

# What Can We Learn From Jet Correlations of Identified Particles in Heavy Ion Collisions?

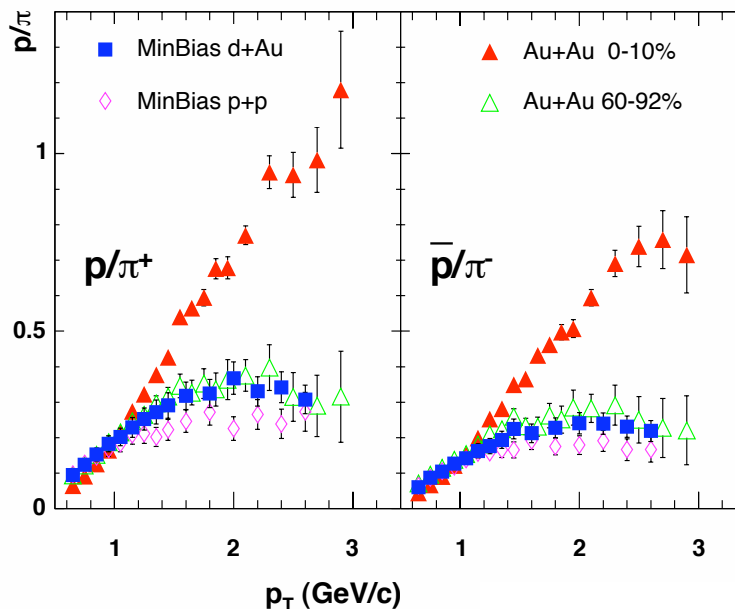
Anne Sickles  
for the PHENIX Collaboration  
Brookhaven National Laboratory

November 15, 2006

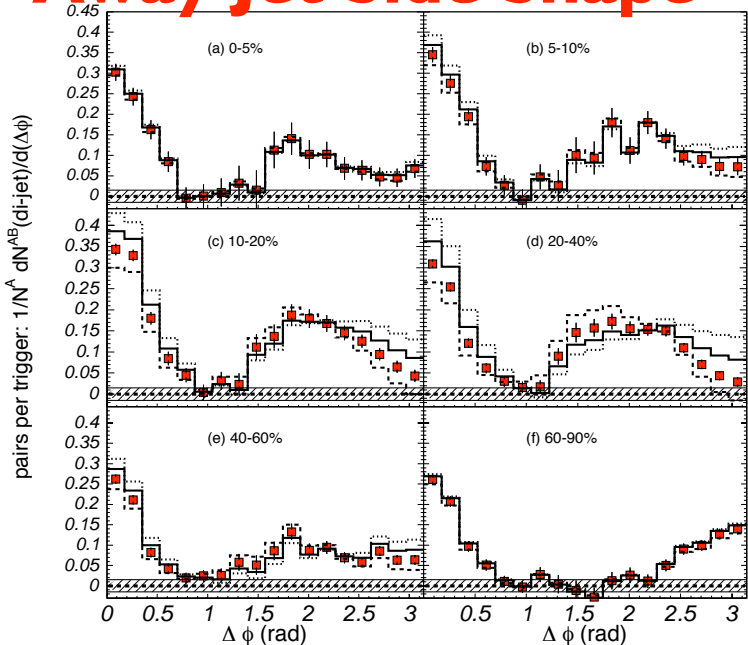
# Intermediate $p_T$ : Many Unexpected Features

## Enhanced Baryon Production

**PRL 91 172901 (2003)**  
**PRC 74 024904 (2006)**

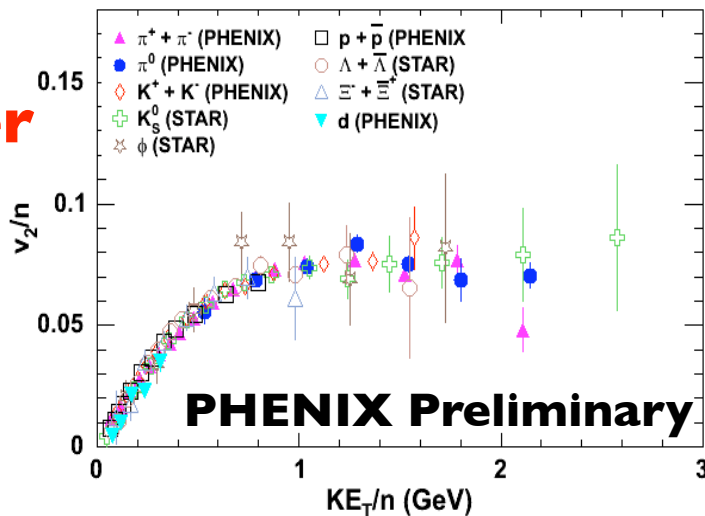


## Strong Modifications to Away Jet Side Shape



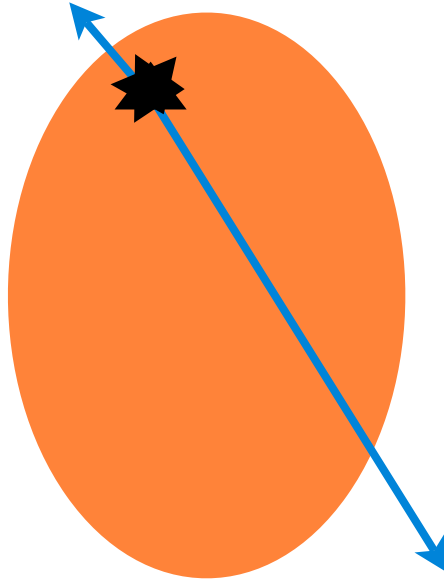
**PRL 97 052301 (2006)**

## Quark Number Scaling of $v_2$



# The Jet Picture

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# The Jet Picture

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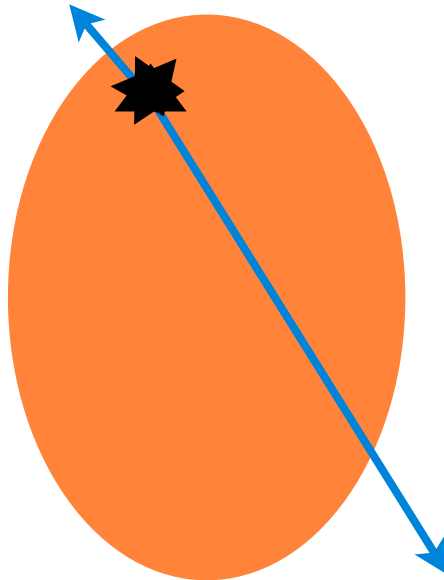
## THE NEAR SIDE

defined by “high”  $p_T$   
particle: surface bias

recombination?

surface emission?

how do jet-like  
correlations change  
with centrality?



# The Jet Picture

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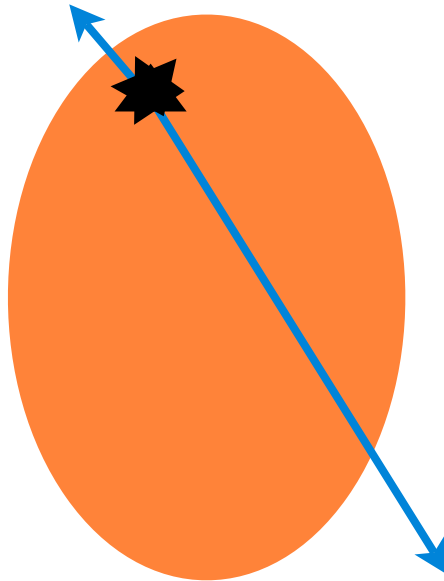
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## THE AWAY SIDE

longer medium path  
length

collective medium  
response?

what can we learn from  
the centrality  
dependence?

# The Jet Picture

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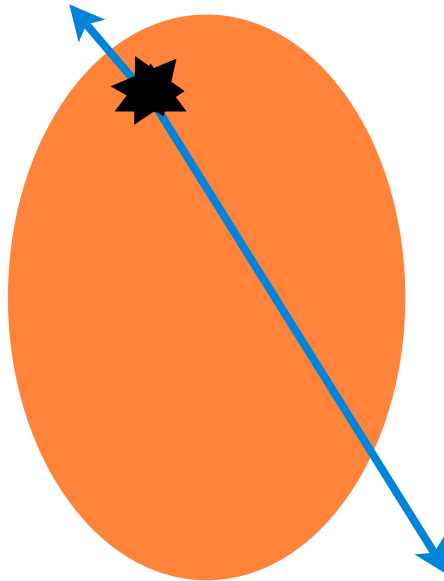
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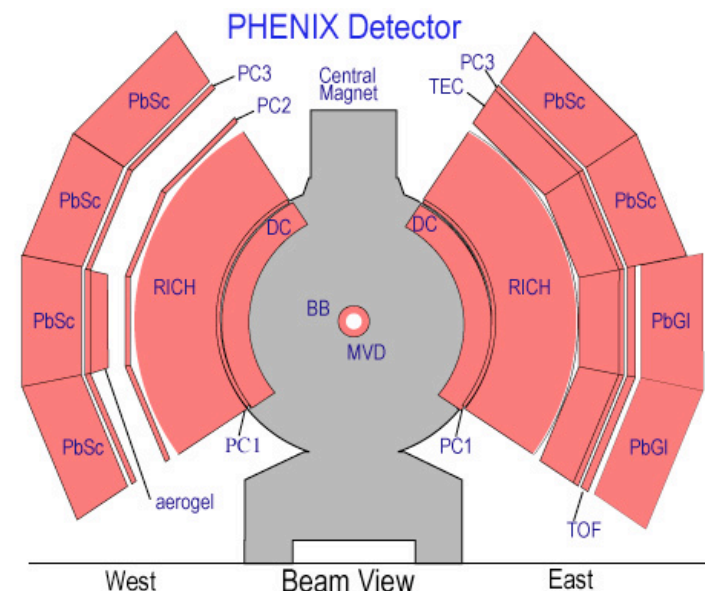
collective medium  
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what can we learn from  
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dependence?

***in light of the baryon/meson differences at intermediate  $p_T$  all jet questions should be addressed separately for baryons and mesons***

# Two particle correlations

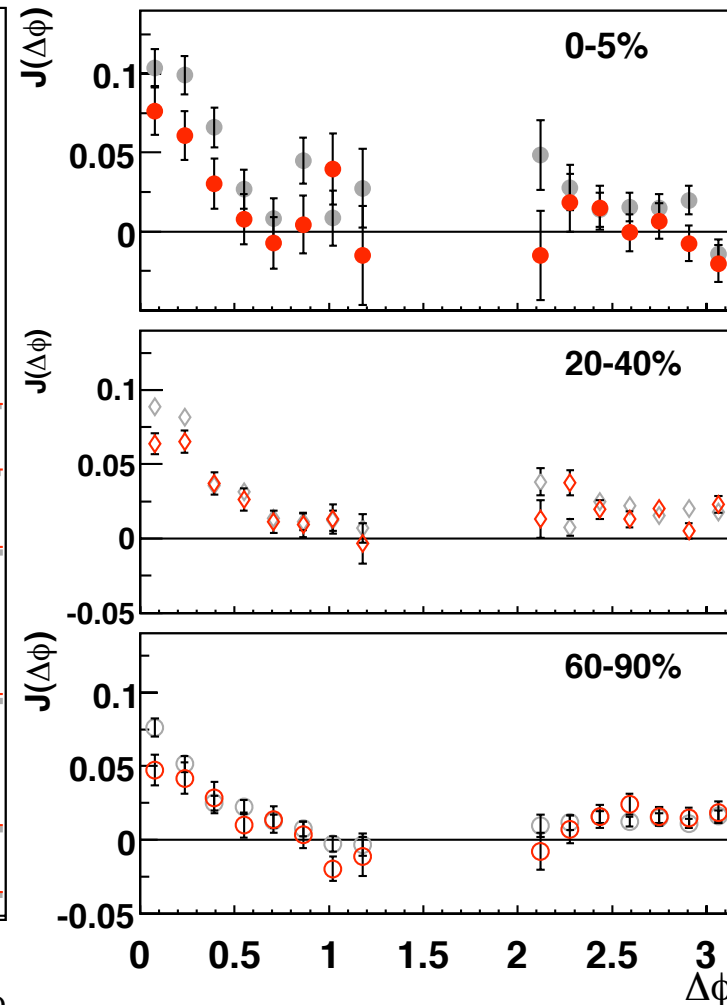
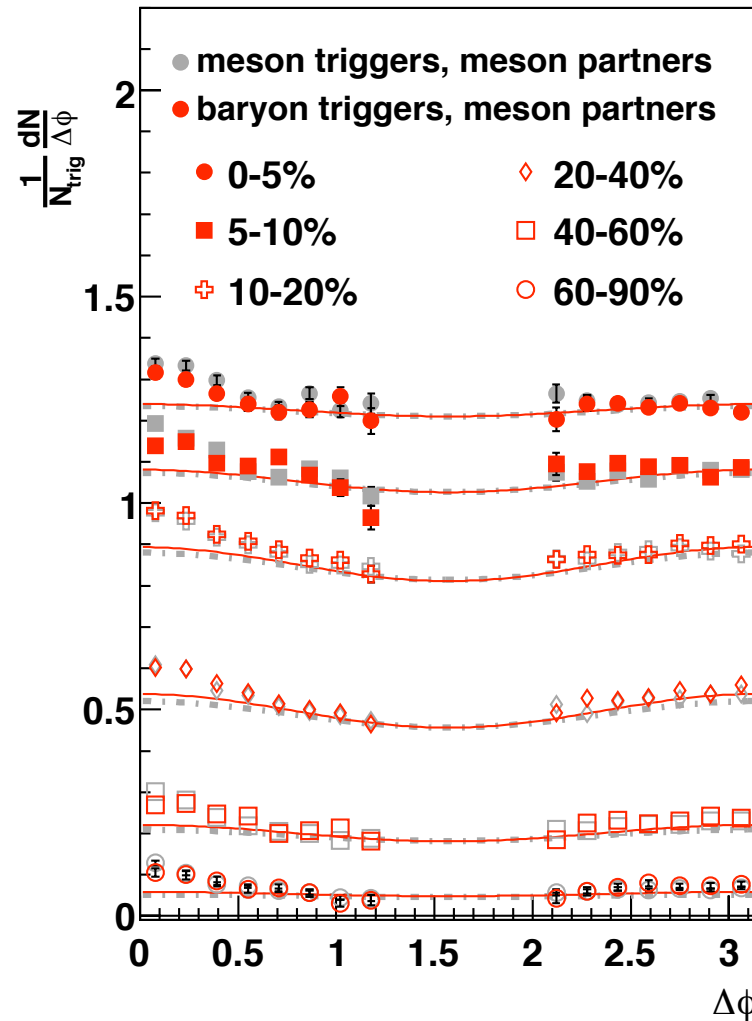
- trigger: higher  $p_T$
- associated particles: lower  $p_T$
- *not average jets: two fairly high  $z$  particles*
- two particle correlations great for studying jets as a function of particle type
  - in the comparisons between particle types the jet biases are the same
  - baseline established in small system (per.Au+Au or p+p)
- PHENIX has charged particle PID over entire azimuthal acceptance
  - TOF  $\Delta\phi=\pi/4$  K/p separation  $\sim 4\text{GeV}/c$
  - PbSc EMCal  $\Delta\phi=3\pi/4$  K/p separation  $\sim 2.5\text{GeV}/c$
  - correct for non-uniform azimuthal acceptance with event mixing



# Baryon and Meson Triggered Jets



## Jet Functions

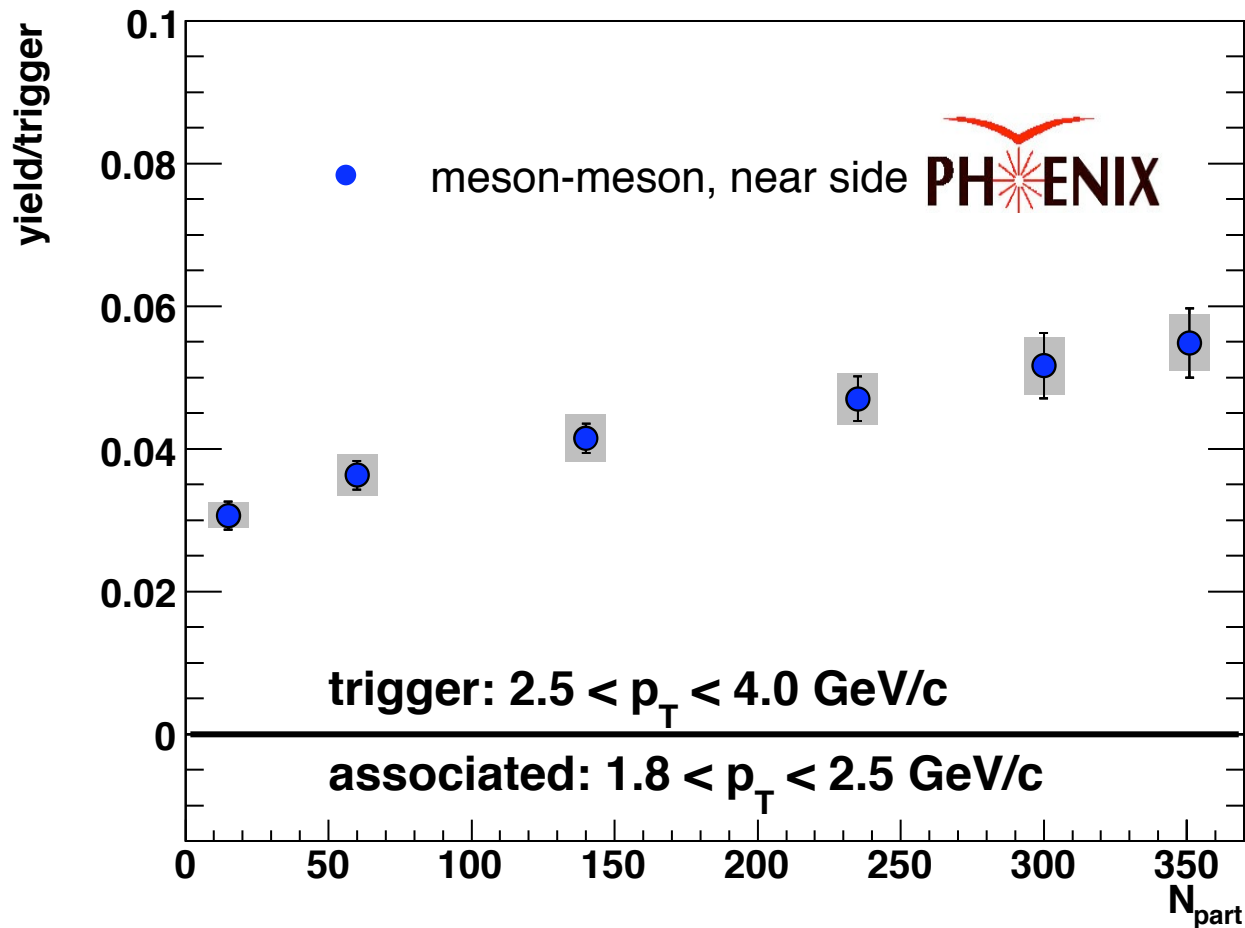


**trigger:  $2.5 < p_T < 4.0 \text{ GeV}/c$**   
**partner:  $1.8 < p_T < 2.5 \text{ GeV}/c$**

submitted to PLB, nucl-ex/0611016



# baryons: $2.5 < p_T < 4.0 \text{ GeV}/c$

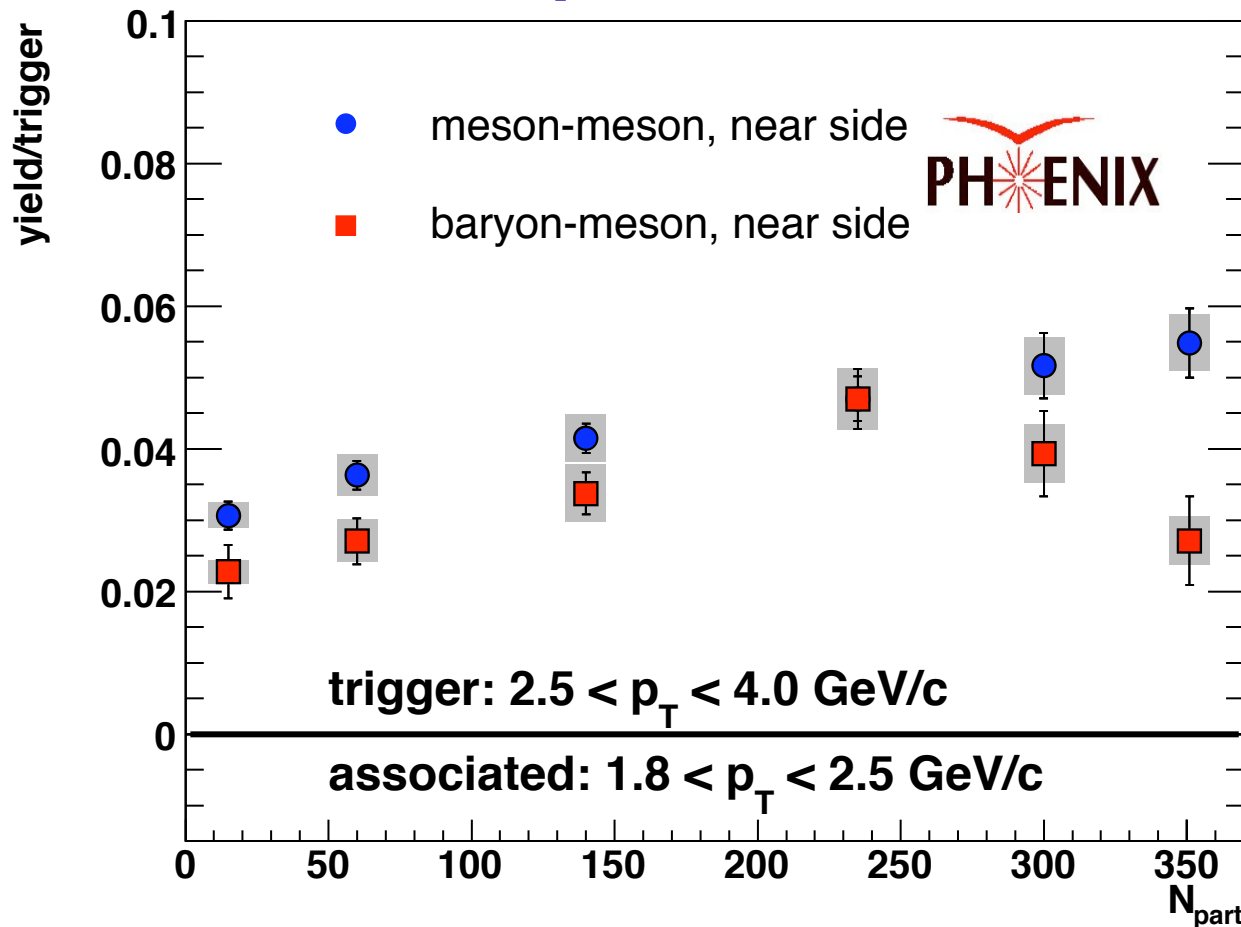


**meson-meson:  
steady increase**

**submitted to PLB, nucl-ex/0611016**

# baryons: $2.5 < p_T < 4.0 \text{ GeV}/c$

*trigger baryons are correlated with mesons, but the centrality dependence different than for mesons!*



**meson-meson:  
steady increase**

**baryon-meson:  
increase, then decrease**

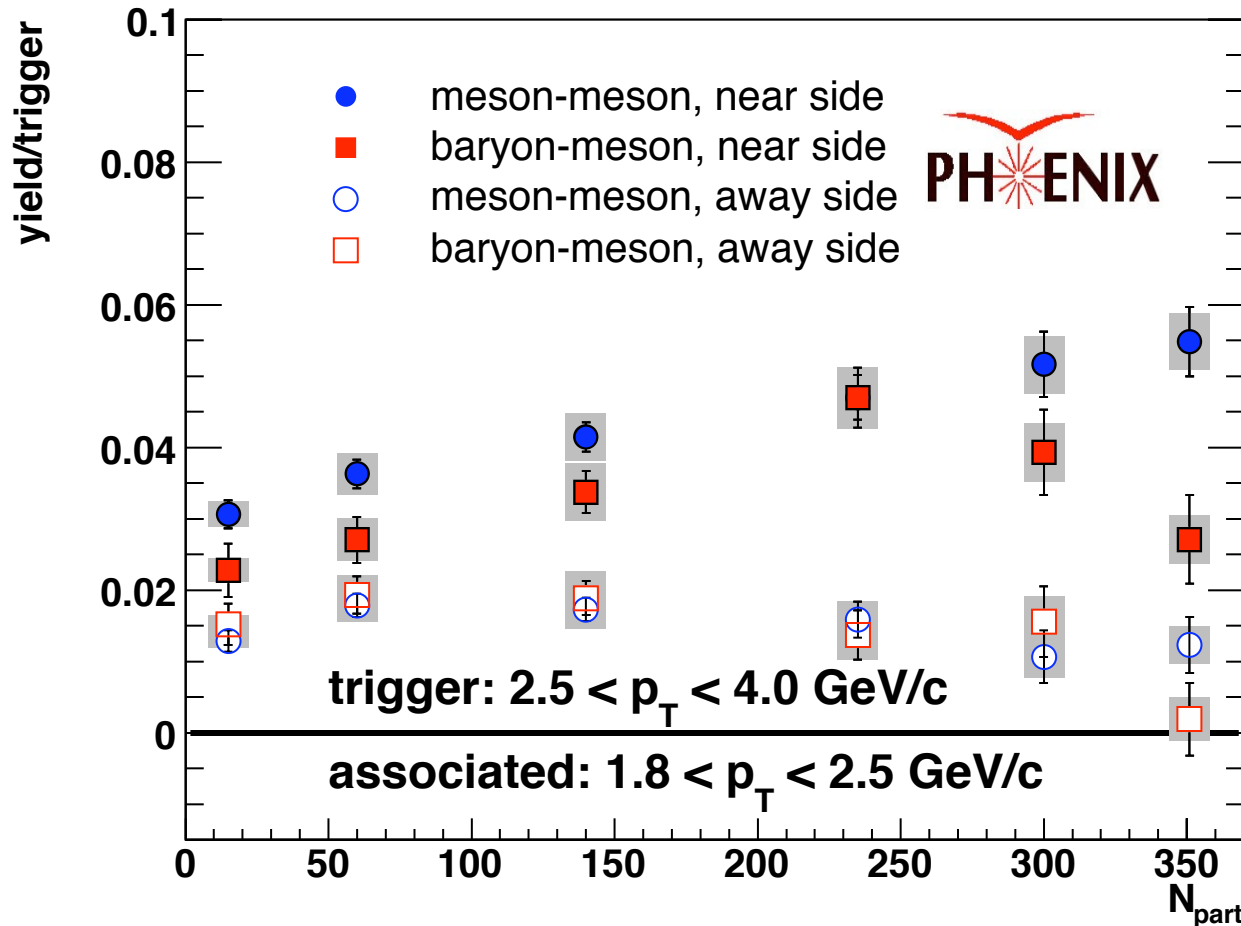
$\bar{p}/\pi = 0.25$

$\bar{p}/\pi = 0.8$

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**meson-meson:  
steady increase**

**baryon-meson:  
increase, then decrease**

**away side:  
no trigger dependence**

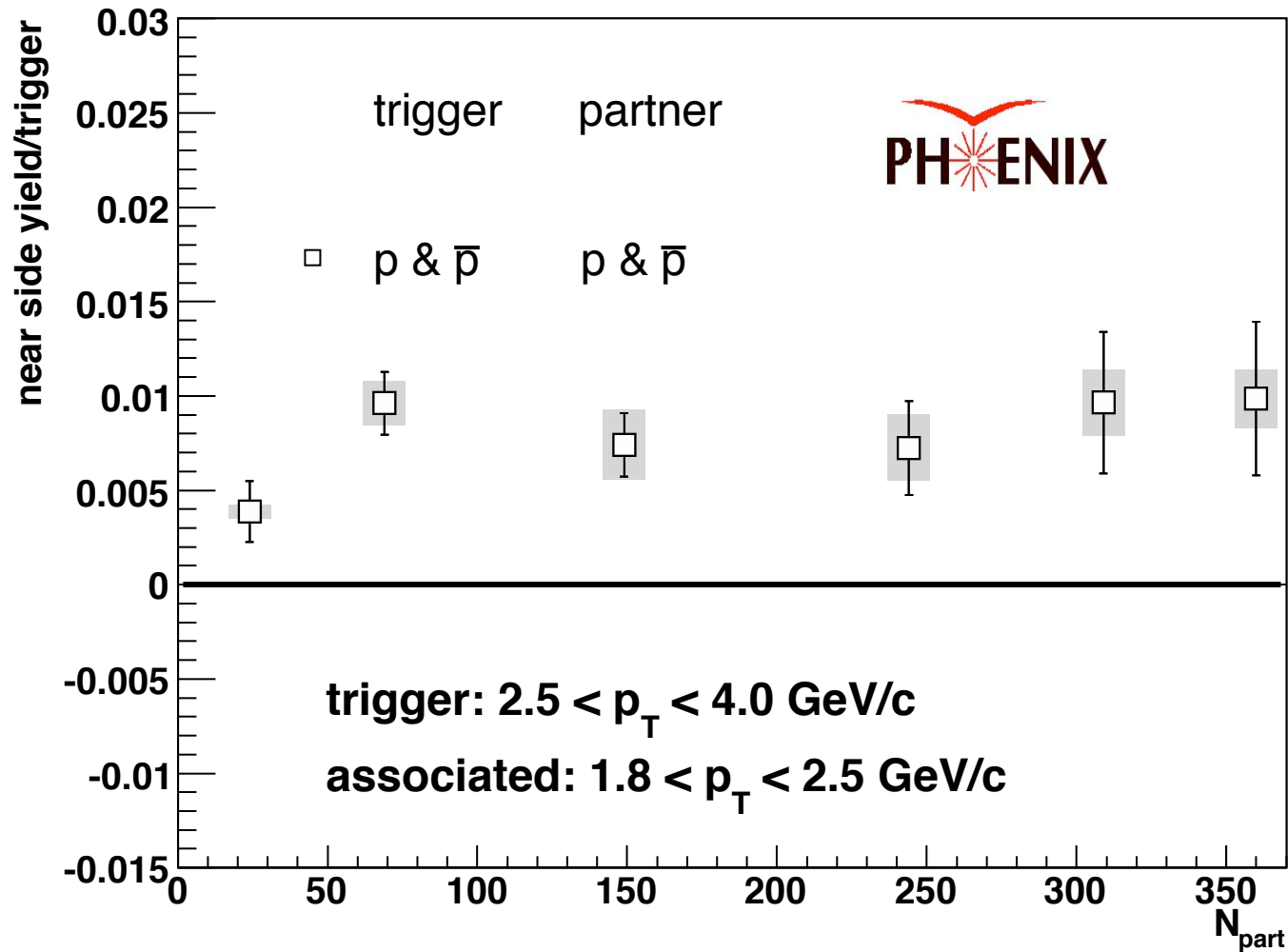
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submitted to PLB, nucl-ex/0611016

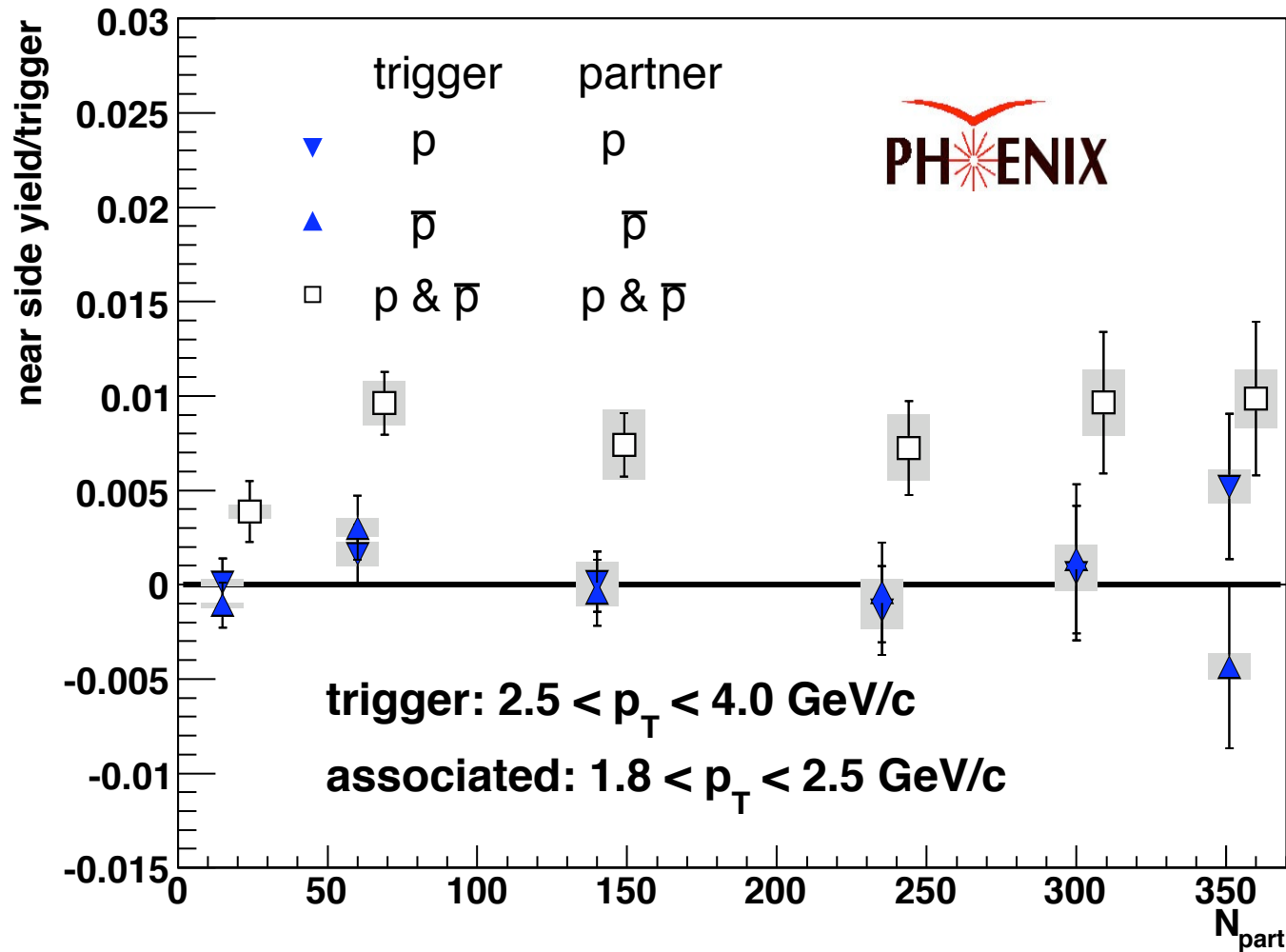
# $\rho$ & $\bar{\rho}$ Correlations

submitted to PLB, nucl-ex/0611016



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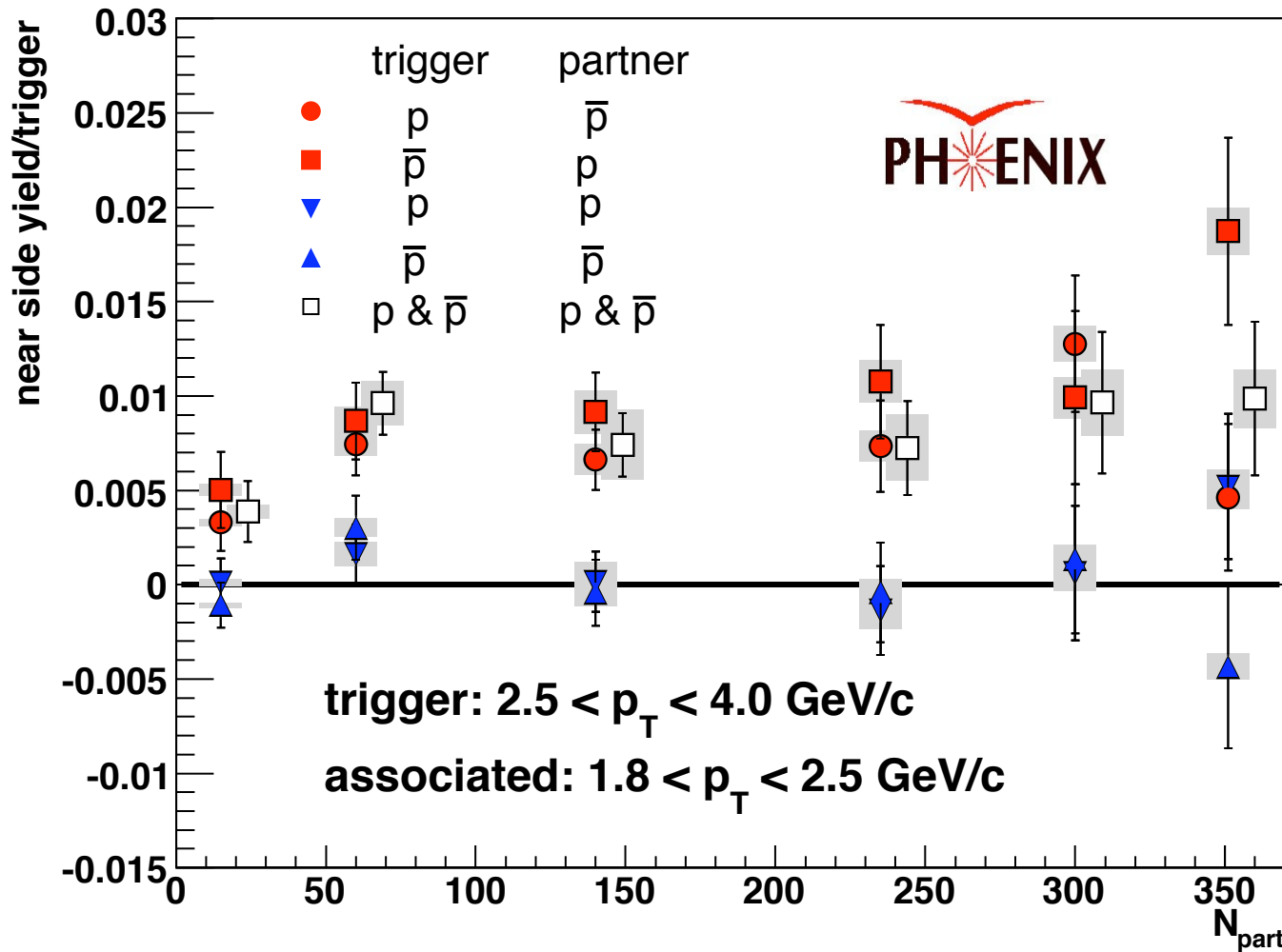
submitted to PLB, nucl-ex/0611016



same sign pairs:  
**NO CORRELATION**

# $\rho$ & $\bar{\rho}$ Correlations

submitted to PLB, nucl-ex/0611016



**opposite sign pairs:  
CORRELATED**

**same sign pairs:  
NO CORRELATION**

$\bar{p}/\pi=0.25$

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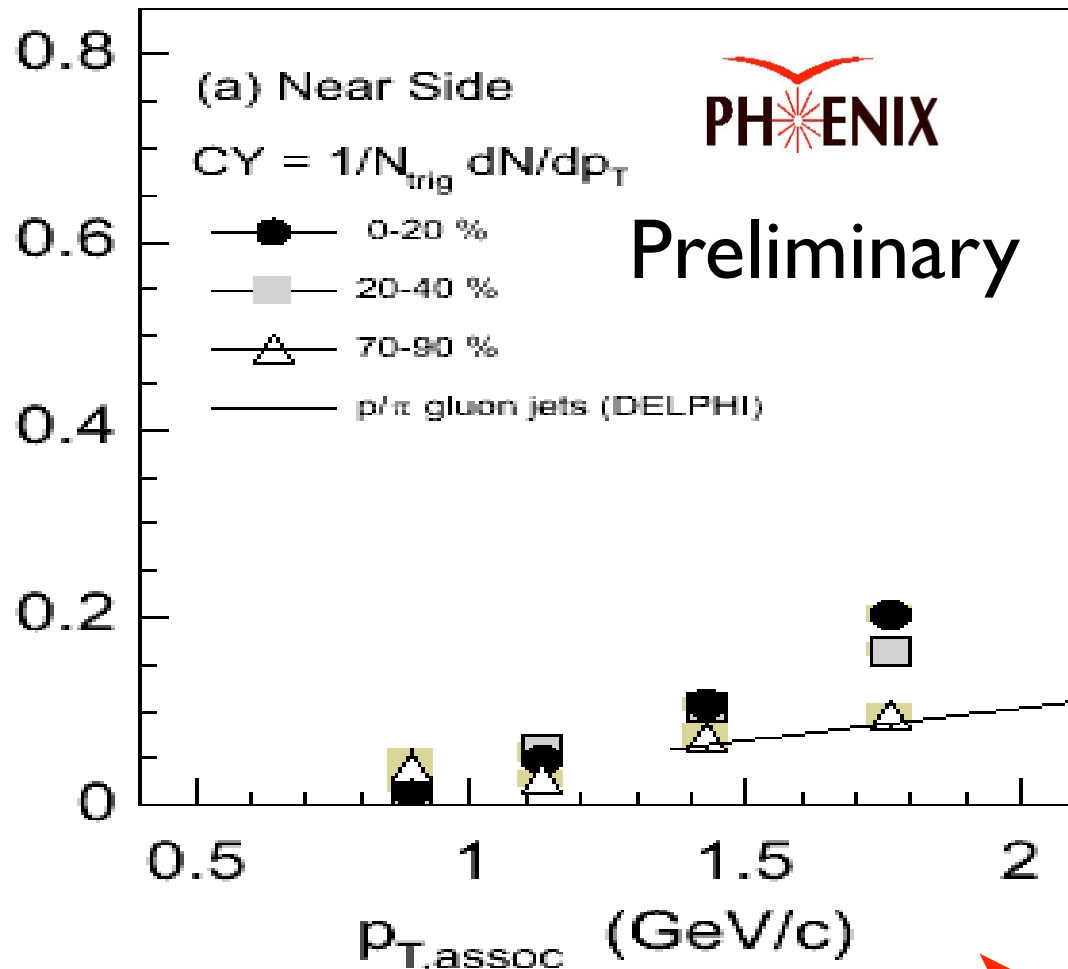
**$p$ - $\bar{p}$  pair correlations nearly independent of baryon excess**

# A Closer Look at the Associated Particles...

# Near Side: Baryons vs Mesons

## hadron trigger

assoc. baryons/assoc. mesons



trigger:  $2.5 < p_T < 4.0 \text{ GeV}/c$

increasing centrality

increasing p/π- ratio

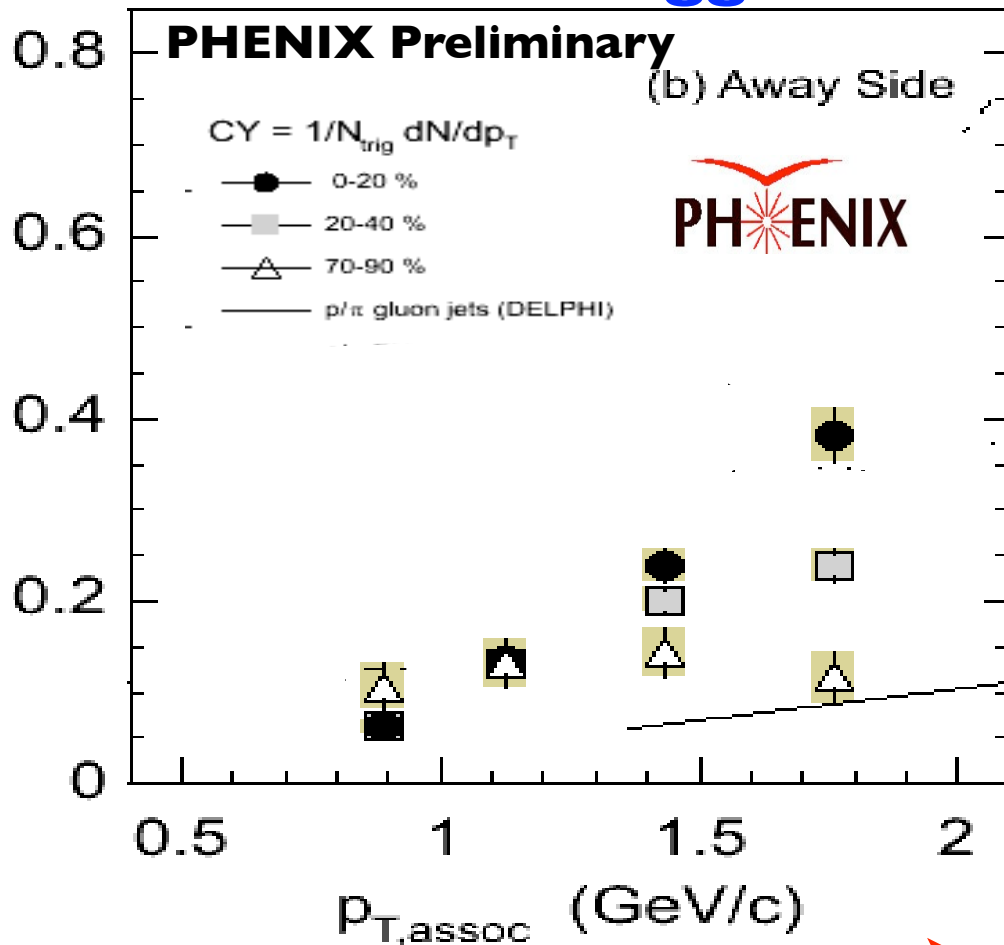
extra baryons in near side correlations!



# Away Side: Baryons vs Mesons

assoc. baryons/assoc. mesons

hadron trigger



trigger:  $2.5 < p_T < 4.0 \text{ GeV}/c$



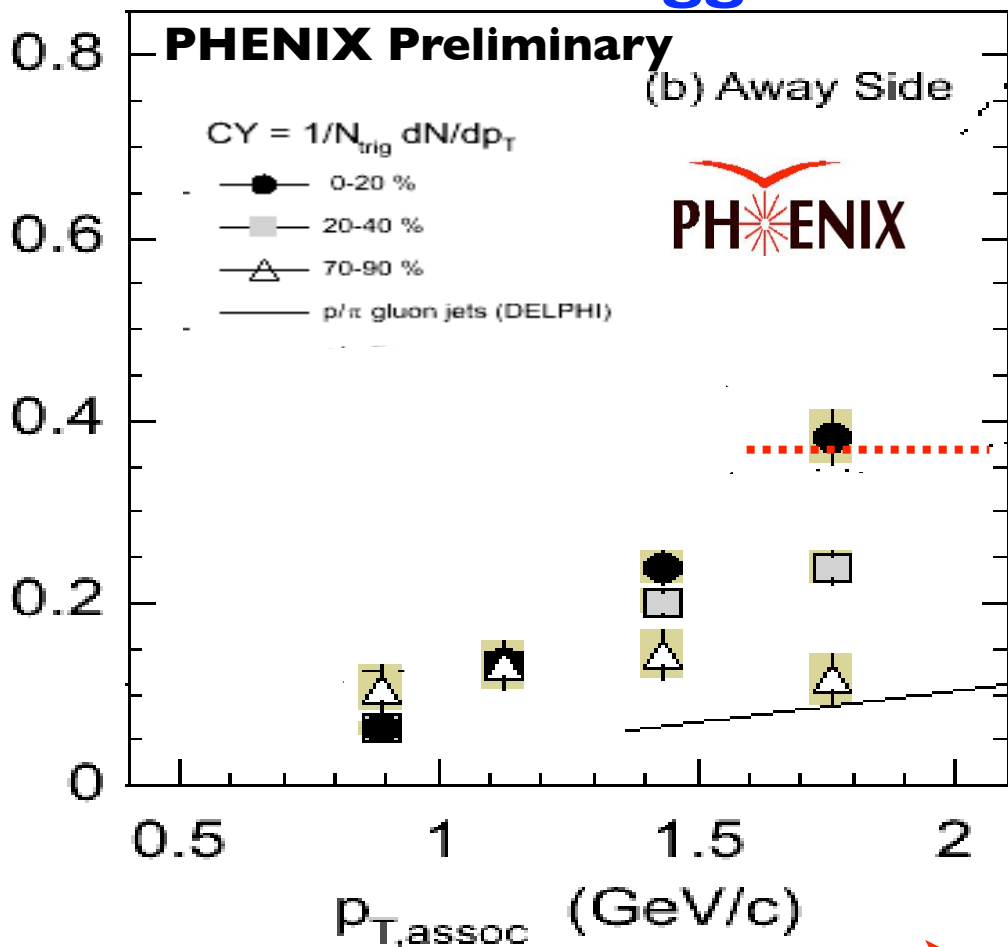
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trigger:  $2.5 < p_T < 4.0 \text{ GeV}/c$

baryon/meson ratio single particles  
central Au+Au 1.85 GeV/c  
PHENIX (PRC 69 034909 (2004))



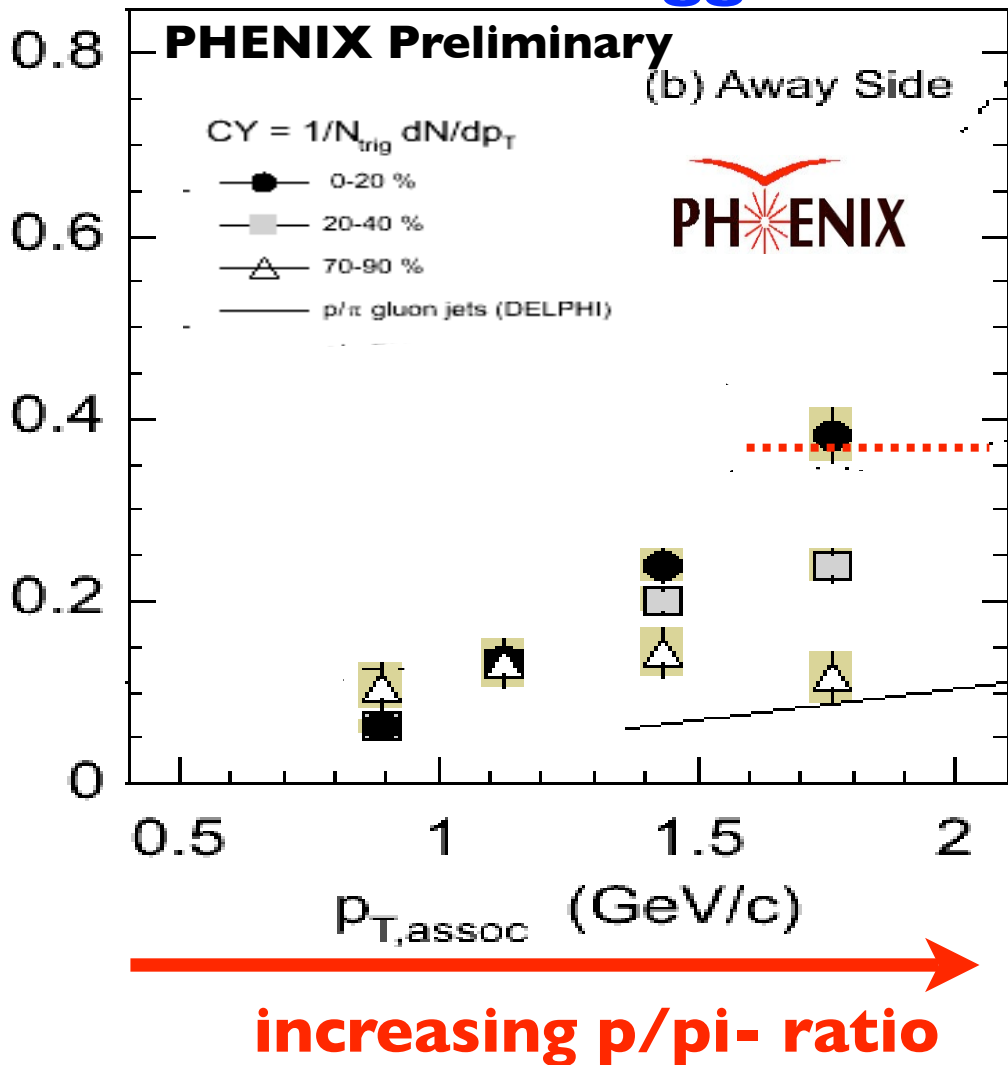
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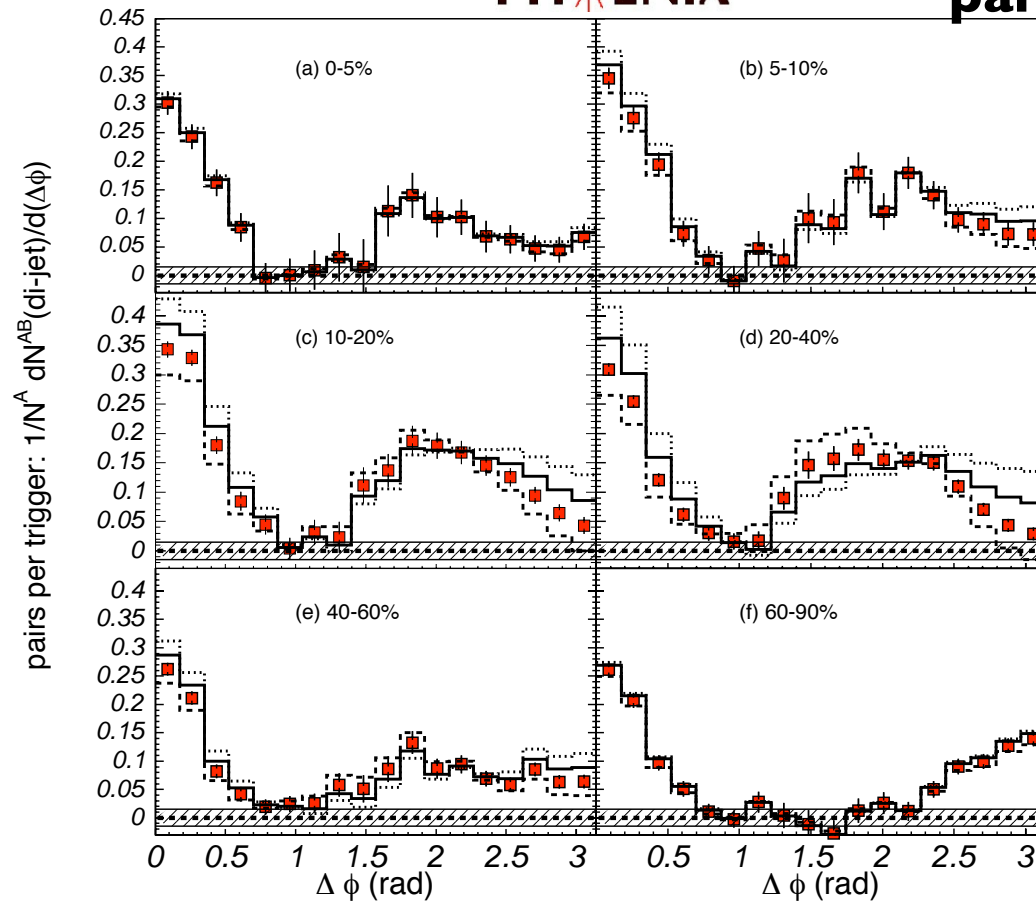
stronger centrality dependence than near side, similar to single particles

# Away Side Shape Modifications

PRL 97 052301 (2006)



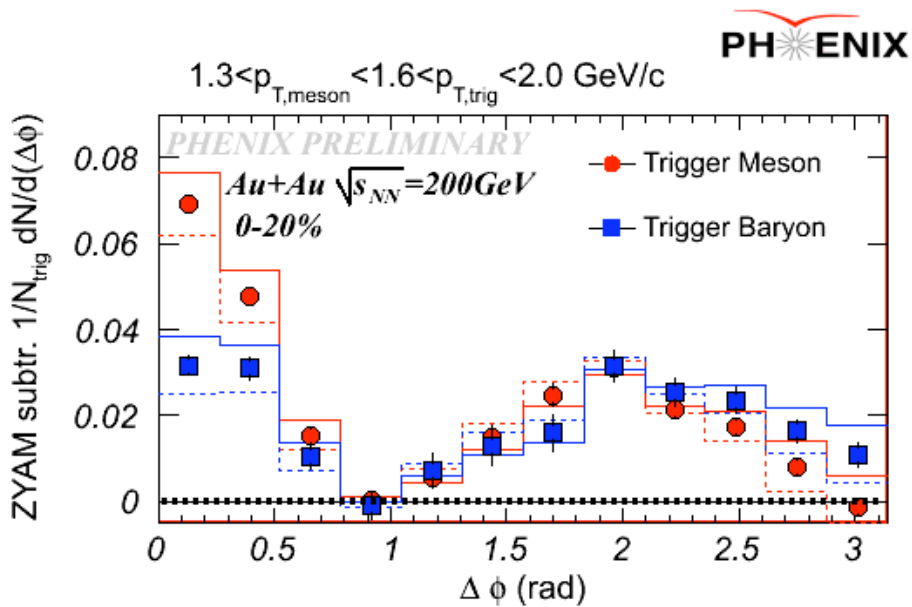
trigger:  $2.5 < p_T < 4.0 \text{ GeV}/c$   
partner:  $1.0 < p_T < 2.5 \text{ GeV}/c$



***Is this shape different for baryons and mesons?***

# Shape Modifications: Low $p_T$

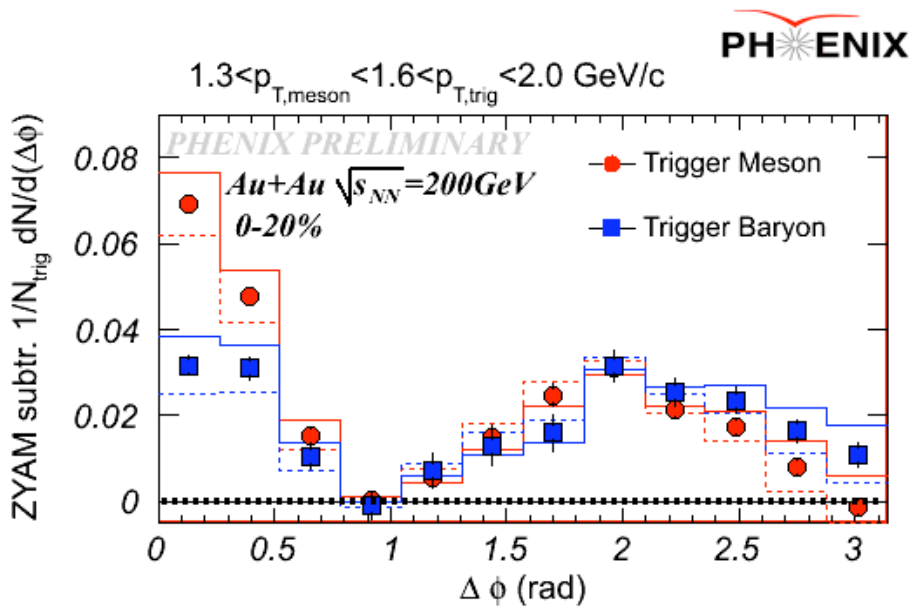
trigger:  $1.6 < p_T < 2.0 \text{ GeV}/c$   
 partner:  $1.3 < p_T < 1.6 \text{ GeV}/c$



**Displaced peak about the same place as at higher  $p_T$**

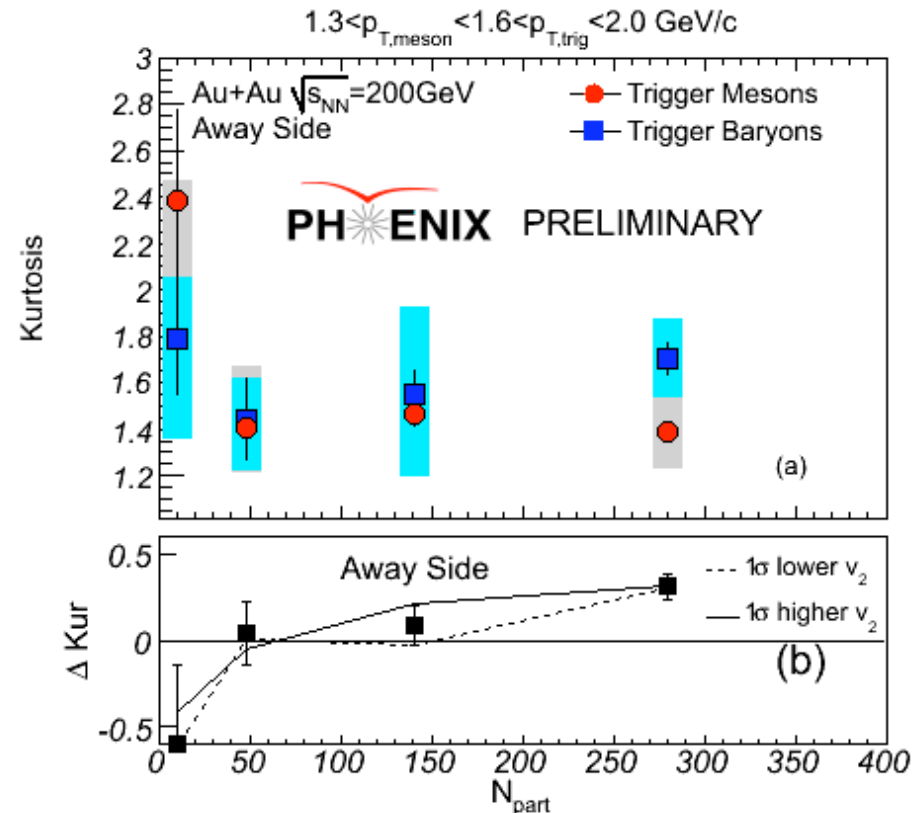
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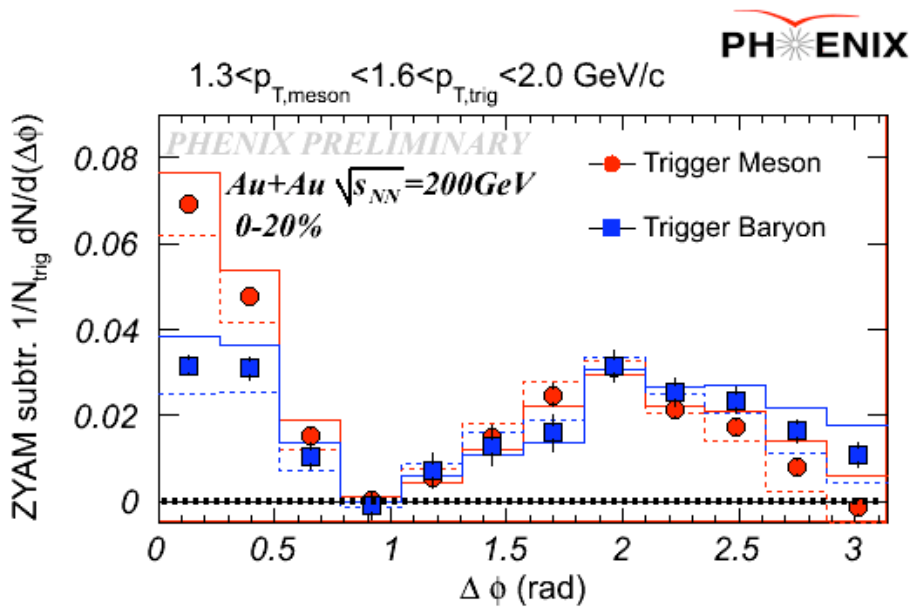
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## Kurtosis ( $\mu_4/\mu_2^2$ )



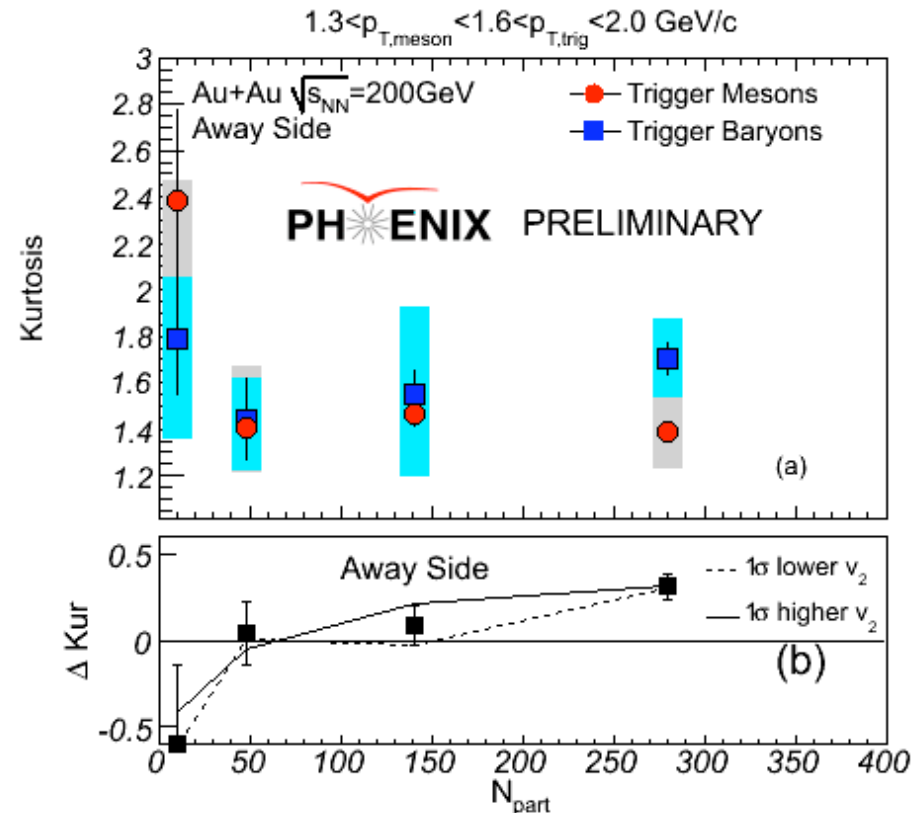
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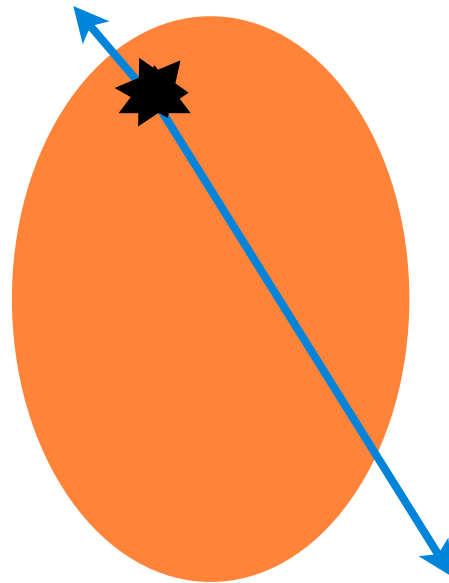
## Kurtosis ( $\mu_4/\mu_2^2$ )



**hints of shape differences between baryon and meson triggers in central Au+Au**

# The Jet Picture @ Intermediate $p_T$

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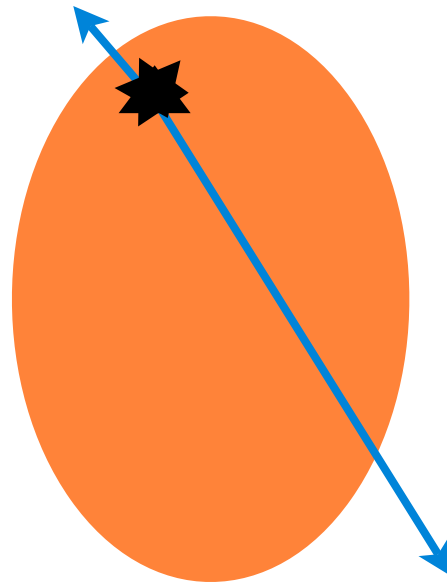
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## THE NEAR SIDE

correlated  $p$  &  $\bar{p}$   
at all centrality

increase in jet pairs/  
trigger  
with centrality

increase in assoc.  
baryon/meson ratio  
in central Au+Au



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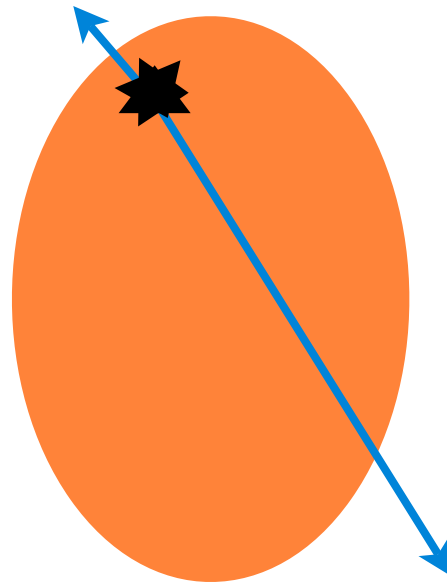
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## THE AWAY SIDE

away side assoc.  
baryon/meson ratio  
similar to single  
particles

hints of trigger type  
dependence of away  
side jet shape @ low  
 $p_T$

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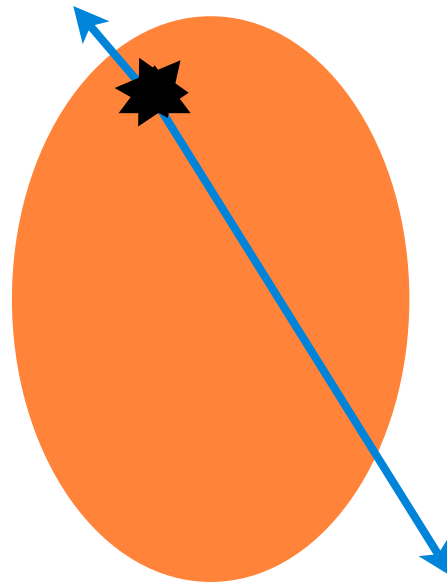
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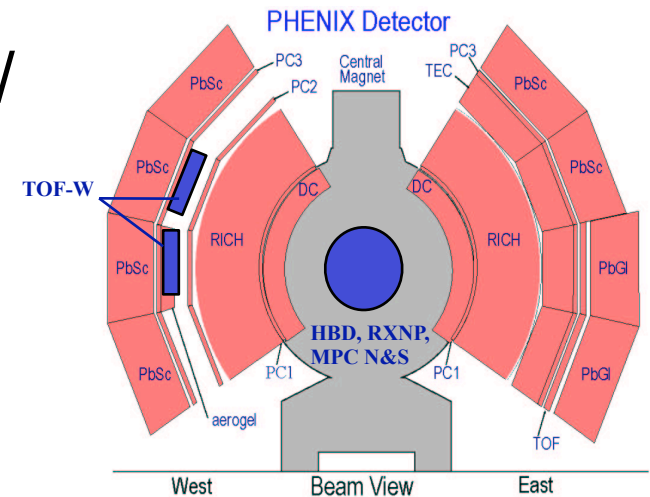
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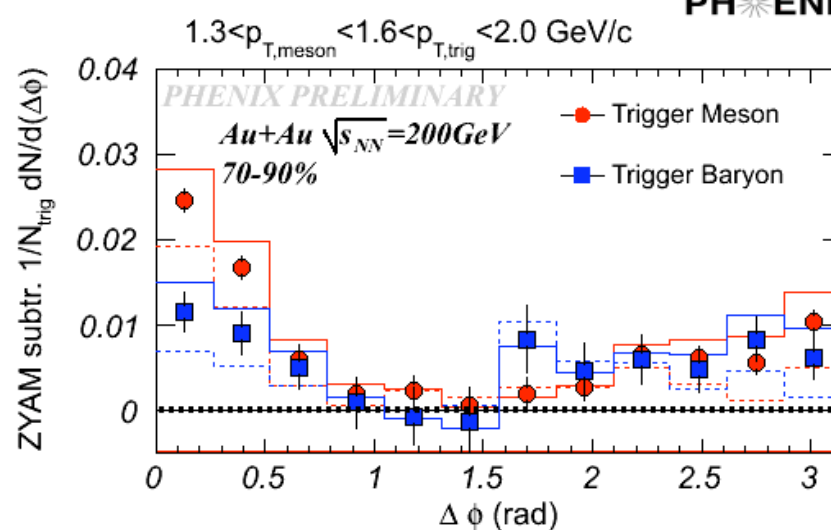
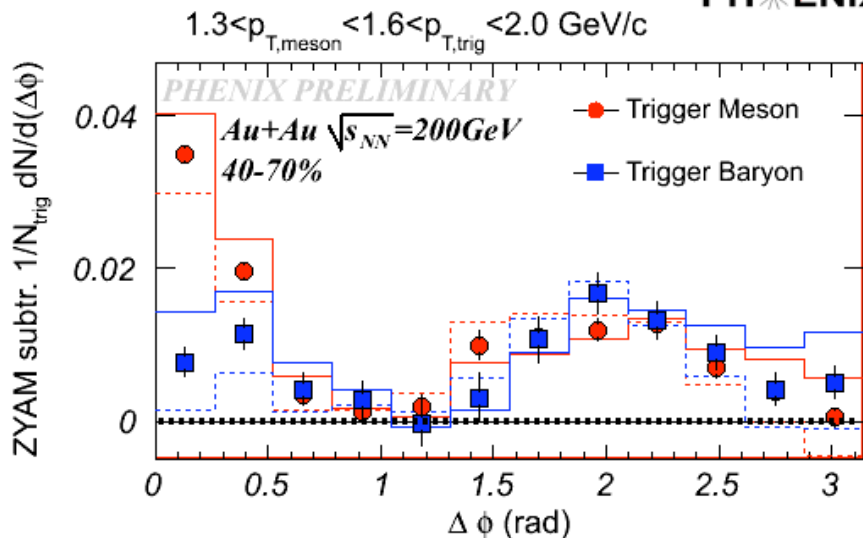
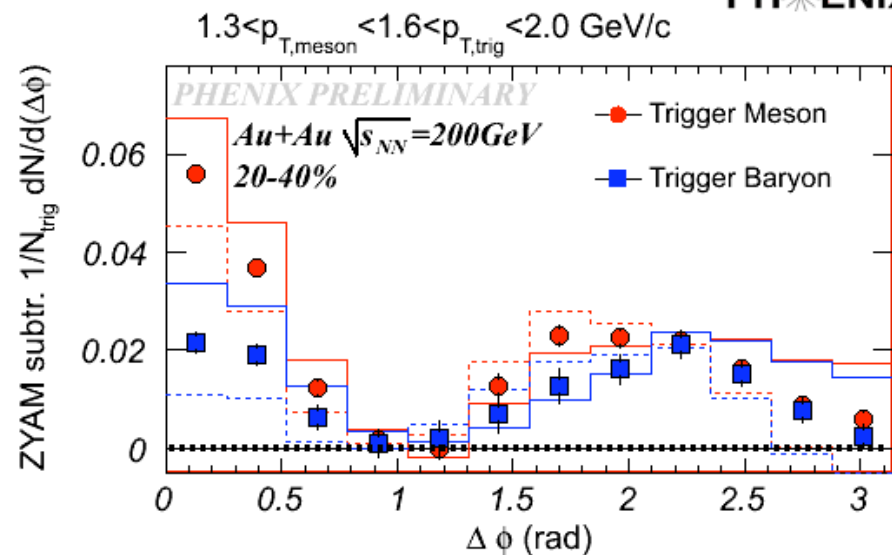
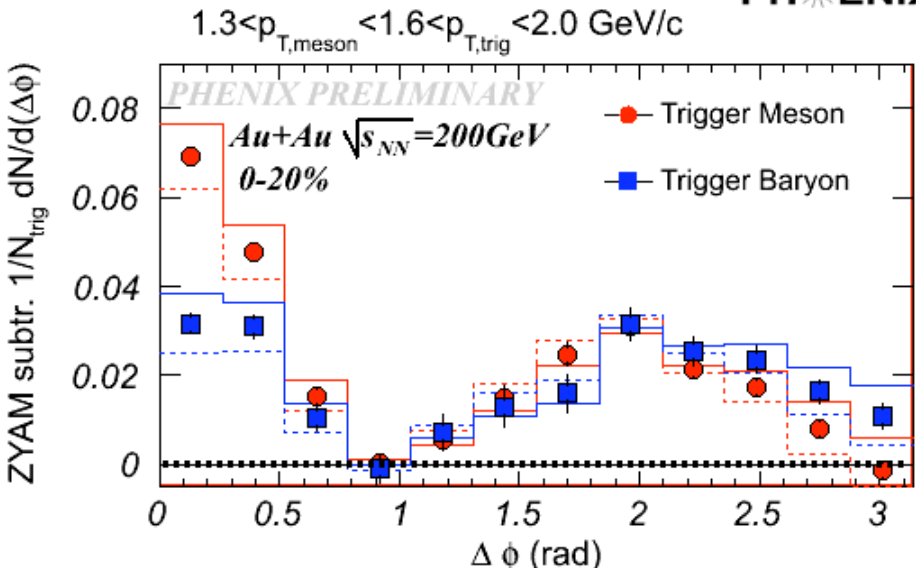
**Many connections between jets and baryon excess seen on both the near and away side**

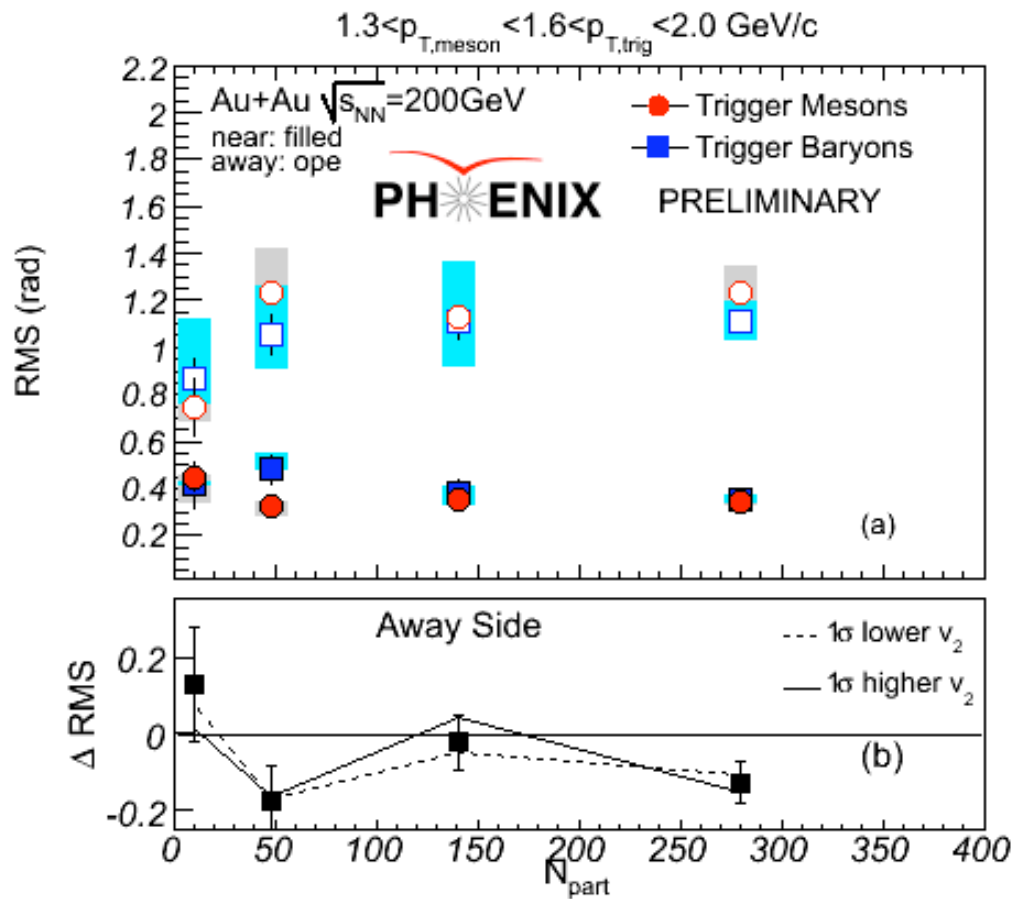
# Where Next?

- systematically explore  $p_T$  dependence
- how are baryon triggered jets different than meson triggered jets
- quantify associated away side baryon/meson ratio compared to single particles
- PHENIX upgrade: TOF.W ( $\sigma \approx 100\text{ps}$ )
- installed for Run 7 & doubles high  $p_T$  ( $>2.5\text{GeV}/c$ ) PID acceptance
- placement helps measurements of PID dependence of away side jet shape



# Backups





# Away Side $p$ - $\bar{p}$ Correlations

