Three-particle pseudorapidity correlations in STAR

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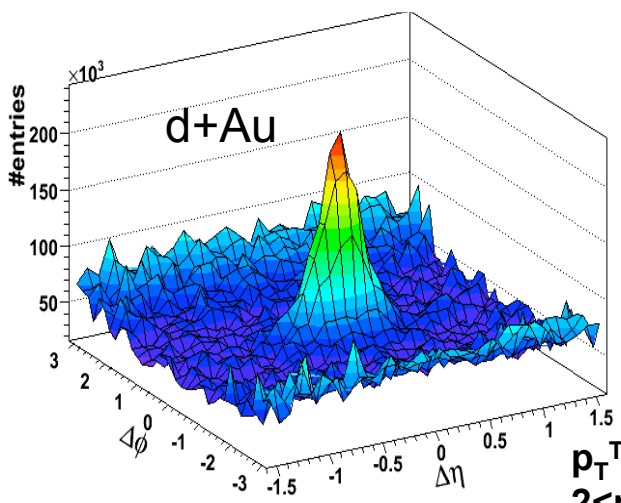
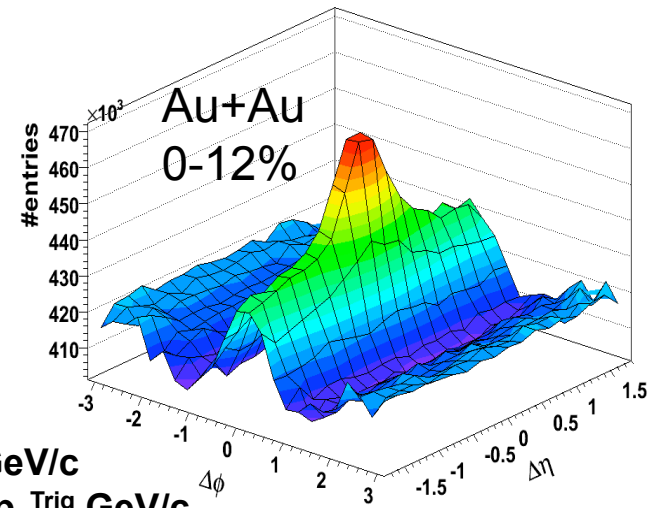
(For STAR Collaboration)

Outline

- The "Ridge"
- Theoretical model expectations
- 3-particle correlations results (**arXiv: 0912.3977**)
- Summary

Ridge : Near-side correlations





$p_T^{Trig} > 4$ GeV/c
$2 < p_T^{Assoc} < p_T^{Trig}$ GeV/c

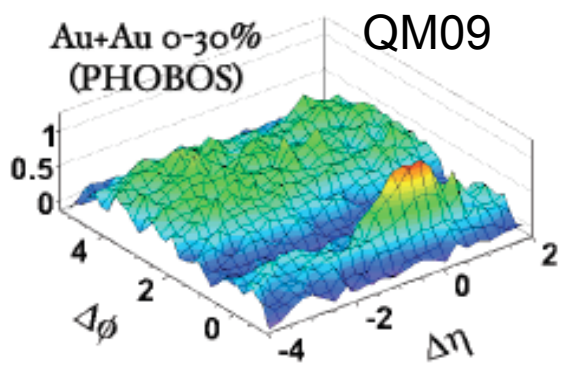
Phys. Rev. C 80 (2009) 064912.

$p_T^{trig} > 2.5$ GeV/c
$p_T^{assoc} > 4 - 35$ MeV/c

Near-side "ridge" in central Au+Au collisions.
- Properties similar to bulk

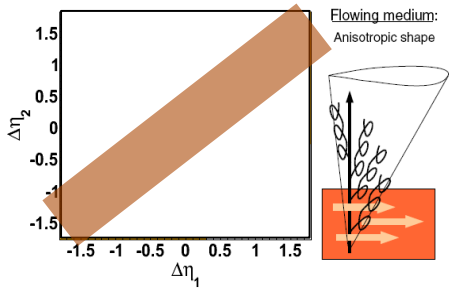
Extends even upto higher rapidities.
- Long range correlations.

Ridge persists to very high p_T trigger particle

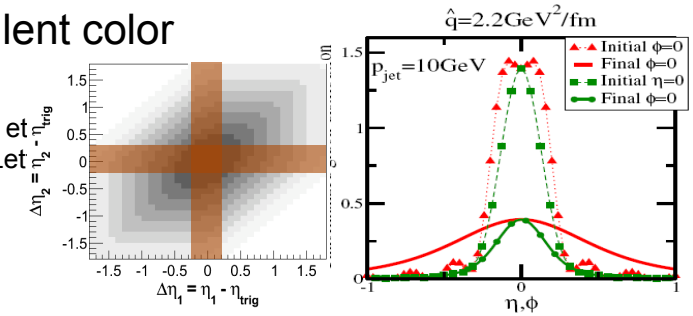


Theoretical model expectations

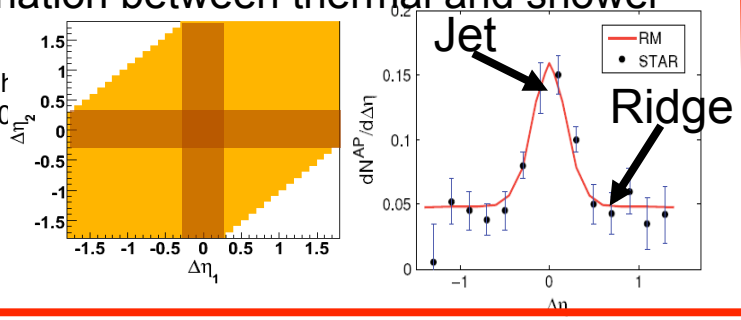
1)In medium radiation + longitudinal flow push
N.Armesto et.al Phys.Rev.Lett. 93(2004) 242301



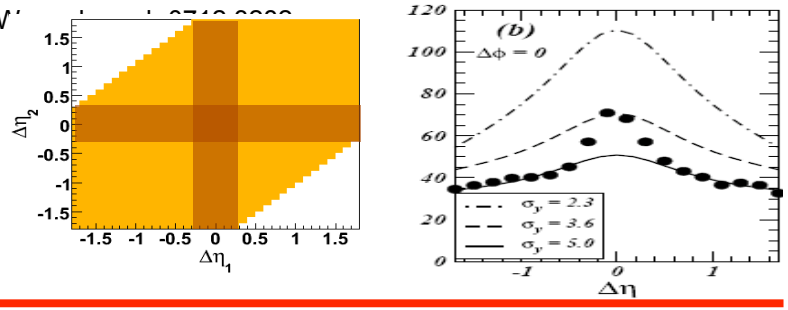
2)Turbulent color fields
A.Majumder et
Phys. Rev. Let



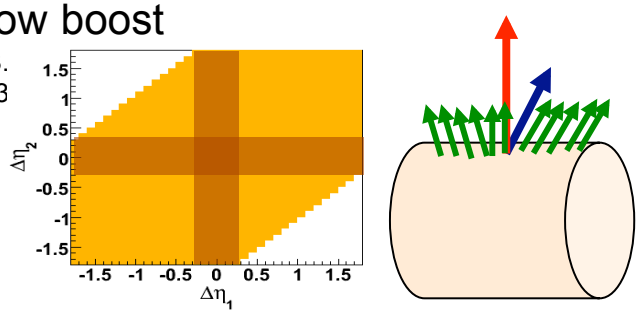
3) Recombination between thermal and shower partons
R.C. Hwa & C.B. Cl
Phys. Rev. C 72 (20

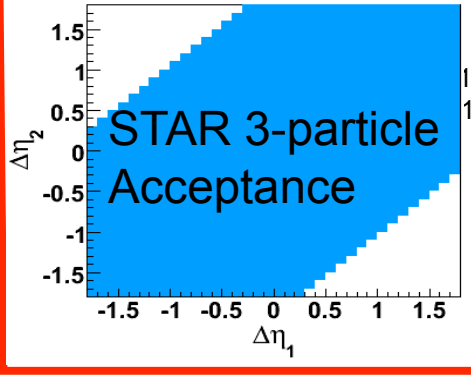


4) Momentum Kick
C.Y. V



5) Transverse flow boost
S.A.Voloshin, Phys.Lett.B.
E.Shuryak, hep-ph:0706.3





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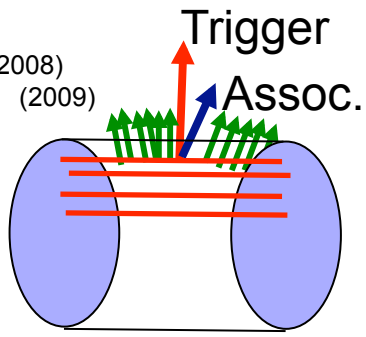
161 (2009)

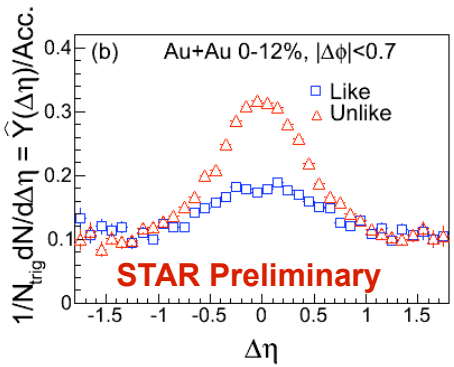


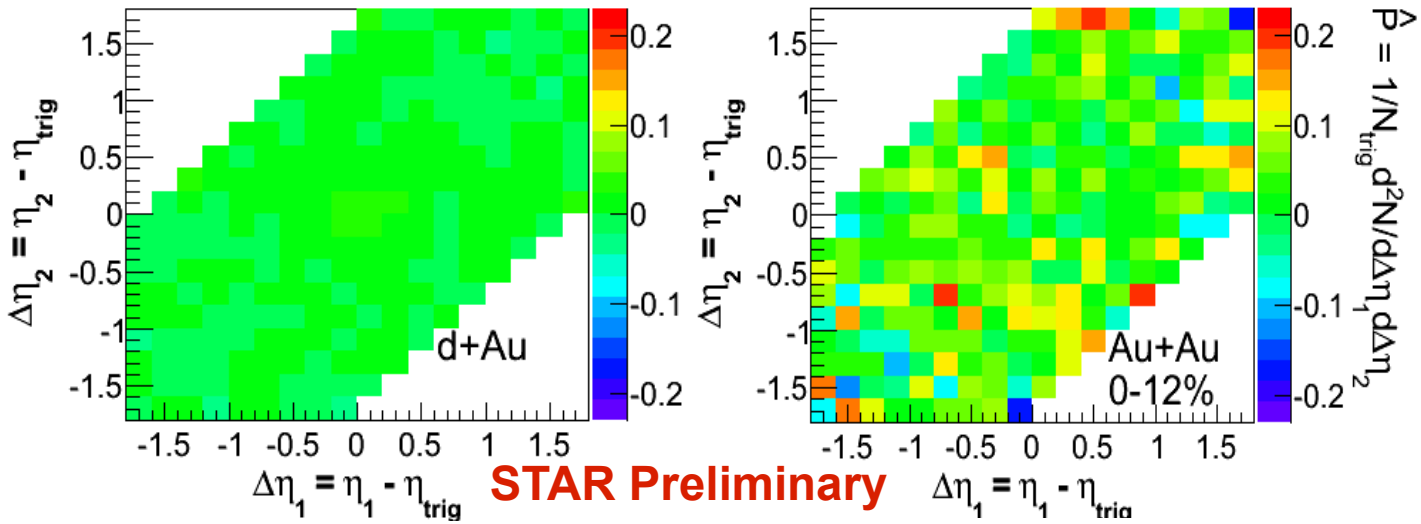
Can we distinguish between these physics interpretations?
→ 3-particle correlation in η

3-particle Δη-Δη correlations

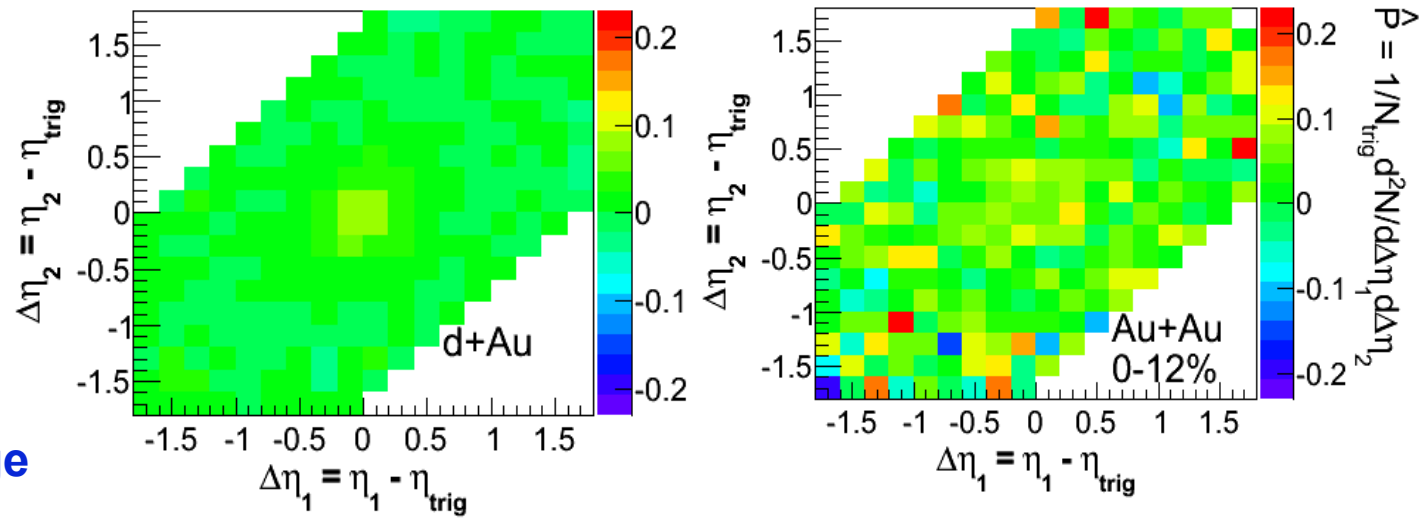
$3<p_T^{trig}<10$ GeV/c $1<p_T^{assoc}<3$ GeV/c $|\Delta\phi|<0.7$

Same-sign triplets
($A^{\pm}A^{\pm}T^{\pm}$)
Ridge : 4* $A^{\pm}A^{\pm}T^{\pm}$





Same-sign associated pair and opposite sign trigger particle **($A^{\pm}A^{\pm}T^{\mp}$)**
Jet-like: Total - Ridge



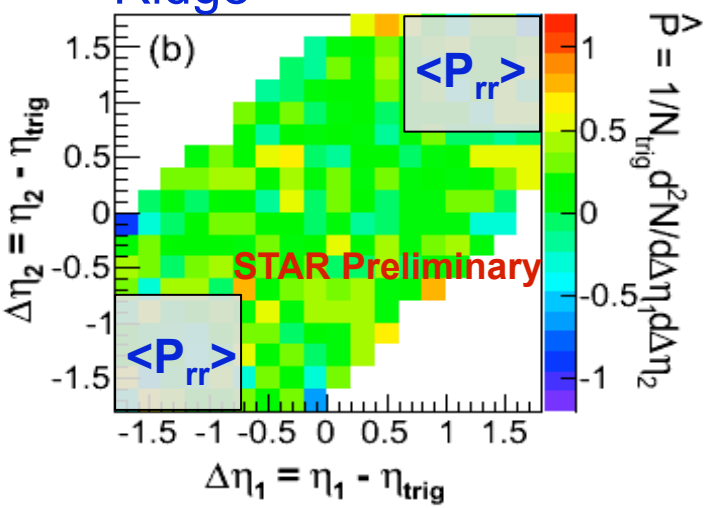
Like-sign triplets : Dominated by ridge

Average pair densities

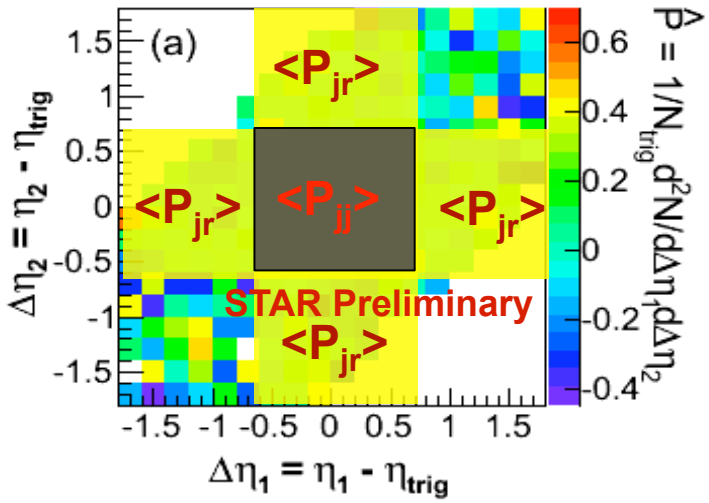
Au+Au 0-12%

$3<p_T^{trig}<10$ GeV/c
$1<p_T^{assoc}<3$ GeV/c
$|\Delta\phi|<0.7$

Ridge



Jet-like



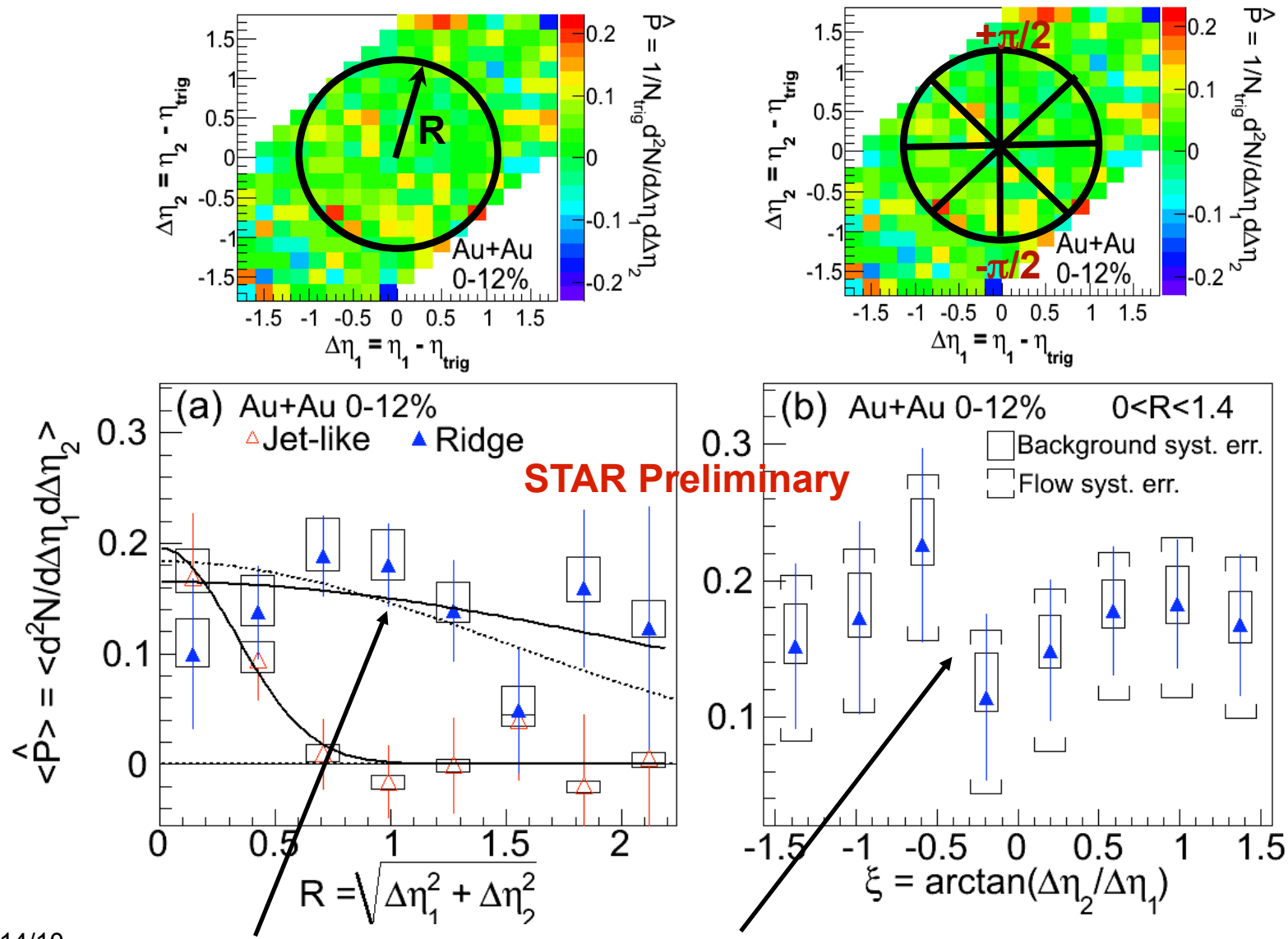
$\langle P_{rr}\rangle$: **0.114 ± 0.039**

$\langle P_{jj}\rangle$: **0.077 ± 0.026**

Jet-ridge cross pairs
$\langle P_{jr}\rangle$: **-0.004 ± 0.025**

Ridge production appears to be uncorrelated with the presence of jet.

Radial and Angular dependence



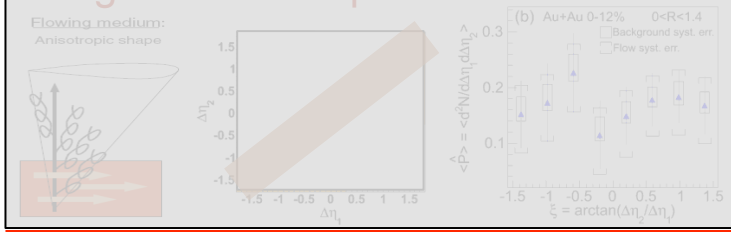
Ridge is broad. No prominent substructures in ridge.

Data and Models

1)In medium radiation + longitudinal flow push

Model : Diagonal excess

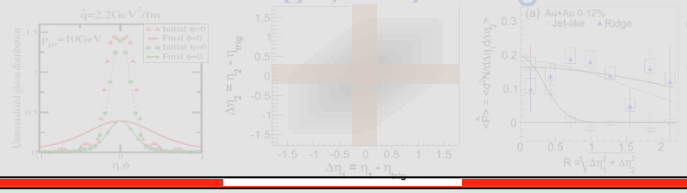
Data: Uniform



2)Turbulent color fields

Model: uniform ridge, jet-ridge cross pairs.

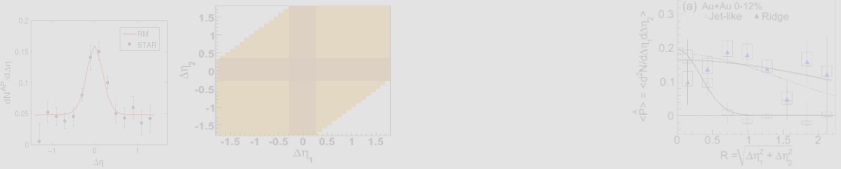
Data:Broad Ridge, no jet-ridge cross pairs



3) Recombination Model

Model: jet-ridge cross pairs.

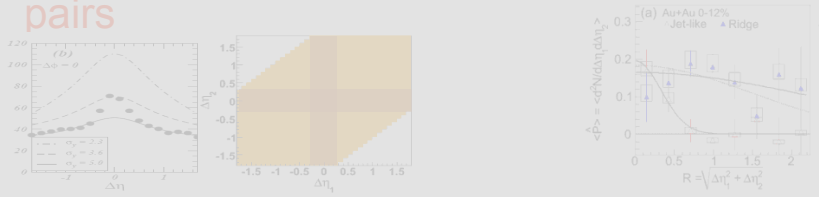
Data : $\langle P_{jr} \rangle \sim 0$



4) Momentum Kick

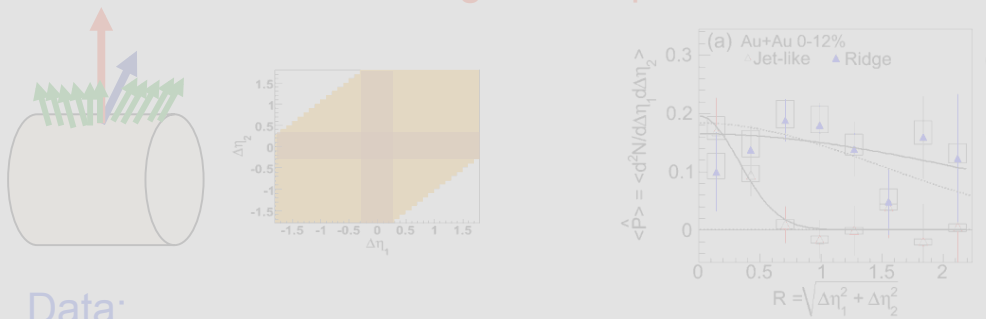
Model : Jet-ridge cross pairs

Data $\langle P_{jr} \rangle \sim 0$



5) Transverse flow boost

Model: Uniform, Jet-ridge cross pairs

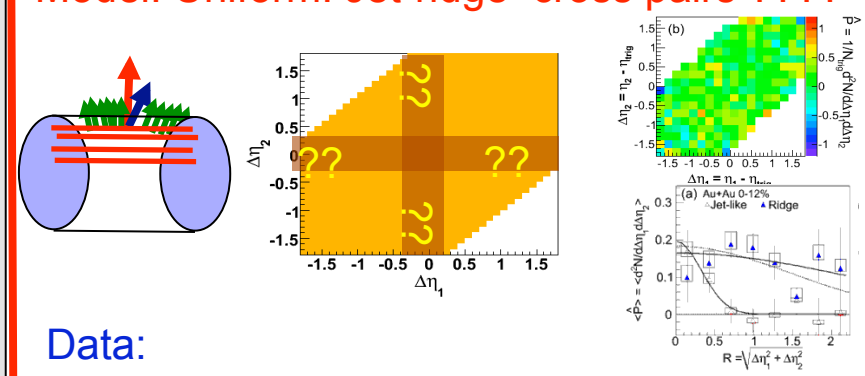


Data:

Uniform. No jet-ridge cross pairs

6) Glasma Flux tube

Model: Uniform. Jet-ridge cross pairs ????



Data:

Uniform. No jet-ridge cross term

Summary

- Jet and Ridge are “separated” by using the charge dependence.

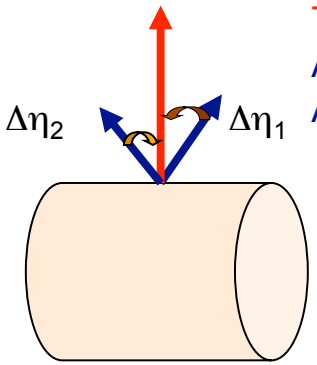
- Ridge broad and uniform, jet narrow in η.

- Ridge production appears to be uncorrelated to the presence of the jet.

Thank you

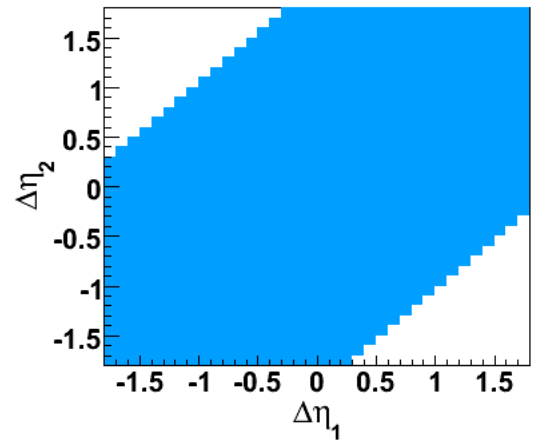
Back up Slides

Expectations from data



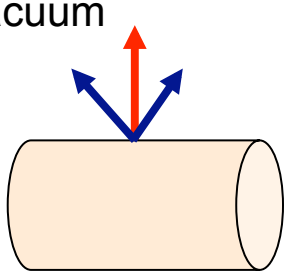
T : Trigger particle
A1: First Associated particle
A2: Second Associated particle

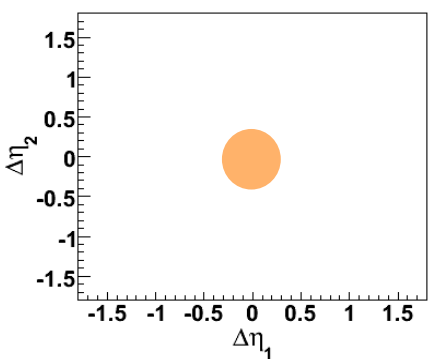
$\Delta\eta_1$ = A1-T
$\Delta\eta_2$ = A2-T



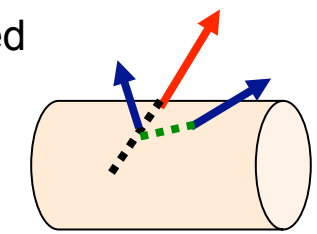
STAR TPC acceptance for 3-particle correlation in η ($|\eta|<1$ and full azimuth)

1) Jet fragmentation in vacuum

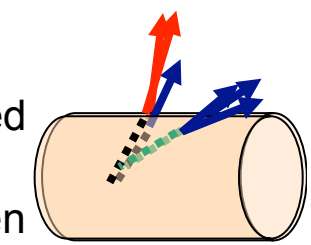




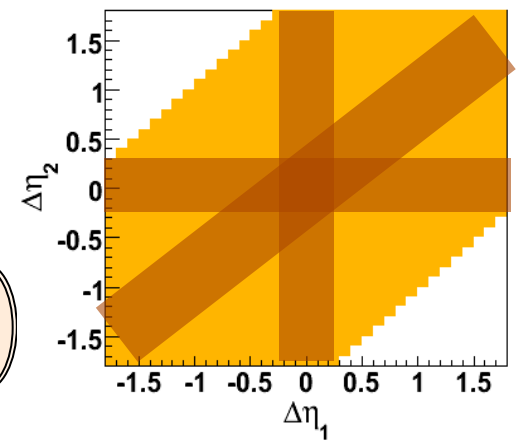
2) In medium radiated gluons diffused in η



3) In medium radiated gluons still collimated

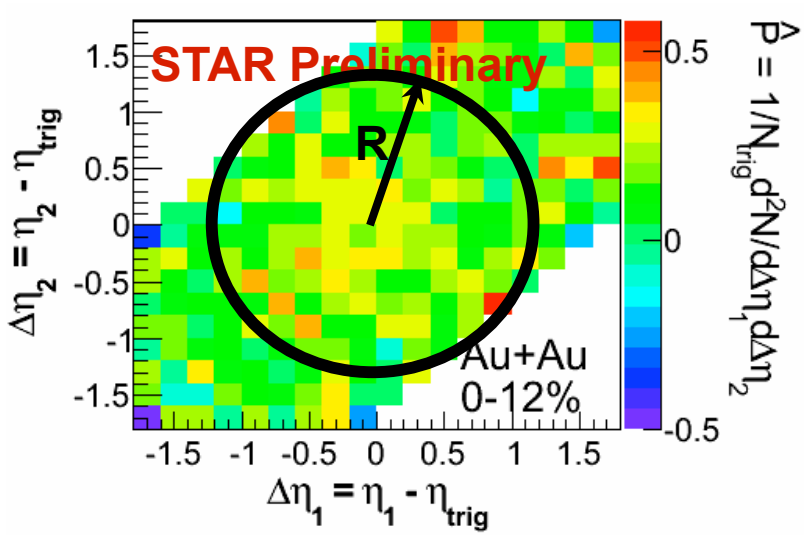


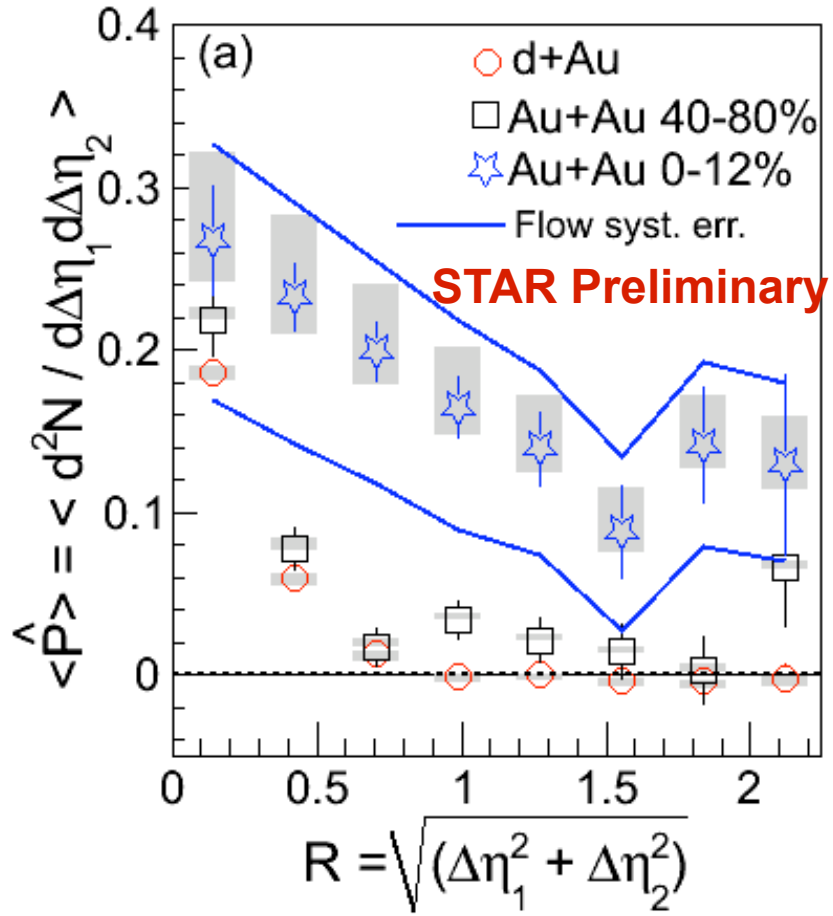
4) Combination between jet fragmentation and diffused gluons



Radial dependence for correlations

$3<p_T^{trig}<10$ GeV/c
$1<p_T^{assoc}<3$ GeV/c
$|\Delta\phi|<0.7$



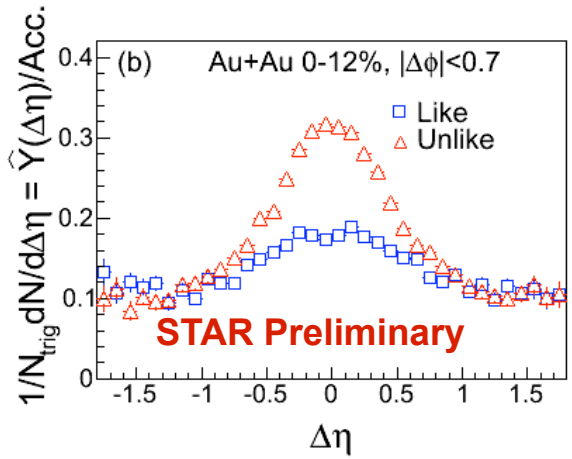


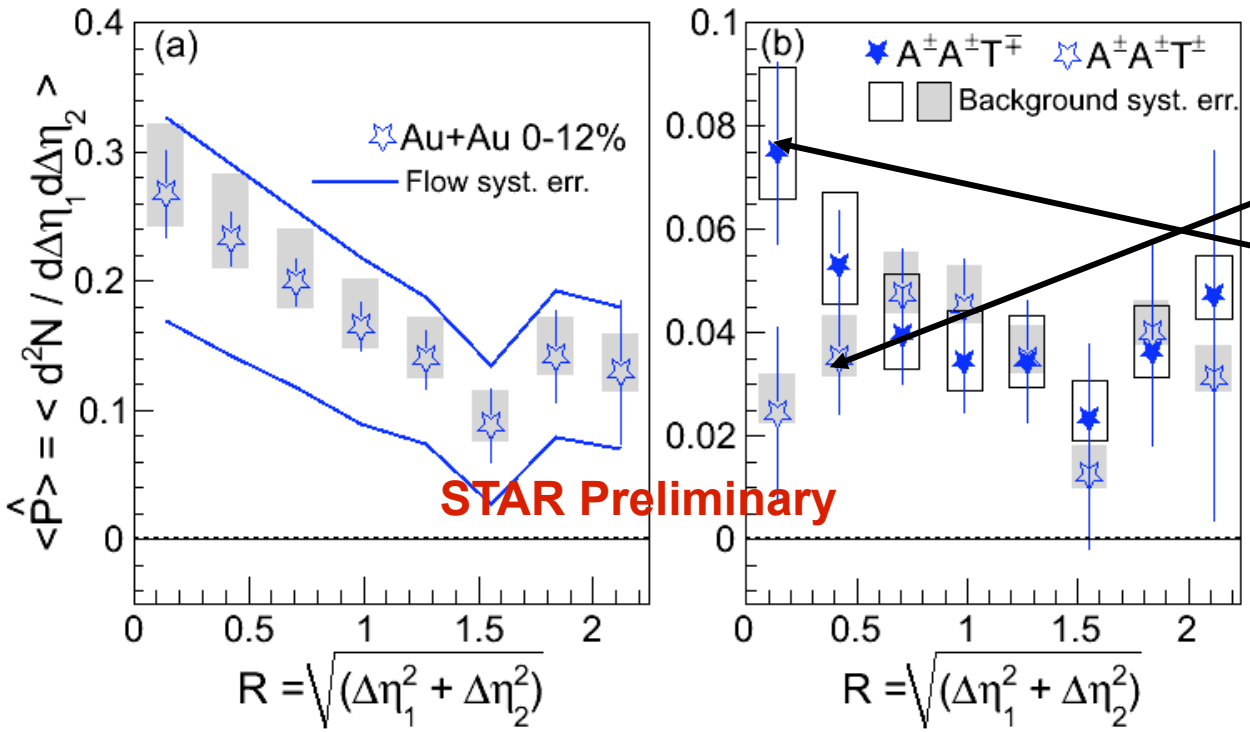
Jet-like peak is observed in all systems at R~0
d+Au and 40-80% Au+Au have similar trend
Average yield in Au+Au 0-12% decreases with R and is almost constant for R>1.

Jet and Ridge separation

Ridge (T- A+ = Ridge (T+ A+
Ridge (T+ A- = Ridge (T- A-

Ridge($A^{\pm}A^{\pm}T^{\mp}$) = Ridge ($A^{\pm}A^{\pm}T^{\pm}$)





$A^{\pm}A^{\pm}T^{\pm}$:
Dominant Ridge
$A^{\pm}A^{\pm}T^{\mp}$:
Jet + Ridge

A±A±T :
A+A+T+,A-A-T-,
A+A+T- ,A-A-T+
$A^{\pm}A^{\mp}T$:
T+A-A+,T+A+A-
T-A-A+ ,T-A+A-

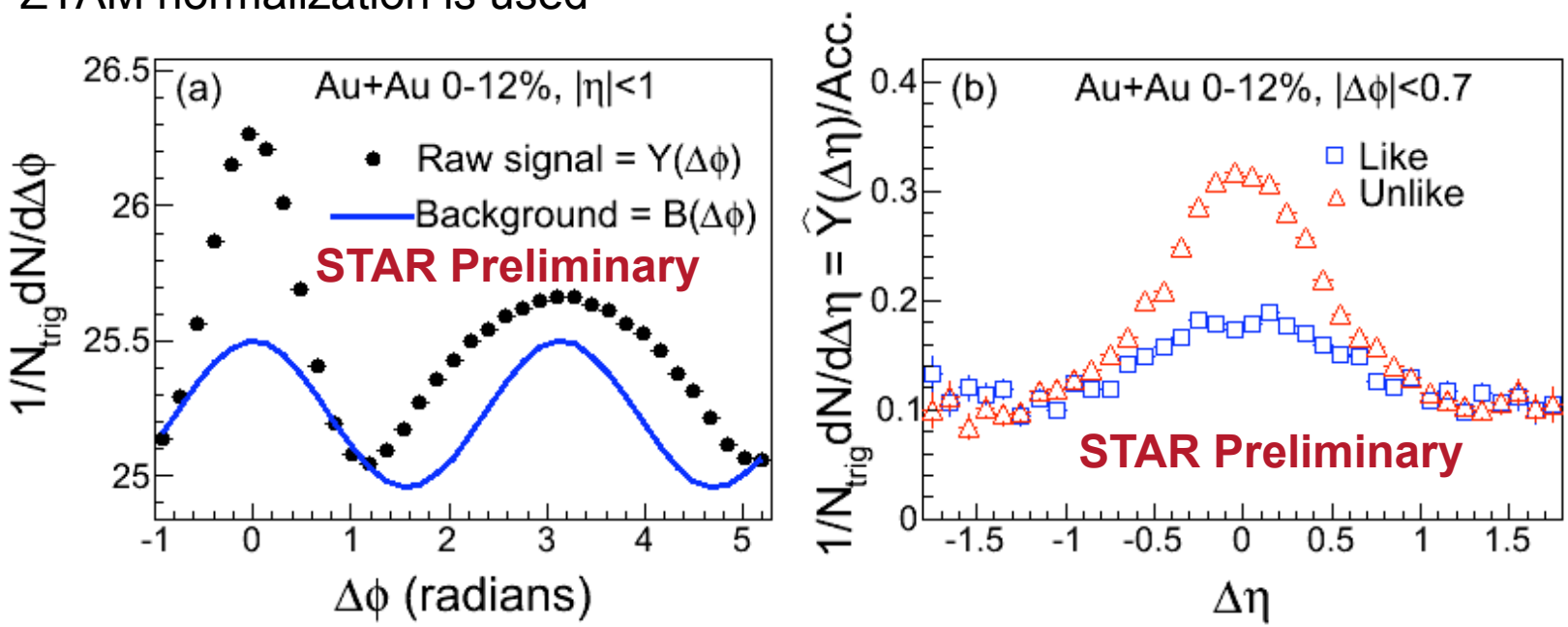
4X

Di-hadron correlations

$3<p_T^{Trig}<10$ GeV/c $1<p_T^{Assoc}<3$ Gev/c

Flow modulated background
is from mixed events
ZYAM normalization is used

Like : (T+,A+) or (T- A-)
Unlike : (T- A+) or (T+ A-)



More unlike-sign at $|\Delta\eta|<0.7$.

➔ Charge ordering property in jets

Like- sign ≈ unlike-sign pairs at $|\Delta\eta|>0.7$

➔ Ridge is charge independent