# Jet-Like Correlations in 200GeV $Au + Au$ Collisions

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RHIC and AGS Users' Meeting

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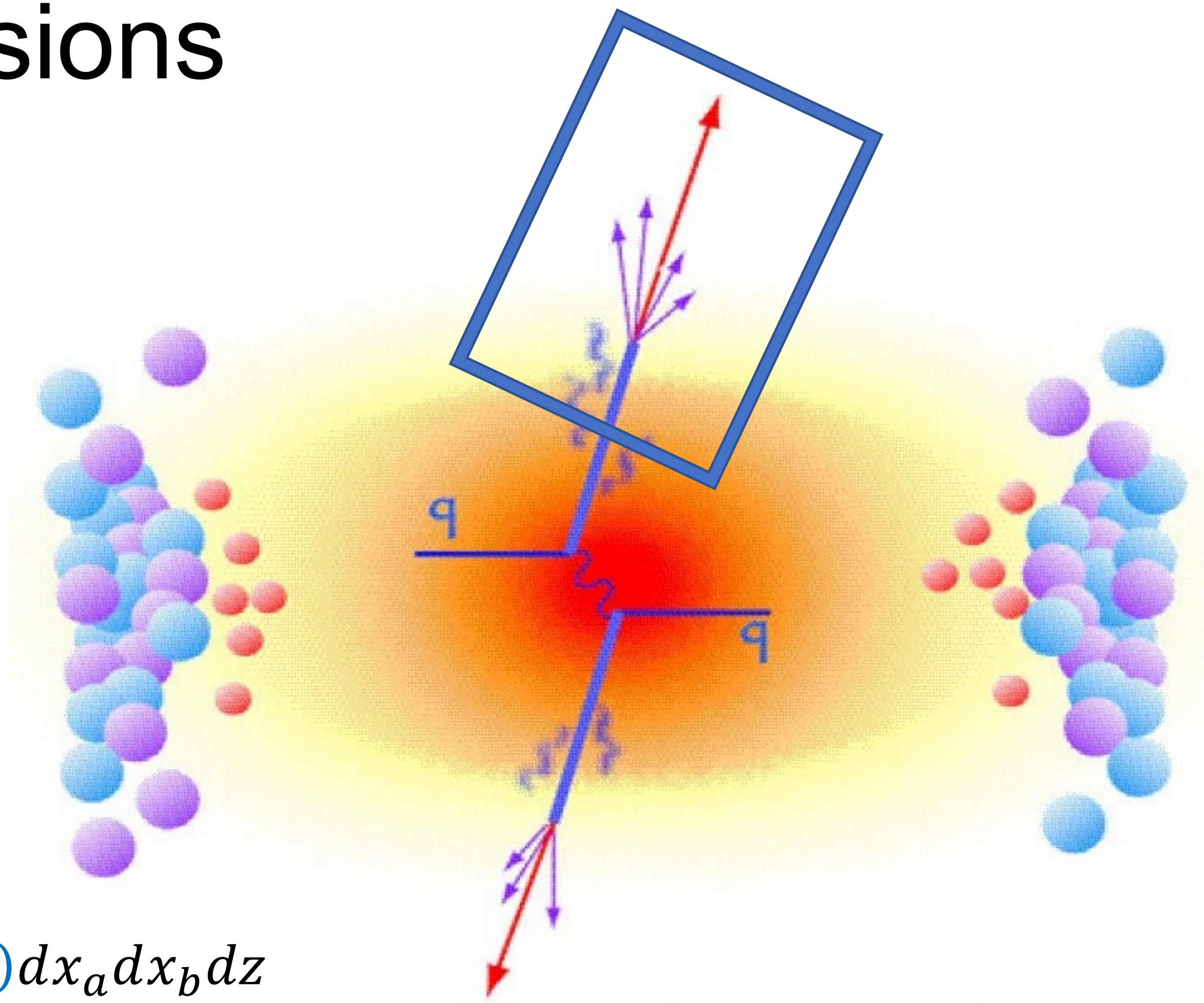
# Jets in Heavy Ion Collisions

- Presence of medium modifies parton kinematics
- Jets acts as experimentally accessible proxies for partons
- Measurement of jet modification allows us to measure partonic energy loss



Heavy Ion Collision

Differential cross section

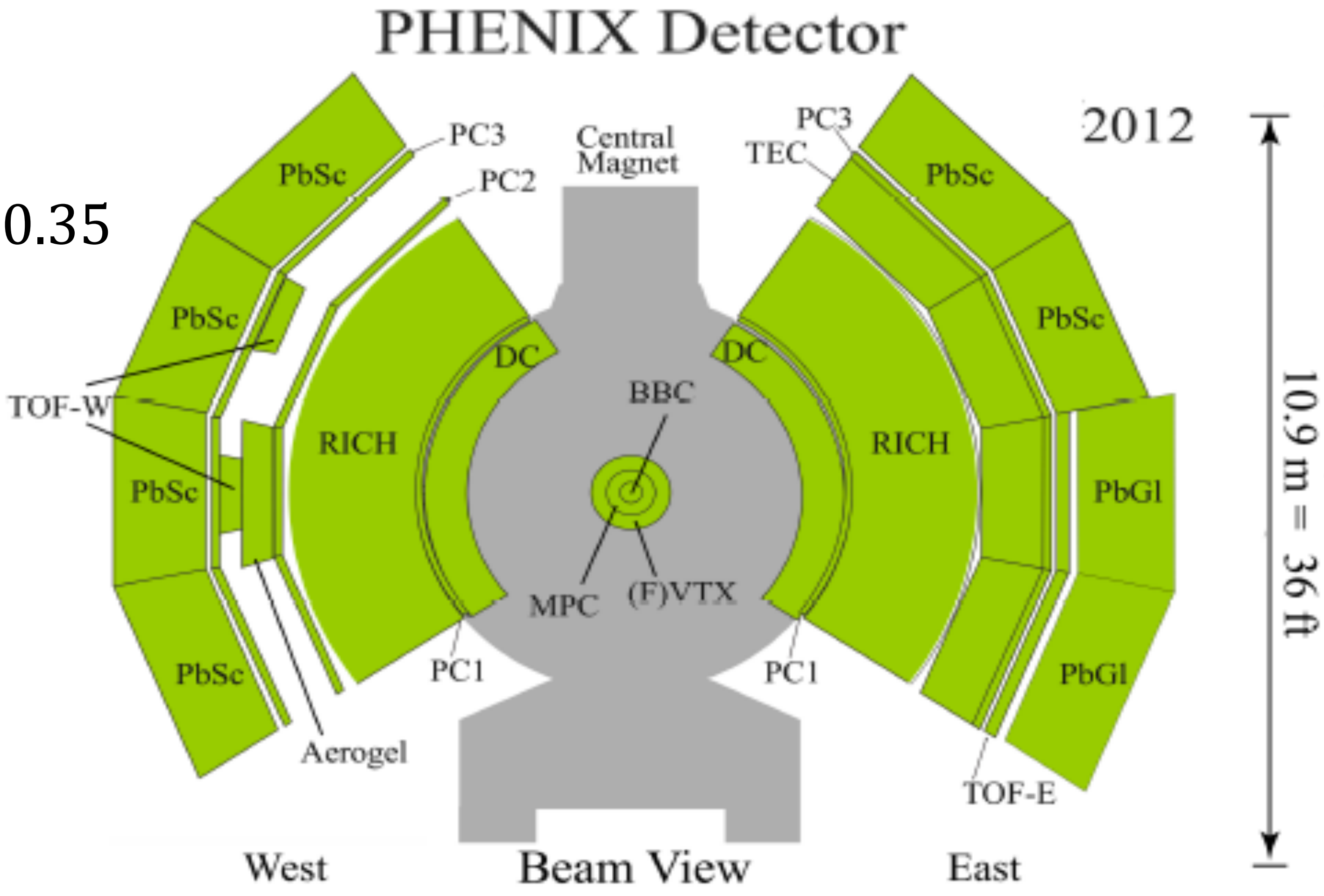
$$d\sigma = \int\int\int f_a^A(x_a) f_b^B(x_b) \cdot d\sigma_{ab\to cX} \cdot D_c^h(z) dx_a dx_b dz$$

Modification

$D_c^h(z) \to D_c^h(z')$ as $p^{Parton} \to p'^{Parton}$

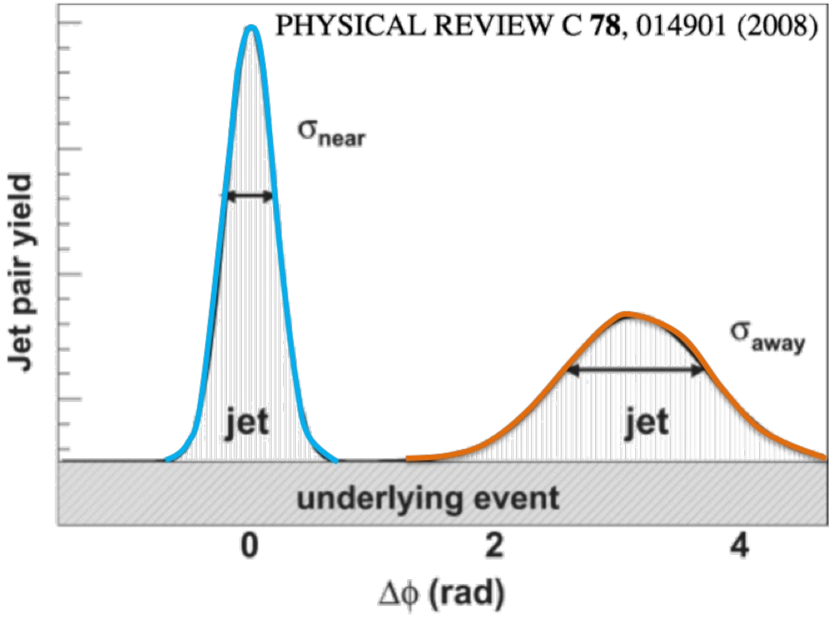
# The PHENIX Detector

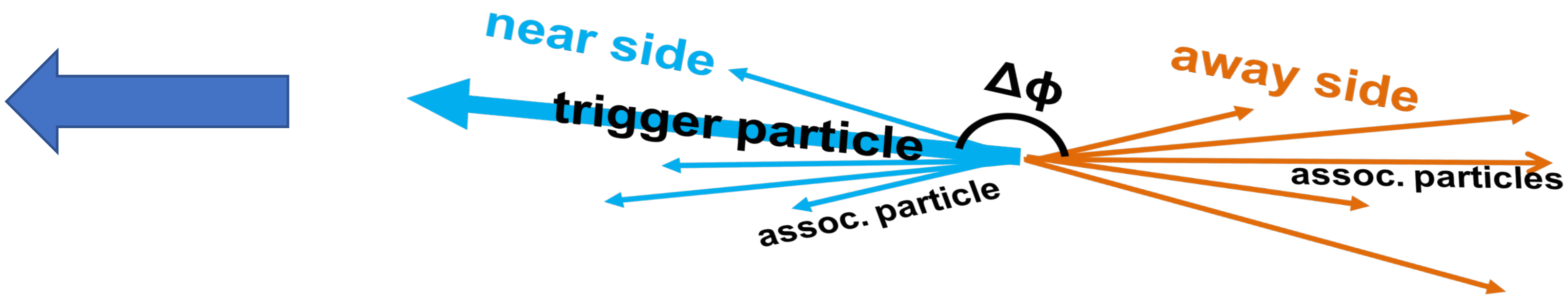
- Central arms
  - $\pi$ coverage in azimuth
  - Pseudorapidity coverage of $|\eta| < 0.35$
- Electromagnetic calorimeter
  - Photon and electron energy
- Drift/Pad chambers
  - Charged hadron momentum
- Beam-beam counters (BBC)
  - Event characterization



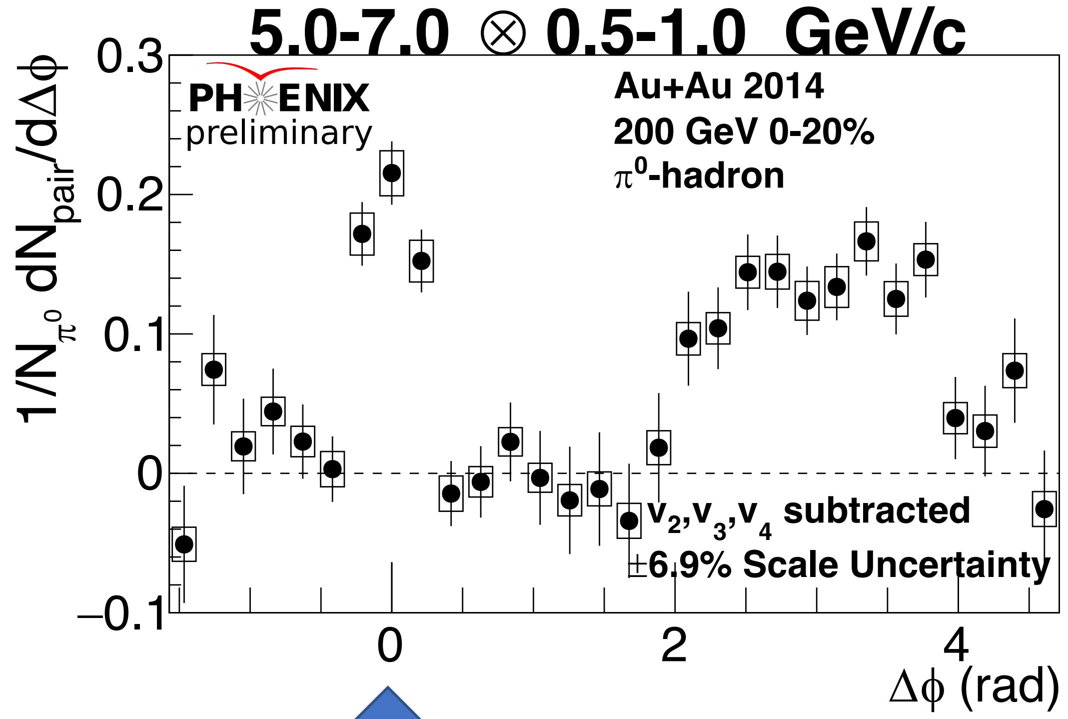
# Measuring Jets – Two Particle Correlations

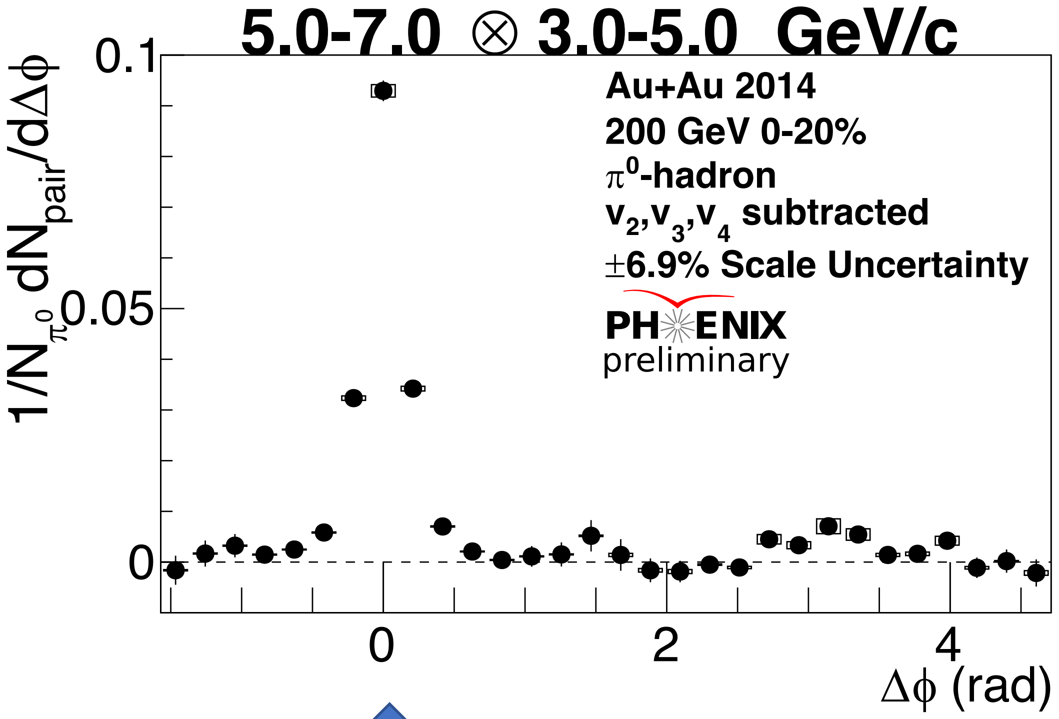
- Pick a high momentum trigger particle (trigger≈jet)
- Correlate all the charged hadrons in the event to it



# Extracted $\pi^0$–Hadron Jet Functions

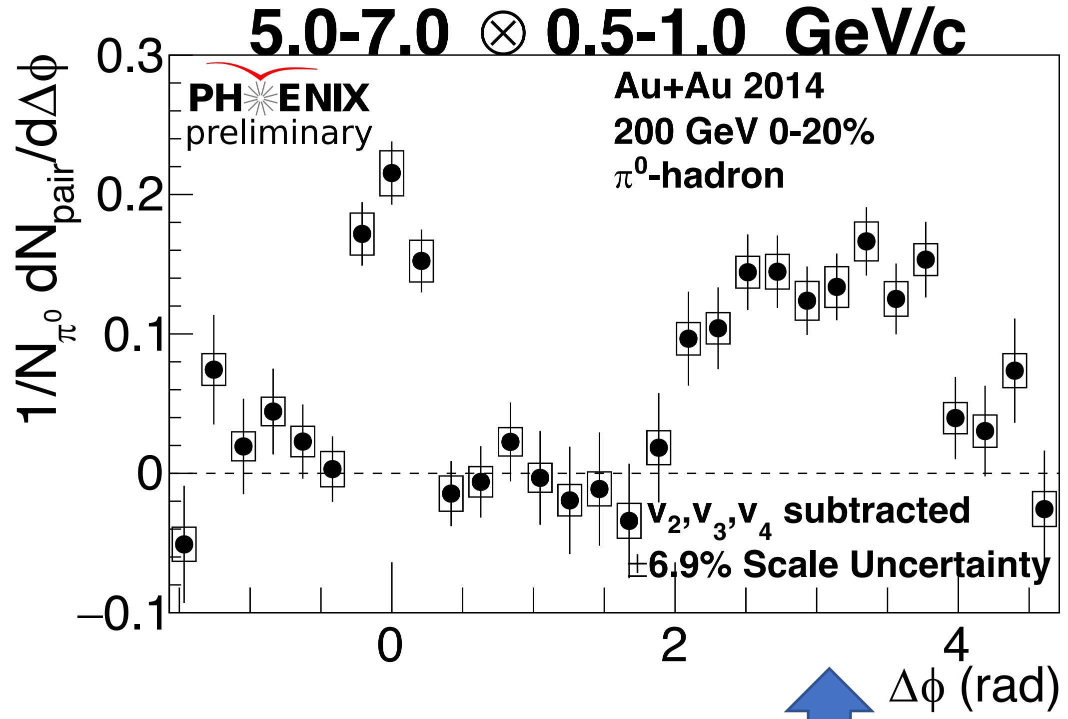


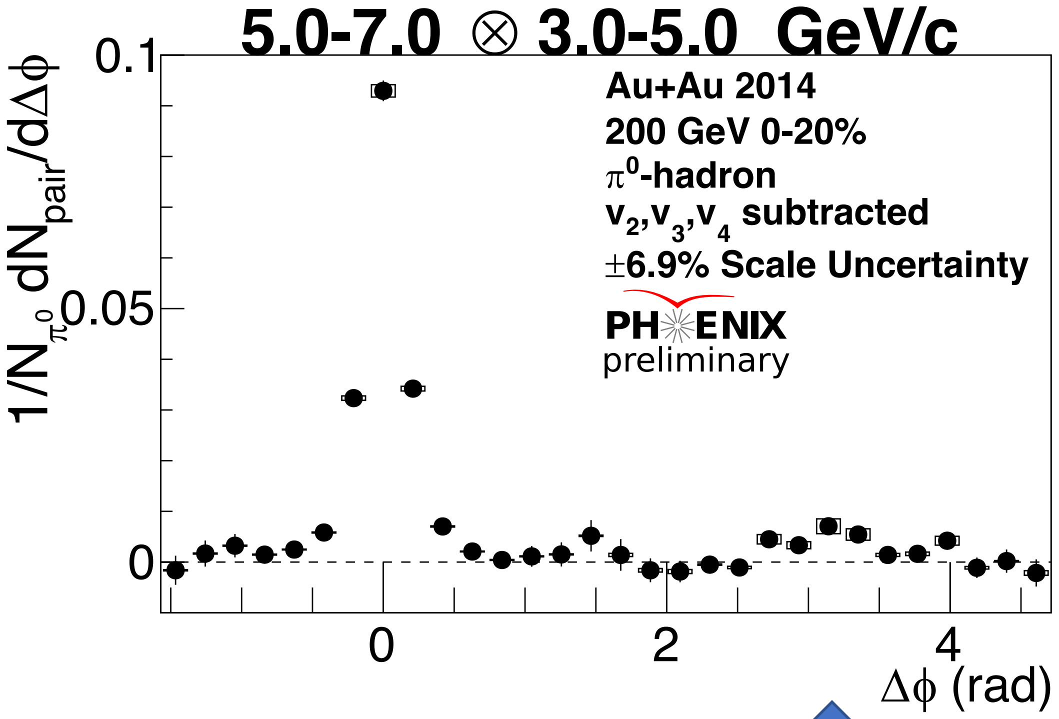




$\Delta\phi = 0 \rightarrow$ Near-side peak

Location of jet containing $\pi^0$

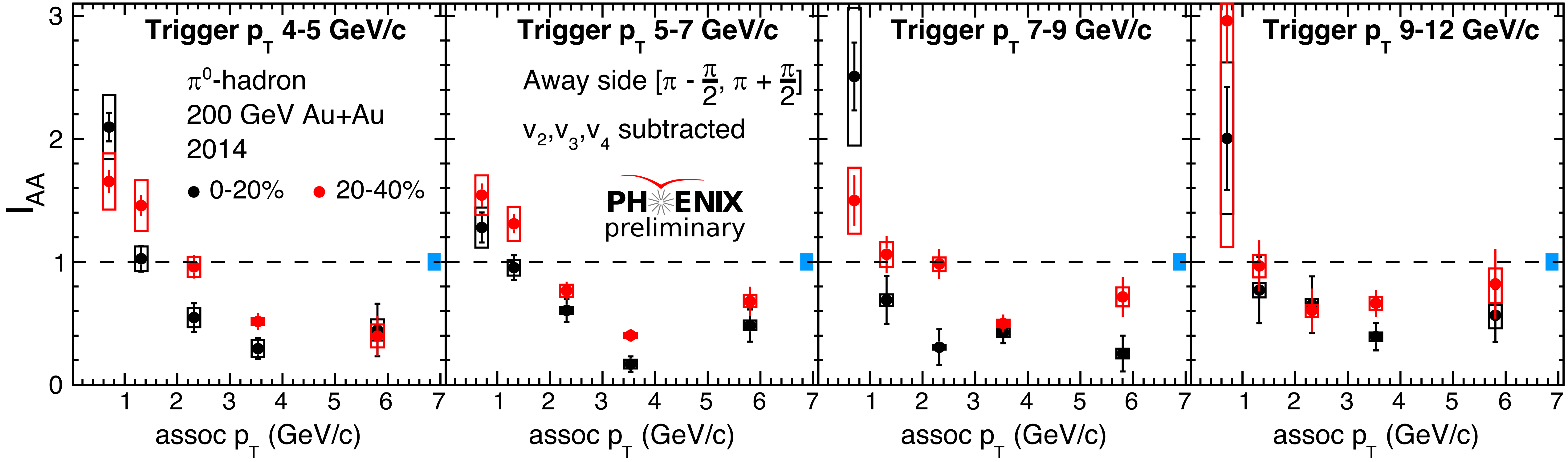
# Extracted $\pi^0$–Hadron Jet Functions



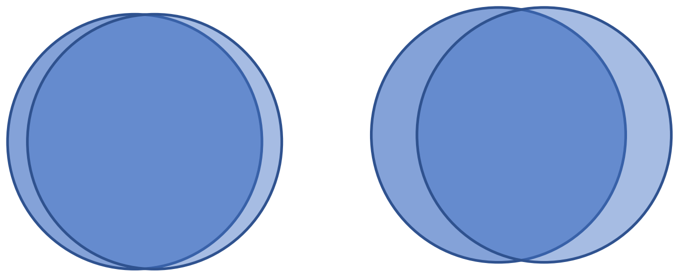




$\Delta\phi = \pi \rightarrow$ Away-side peak
Location of recoil jet

# $\pi^0$-Hadron Correlations - $I_{AA}(p_T)$



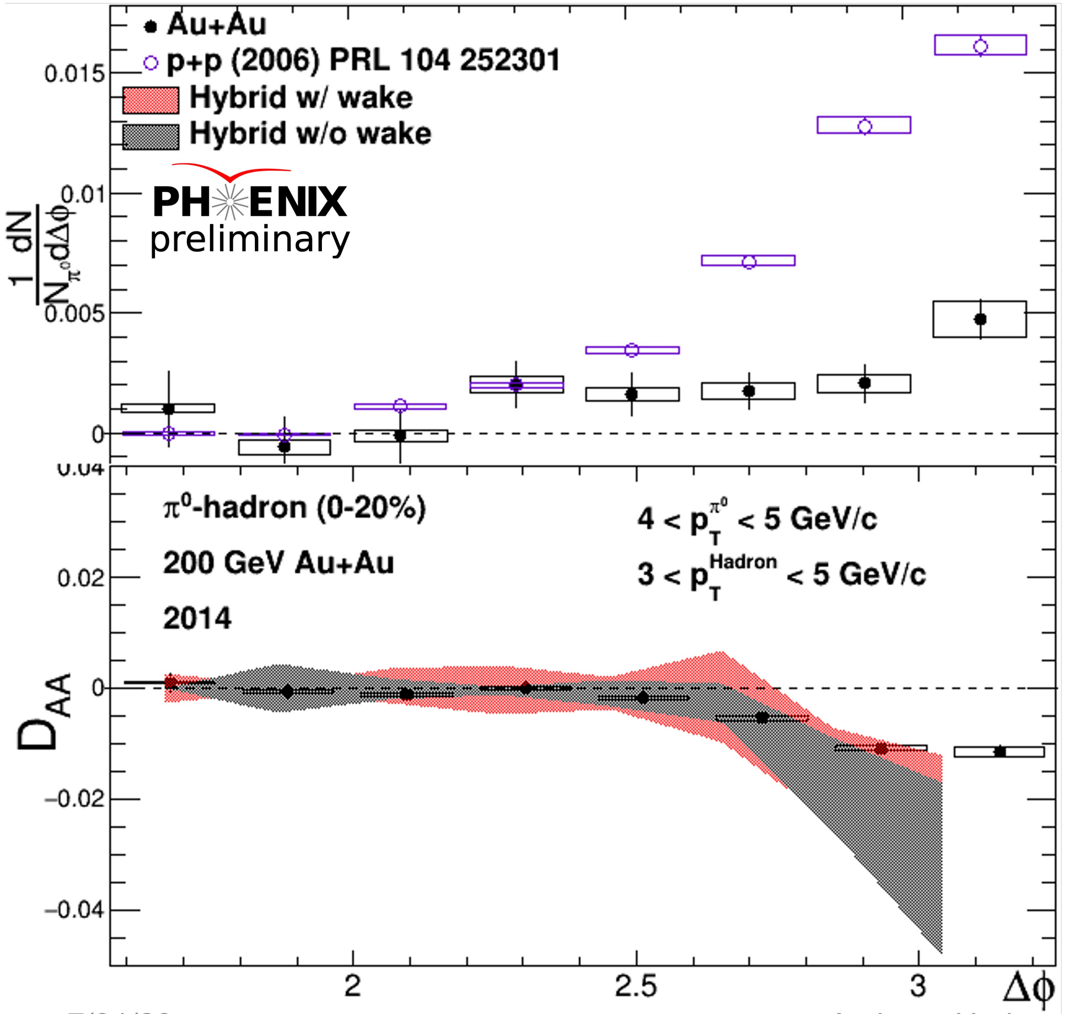

$$I_{AA} = \frac{Y^{AA}_{Away}}{Y^{pp}_{Away}}$$

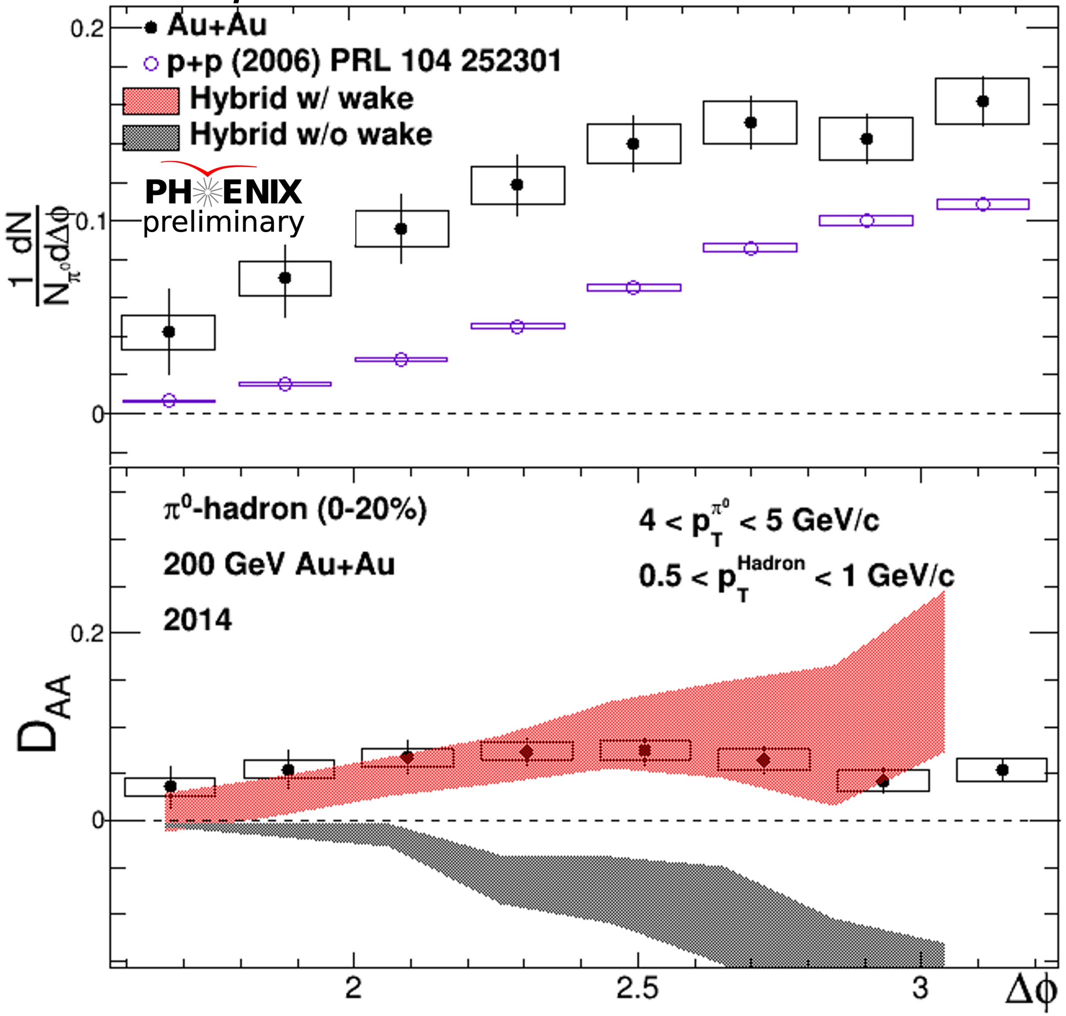



- Enhancement of yield ($I_{AA} > 1$) at low associate particle momentum
- Depletion ($I_{AA} < 1$) at high associate particle momentum

# $\pi^0$-Hadron Correlations - $D_{AA}$ vs. $\Delta\phi$

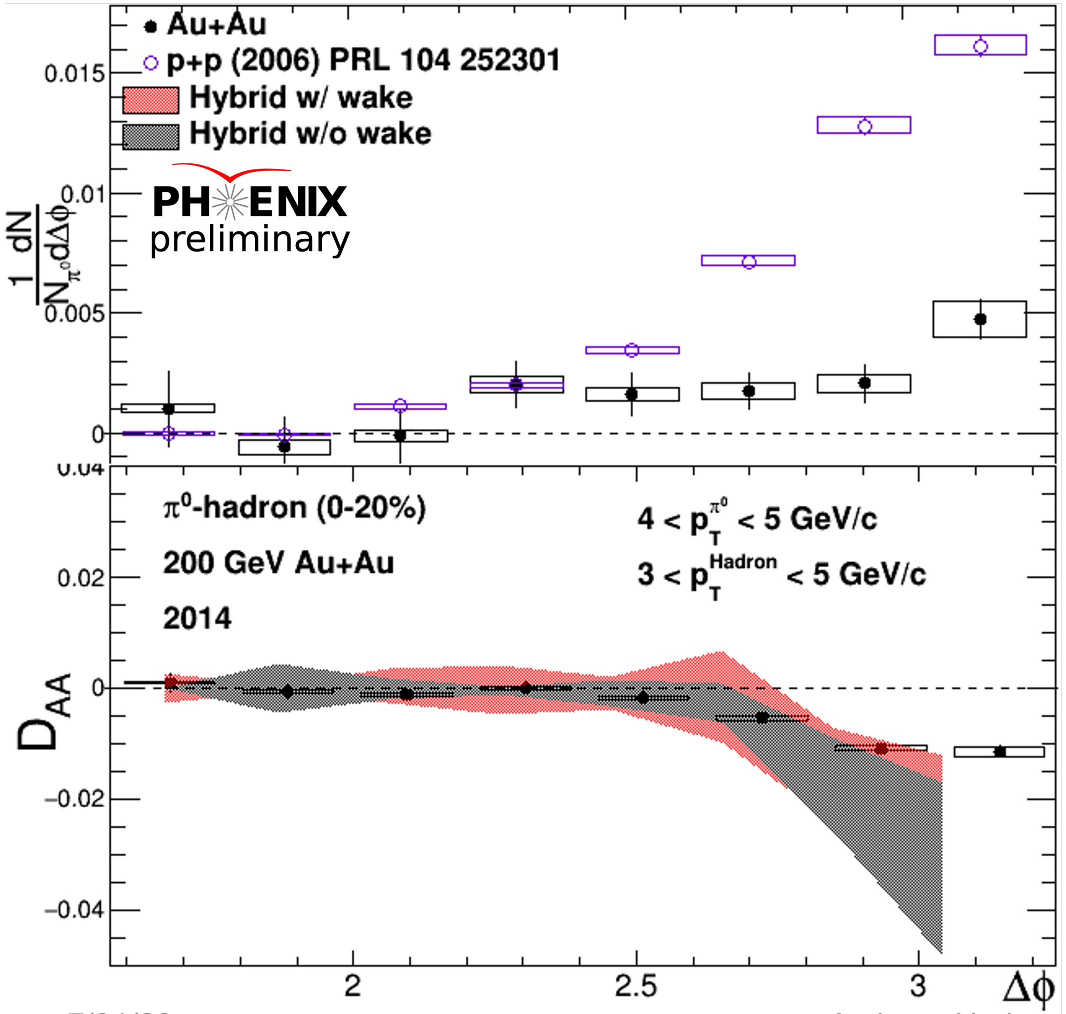
- Left: Suppression in the yield of high $p_T$ associate hadrons
  - $D_{AA}$ vs. $\Delta\phi$ shows suppression is most severe at $\Delta\phi \approx \pi$

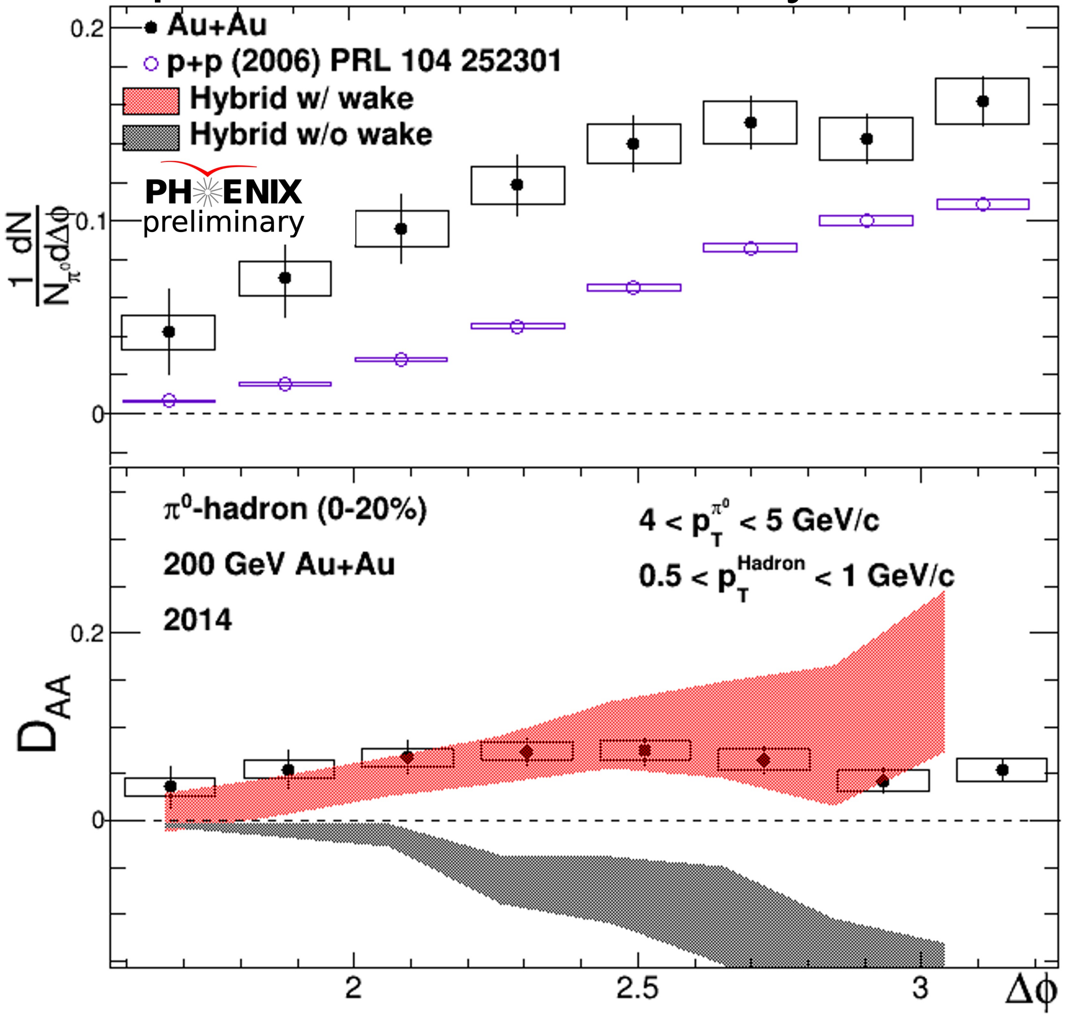


# $\pi^0$-Hadron Correlations - $D_{AA}$ vs. $\Delta\phi$

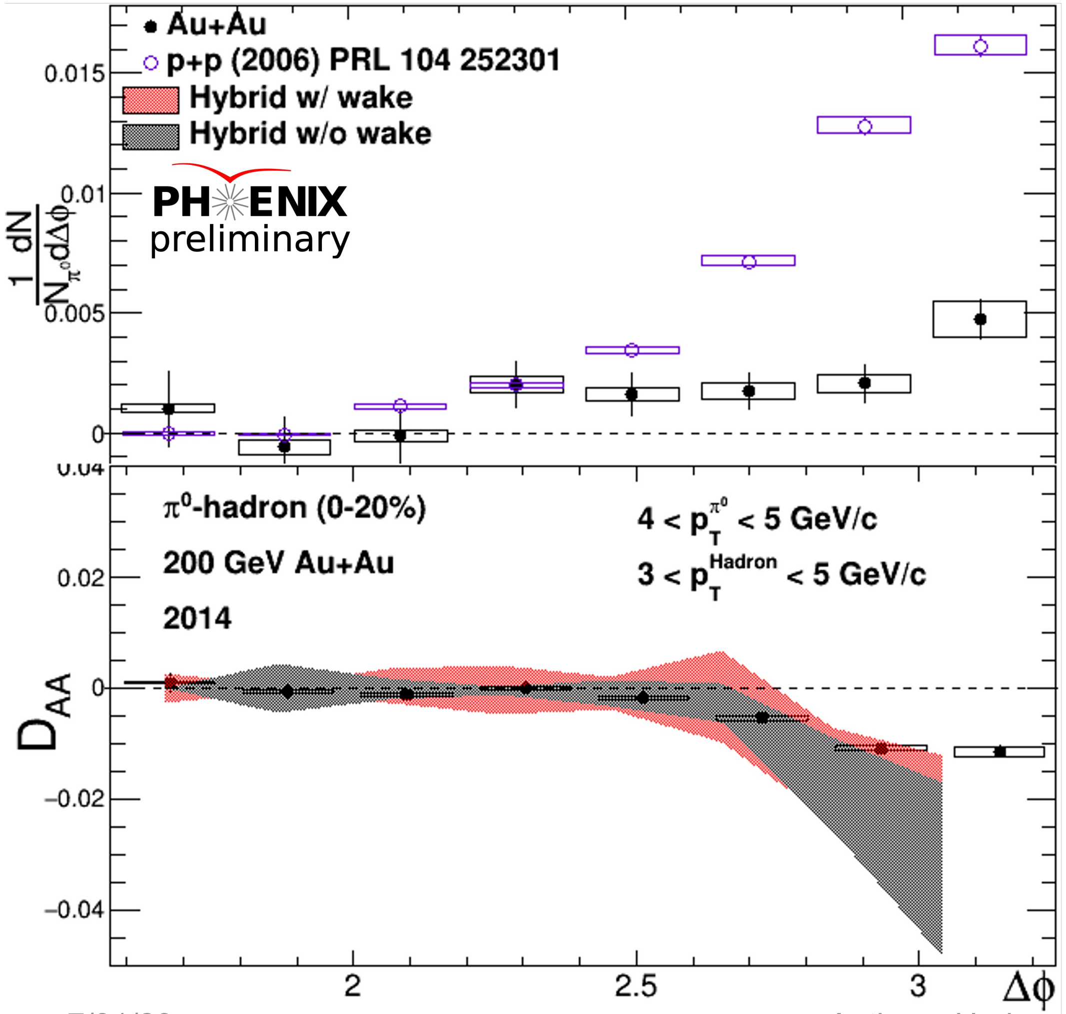
- Right: enhancement in the yield of low $p_T$ associate hadrons
  - $D_{AA}$ vs. $\Delta\phi$ shows enhancement is almost isotropic to within uncertainty

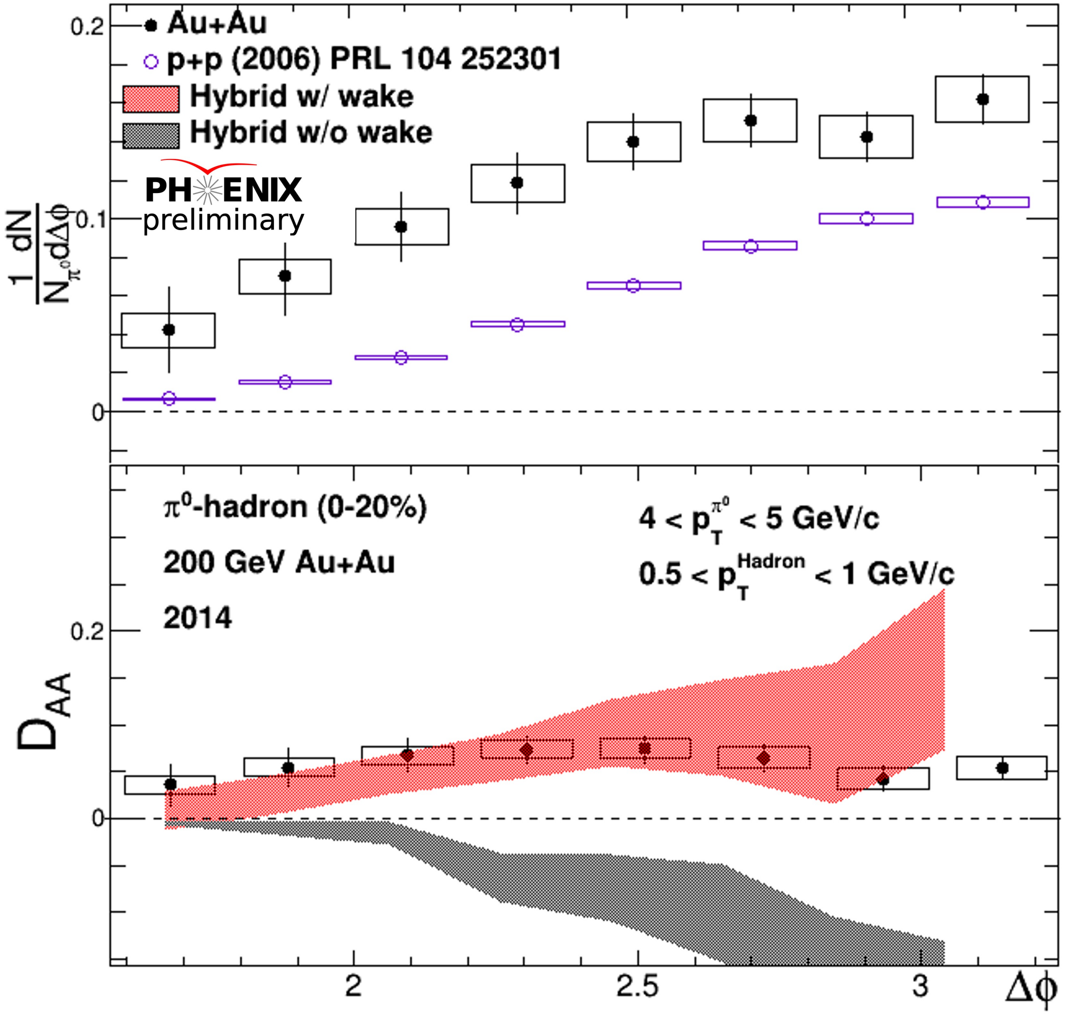


# $\pi^0$-Hadron Correlations - $D_{AA}$ vs. $\Delta\phi$

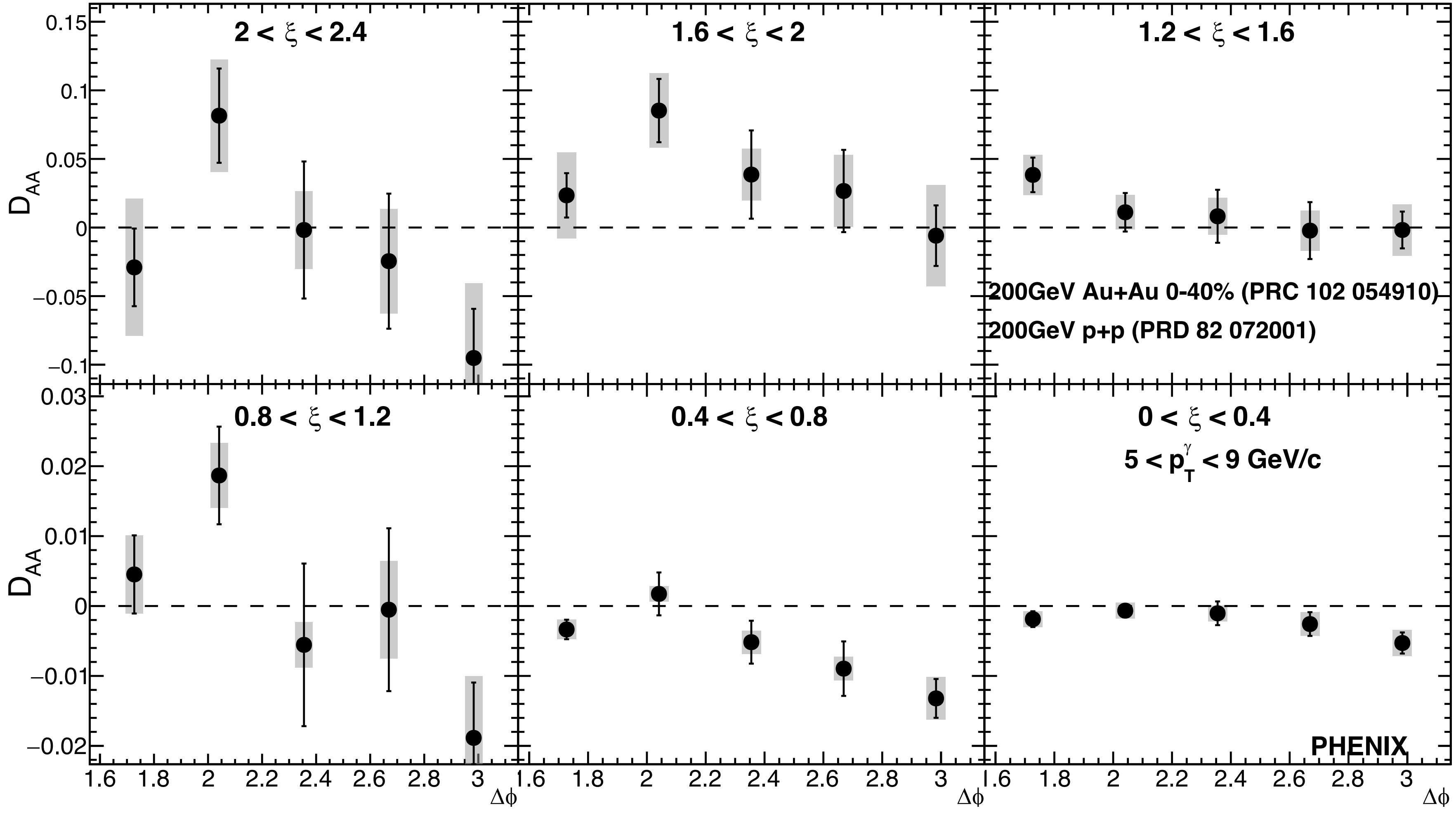
- Hybrid model (1405.3864) w/ wake of low momentum particles captures behavior data very well



# Direct photon - Hadron Correlations

- Here, direct photon takes place of $\pi^0$
- High $\xi \rightarrow$ low $p_T$
- Low $\xi \rightarrow$ high $p_T$
- Similar trends of enhancement and suppression
- Improvement possible by inclusion of later PHENIX data sets



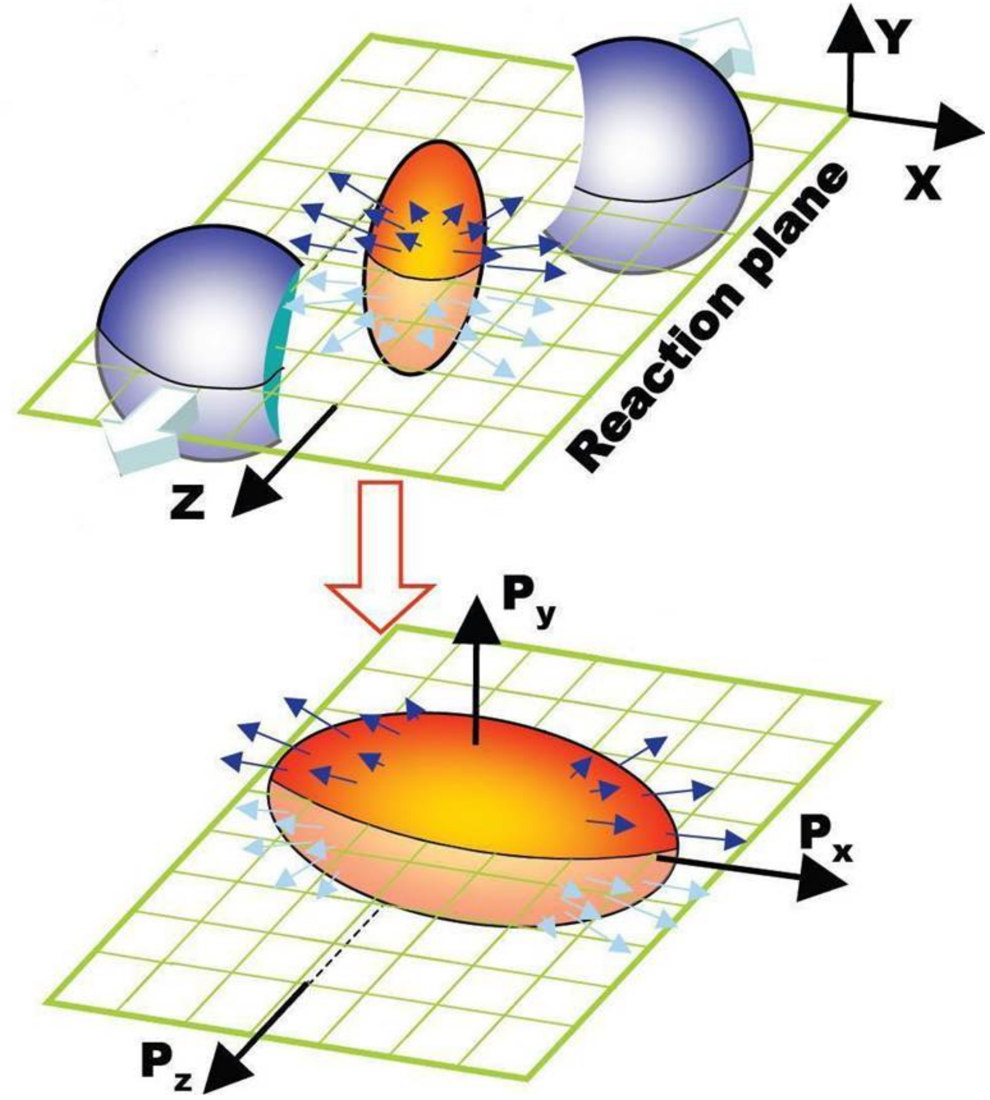

$$\xi = \ln\left(\frac{1}{p_T}\right)$$

# Back-up

# Underlying Event – Flow

$$\frac{dN}{d\Delta\phi} = b(1 + 2\sum \langle \boldsymbol{v_n^t} \rangle \langle \boldsymbol{v_n^a} \rangle \cos(n\Delta\phi))$$

- Model background as Fourier series in $\Delta\phi$-space
- $v_n$ terms quantify background shape, come from previous PHENIX analyses
    - Phys. Rev. Lett. 105, 142301
    - Phys. Rev. C 99, 054903

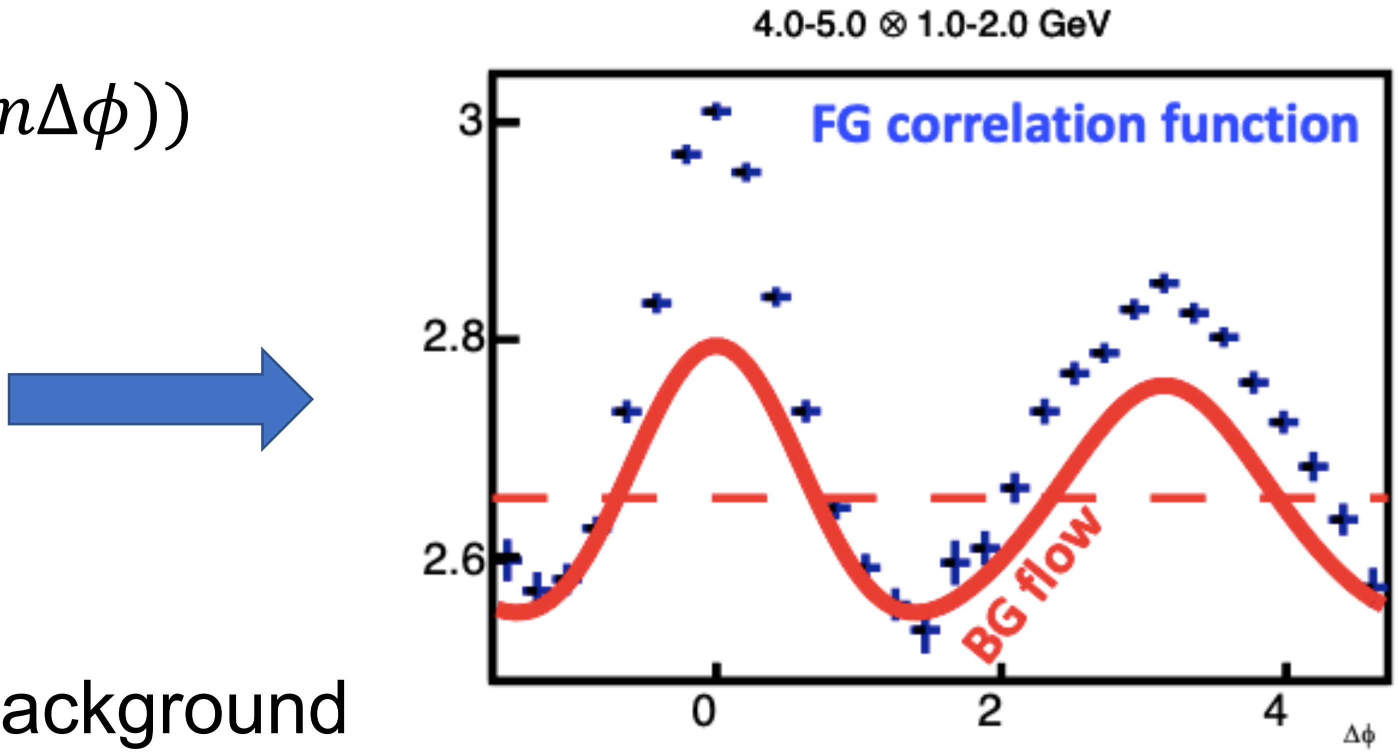



The Direct Photon Puzzle | K. Reygers

# Underlying Event – Flow

$$\frac{dN}{d\Delta\phi} = \boldsymbol{b}(1 + 2\sum\langle v_n^t\rangle\langle v_n^a\rangle\cos(n\Delta\phi))$$

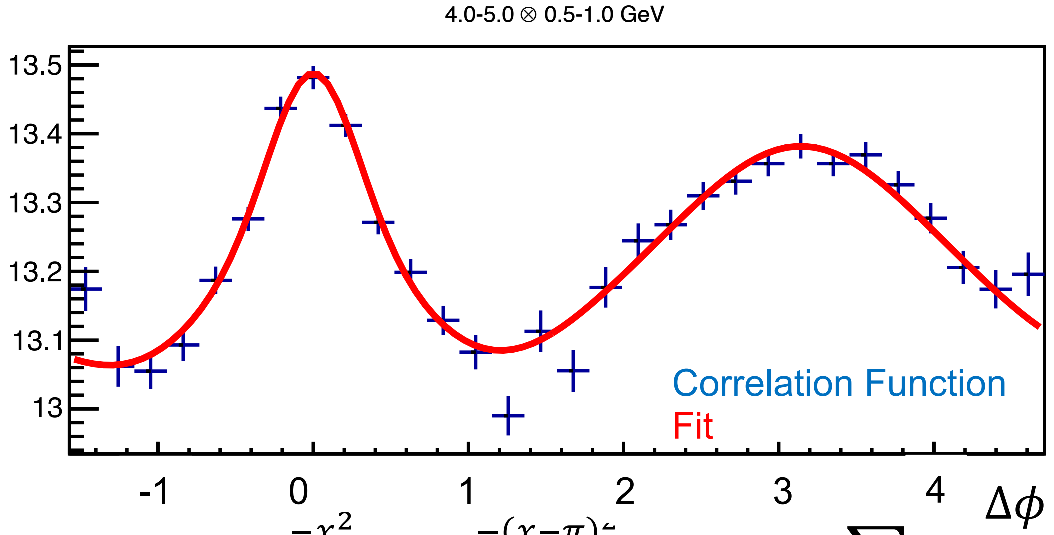
$$b = \frac{\xi\langle N_{Trig}\rangle\langle N_{h^\pm}\rangle}{\langle N_{Pairs}\rangle}$$

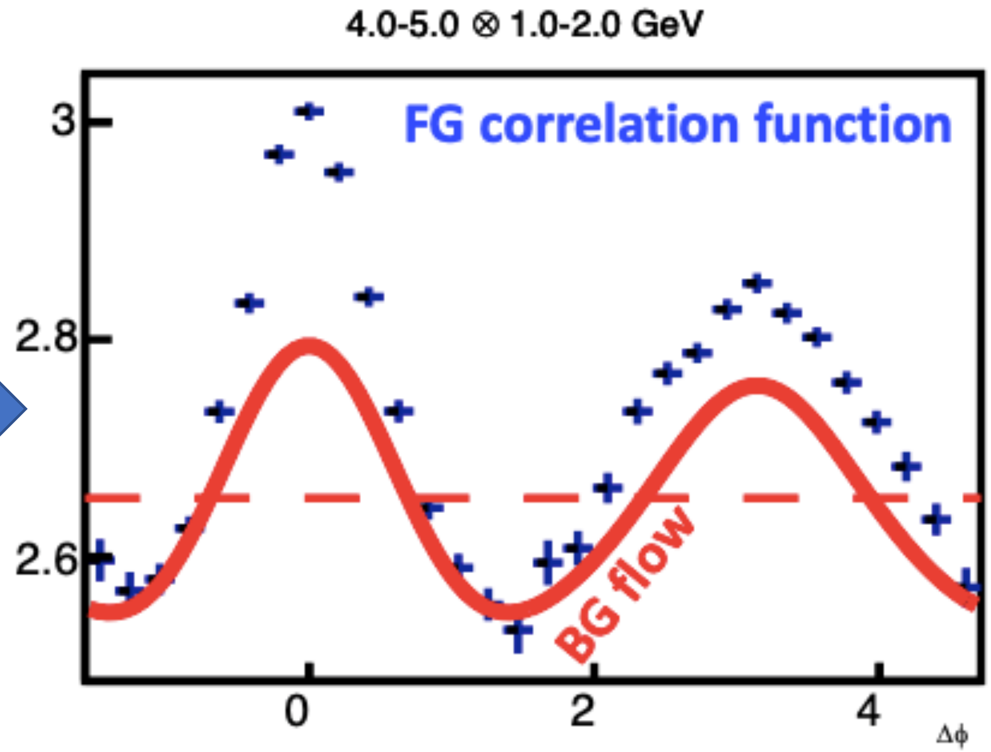



- Amplitude given by Absolute Background Subtraction method for $p_T^{Hadron} > 1$GeV/c
  - Phys. Rev. C **81**, 014908

# Underlying Event – Flow

$$\frac{dN}{d\Delta\phi} = \boldsymbol{b}(1 + 2\sum\langle v_n^t\rangle\langle v_n^a\rangle\cos(n\Delta\phi))$$



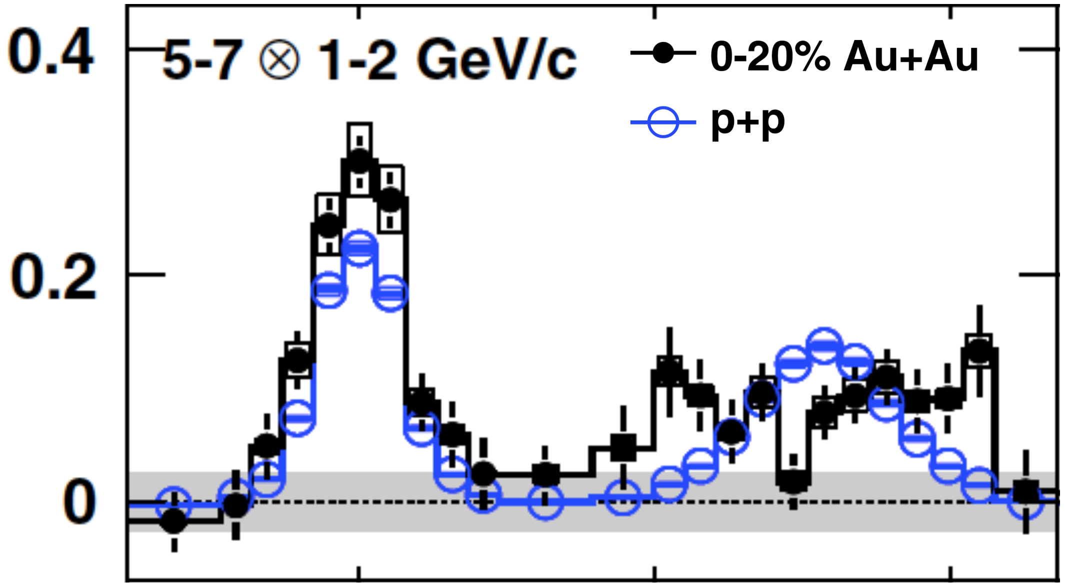

$$Corr(\Delta\phi) = Ae^{\frac{-x^2}{C}} + De^{\frac{-(x-\pi)^2}{E}} + \boldsymbol{b}(1 + 2\sum\langle v_n^t\rangle\langle v_n^a\rangle\cos(n\Delta\phi))$$

- $b$ from ZYAM (Zero Yield At Minimum) for $p_T^{Hadron} < 1$GeV/c to account for over-subtraction

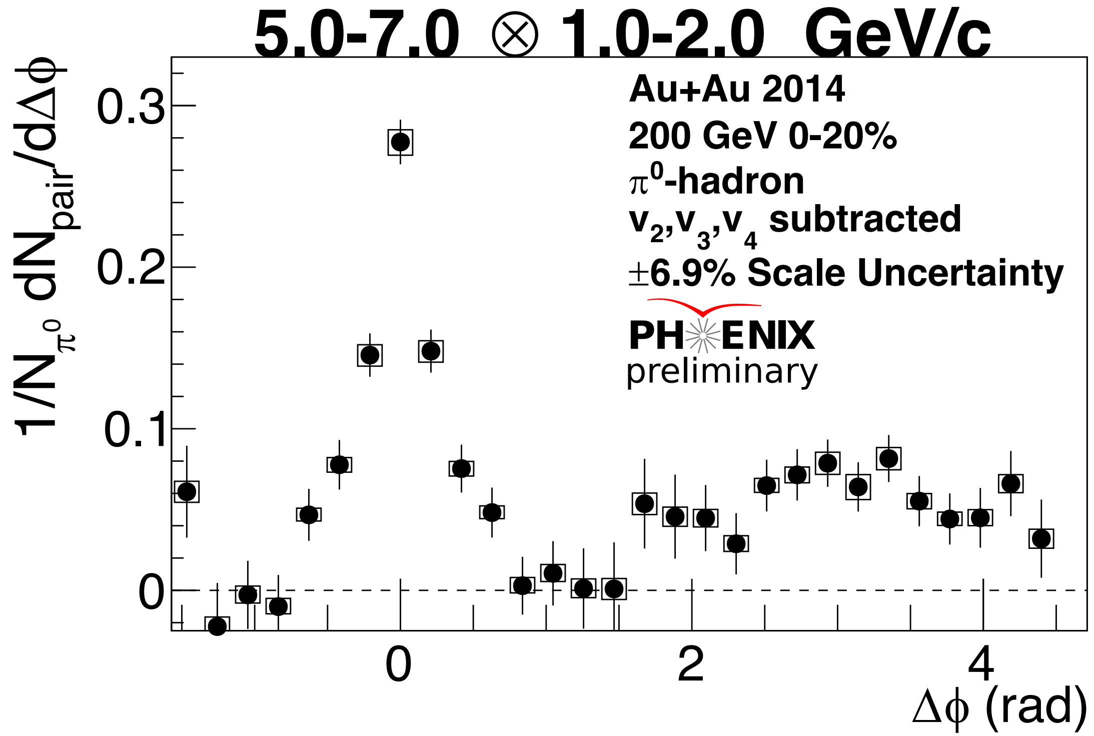
# Improved Background Subtraction

## Previous

PRL 104 252301 (2010)

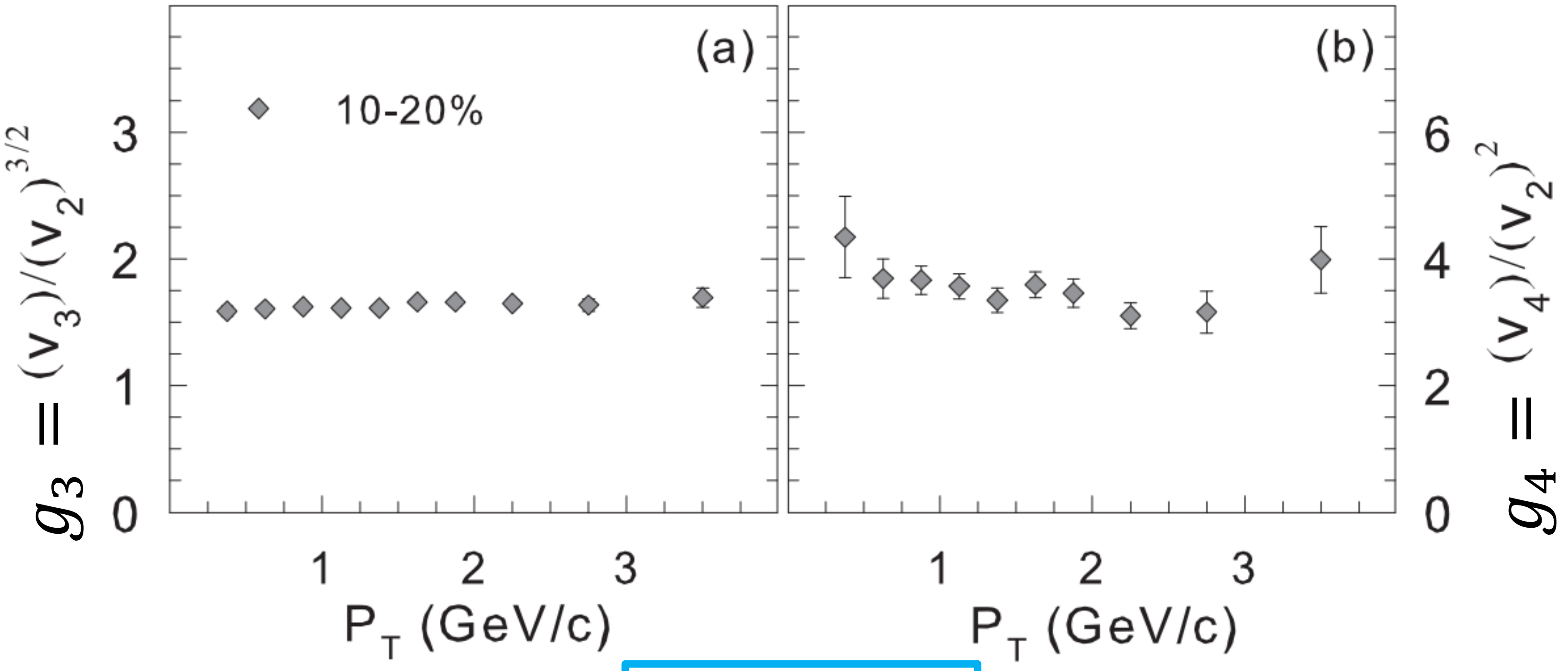



## New




- New results (right) from data from 2014, 3.3x more trigger $\pi^0$'s
- $v_2$ ,$v_3$ ,and $v_4$ subtracted in new results → flow contamination removed

# Flow Subtraction – Acoustic Scaling

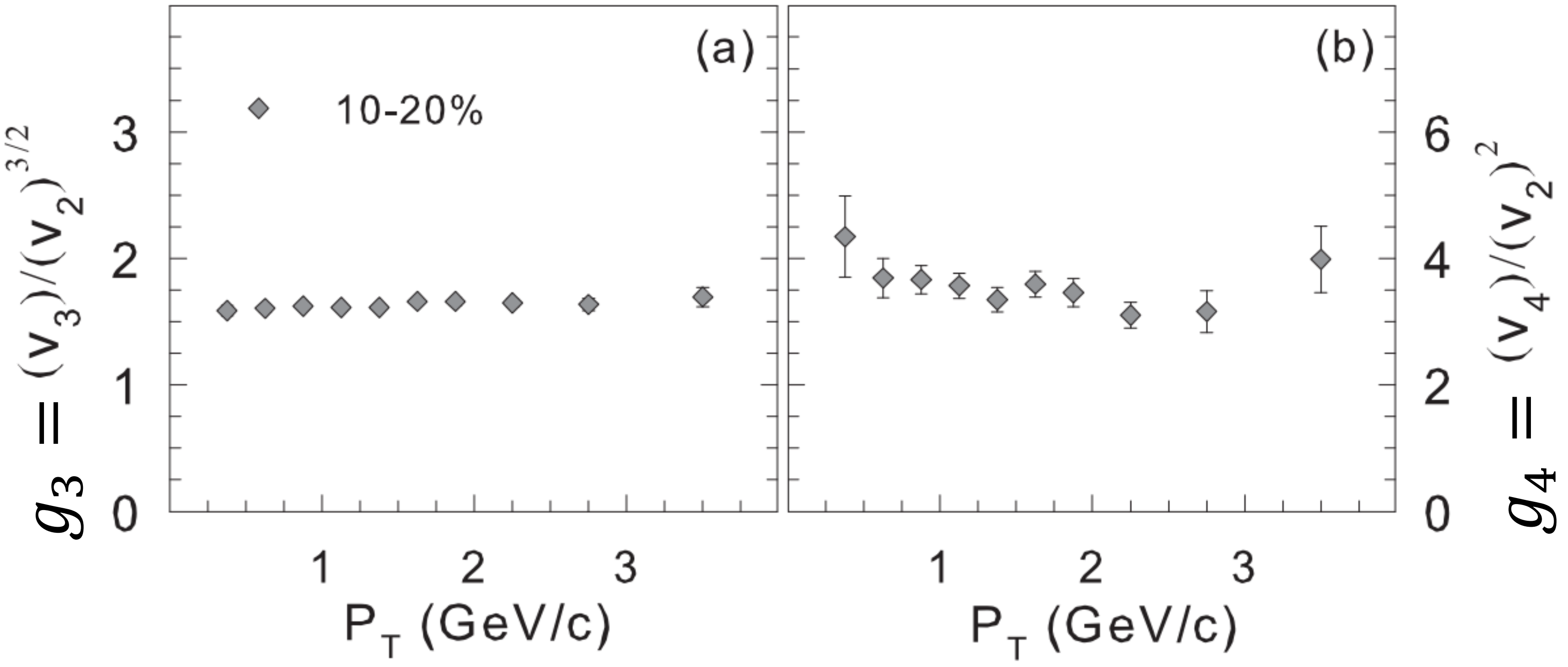



$$g_n = \frac{v_n}{(v_2)^{n/2}}$$

arXiv:1105.3782v2

- Have charged hadron $v_n^a$ for $(n = 2{,}3{,}4)$ from PHENIX results
- No $\pi^0$ $v_3$ or $v_4$ measured at RHIC energies
- $v_n$ harmonics can be scaled to one another via value $g_n$

# Flow Subtraction – Acoustic Scaling




arXiv:1105.3782v2

$$v_n^{\pi^0} = g_n^h \left(v_2^{\pi^0}\right)^{n/2}$$

- Can calculate $\pi^0$ $v_3, v_4$ by scaling $\pi^0$ $v_2$ with charged hadron $g_n$