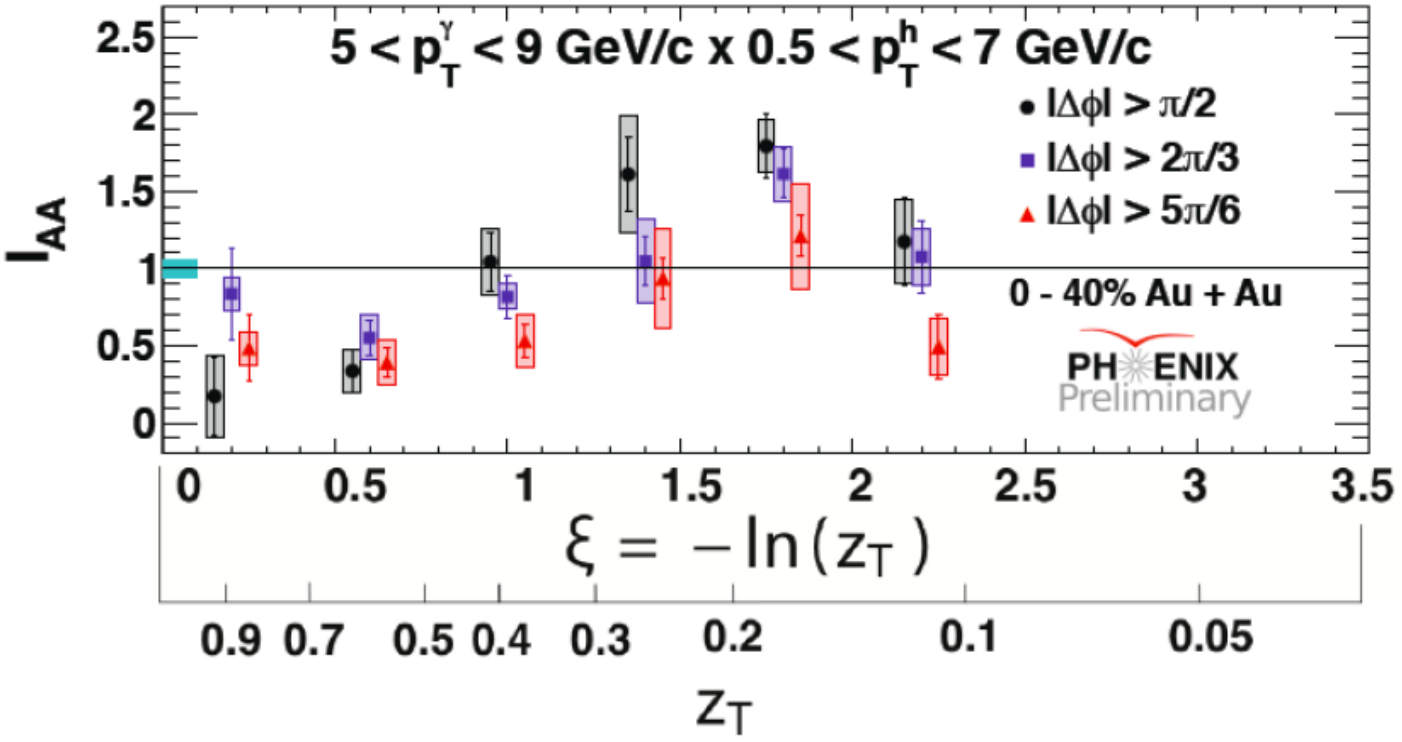
$$I_{AA} = \frac{Y_{jet\_ind}^{Au+Au}}{Y_{jet\_ind}^{p+p}} \qquad z_T = \frac{p_{T,h}}{p_{T,\gamma}} \qquad \xi = -\ln(z_T)$$



Suppression at ***high*** z_T (low ξ)

Modification significant?

- Define different integration regions and compare results.



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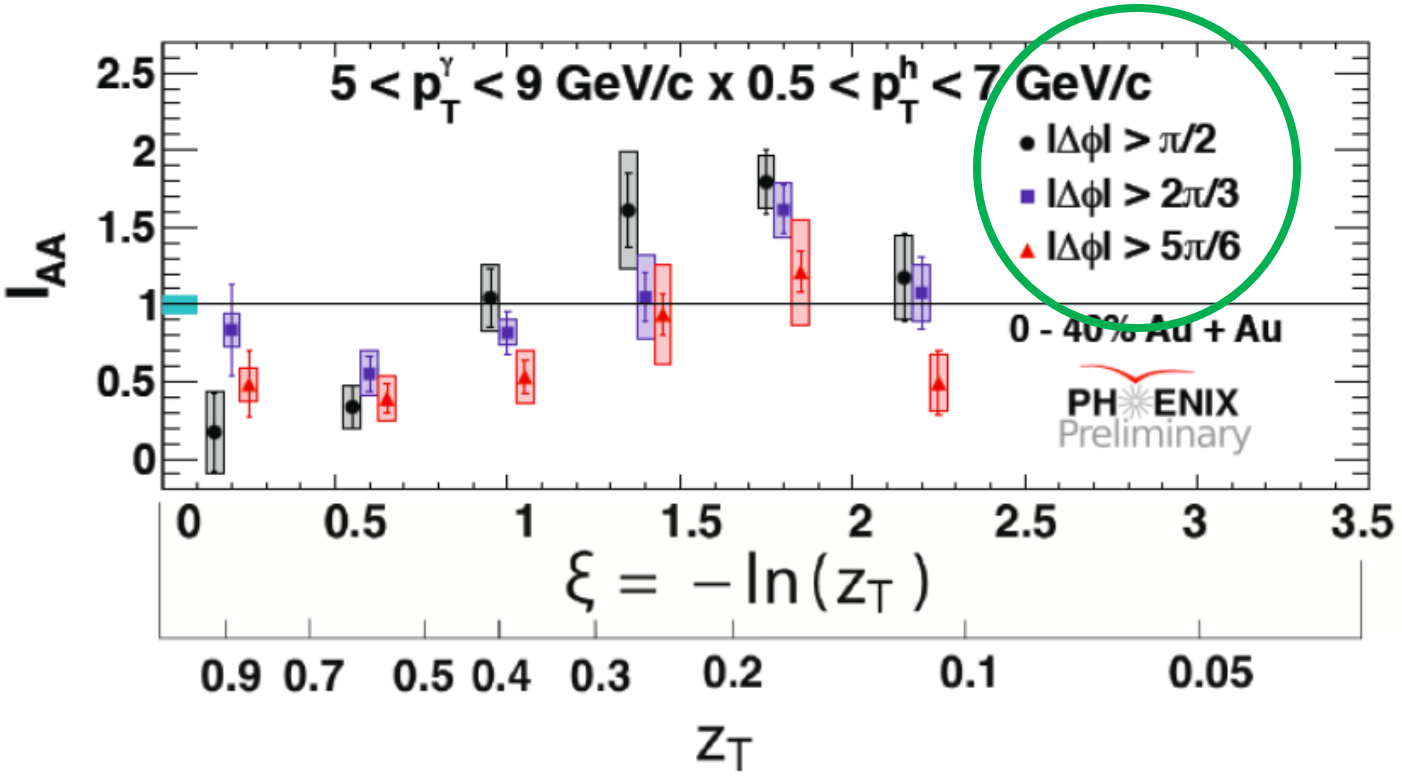
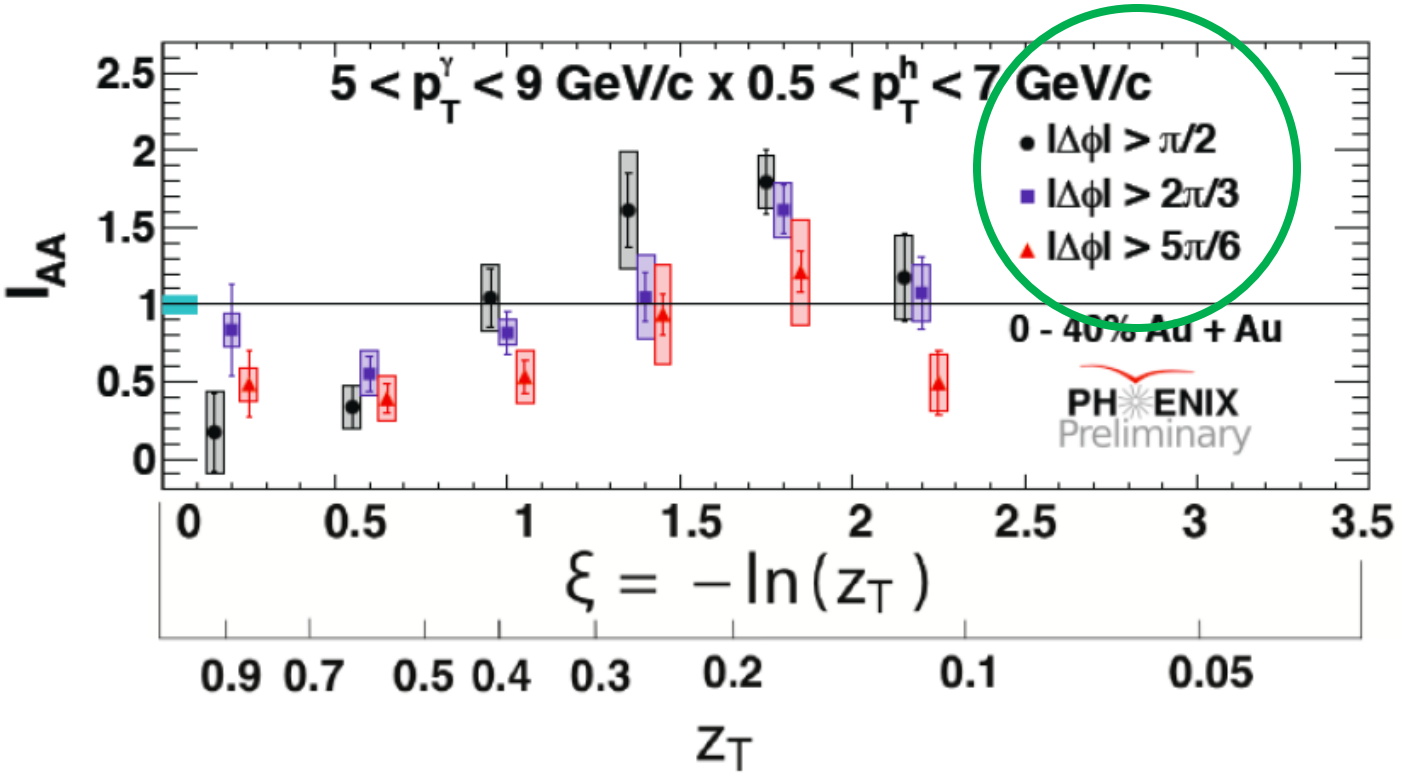


Modification significant?

- Define different integration regions and compare results.
  - ***Suppression significant regardless of integration region!!***

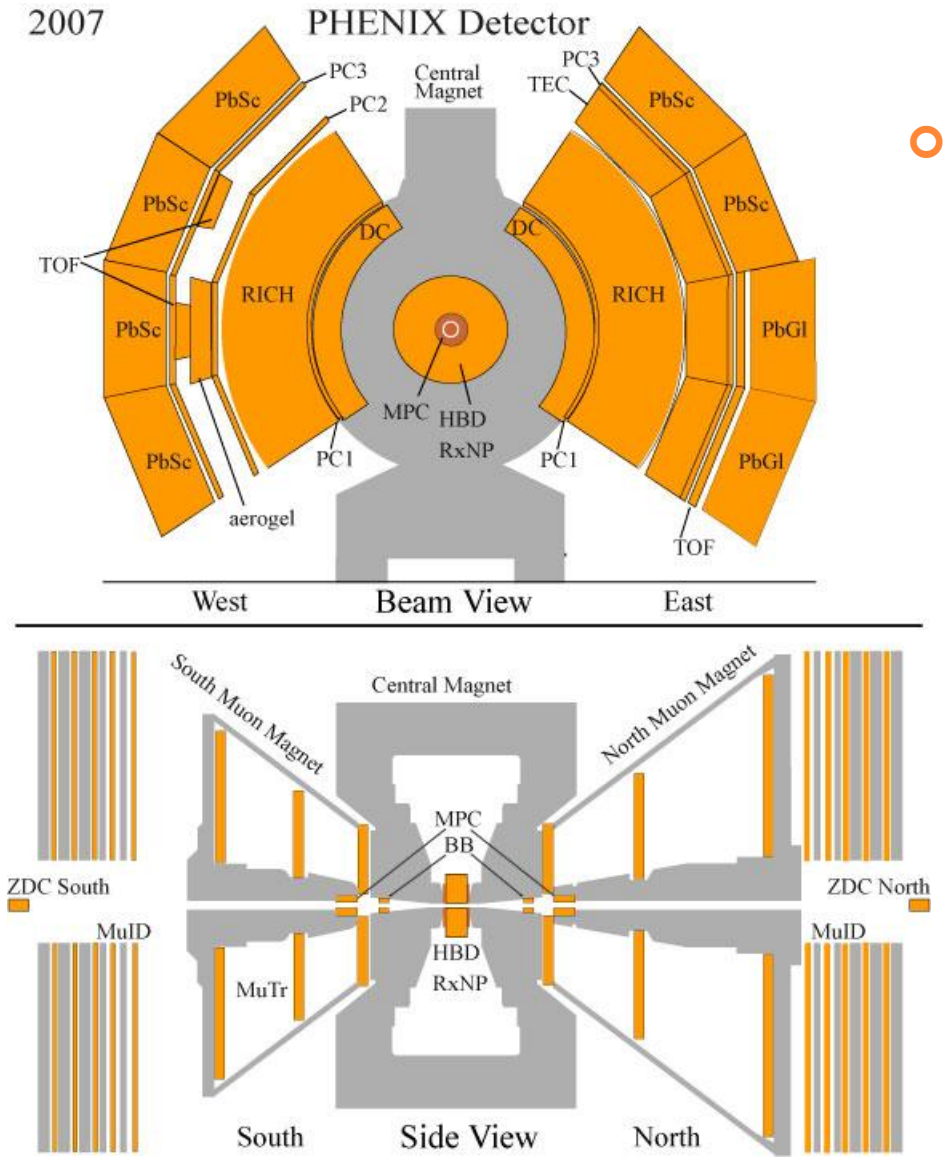


Conclusion

- A modification is seen in Au+Au to the topology of the 2+1 correlations.
  - Harder fragments tend to be biased in the direction of the highest p_T track.
  - Ratio of near-side to away-side yields show significant modification relative to 2006 p+p collision system
- Are we reducing surface bias with 2+1 correlation measurement?
  - Further studies are needed to determine source of modification
- Modification is seen in γ-h correlations at high z_T.

BACK UP

2007 PHENIX DETECTOR



- Measuring hadrons:
  - Tracking done via drift chambers and pad chambers
  - Ring imaging Cerenkov detector allows us to segregate hadrons from electrons below 5 GeV

Measuring 3 tracks in PHENIX

- Remind ourselves that the 2+1 correlation is really a 3-particle measurement.
- PHENIX previously published methodology for measuring 2-particle correlations in a limited acceptace detector through ***event-mixing***.

$$C(\Delta\phi) \propto \frac{f(\Delta\phi)\int dv\ \varepsilon(v+\Delta\phi/\sqrt{2}, v-\Delta\phi/\sqrt{2})}{\int dv\, \varepsilon(v+\Delta\phi/\sqrt{2})\cdot\varepsilon(v-\Delta\phi/\sqrt{2})}$$

- **Key point:** Can recover physics correlations as long as pair efficiencies can be approximated by single particle efficiencies.

Measuring 3 tracks in PHENIX

- Extend logic to three tracks:

$$\varepsilon(\phi_1,\phi_2,\phi_3) \approx \varepsilon(\phi_1)\cdot\varepsilon(\phi_2)\cdot\varepsilon(\phi_3)$$

- The single particle efficiencies are given by event-mixing which leads to a three event-mixing technique (similar to two event-mixing technique used in 2-particle correlations)