Azimuthal two-particle correlations at high transverse momenta in p-p and Au-Au collisions at RHIC

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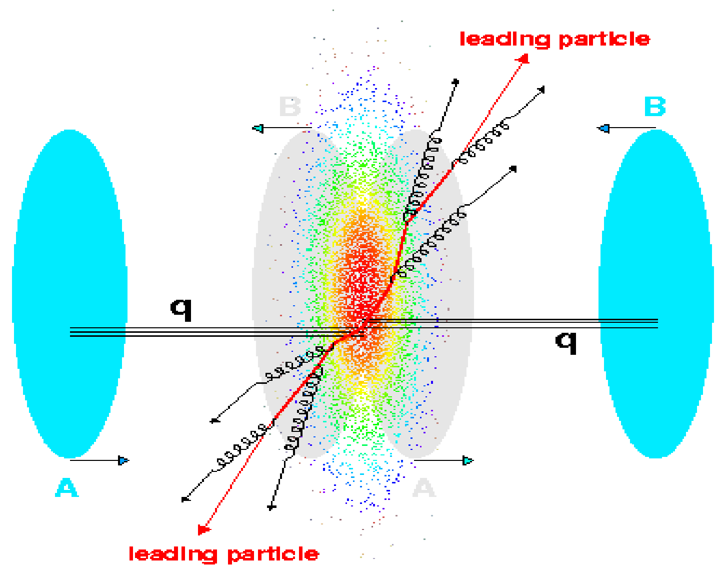
Outline

- Sources of two-particle azimuthal correlations
- Jet shape in pp data:
  - $\langle |j_{\perp y}| \rangle$ and $\langle |k_{\perp y}| \rangle$ measurements
  - comparison with previous measurements
- Jet shape in AuAu data:
  - $p_\perp$ dependence of near-angle width: $j_\perp$-scaling
  - centrality dependence of near-angle width: broadening

Main sources of two-particle correlations

JETS
(p-p,Au-Au)



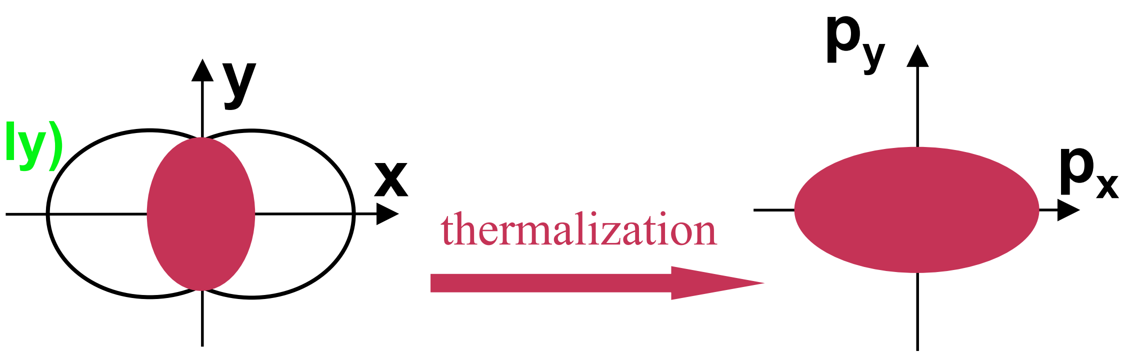
Hard scatterings:

- high Q^2 transfer - small α_s (pQCD)
- early in collision - probe early stages

Produce jets of hadrons by fragmentation:

- near-angle and back-to-back azimuthal correlations
- broadened by interaction with the hot QCD medium via dE/dx (gluon radiation)

FLOW
(Au-Au only)



$$\varepsilon = \frac{\langle y^2 - x^2 \rangle}{\langle y^2 + x^2 \rangle}$$

$$v_2 = \frac{\langle p_x^2 - p_y^2 \rangle}{\langle p_x^2 + p_y^2 \rangle}$$

Spatial azimuthal anisotropy in the initial state → pressure gradients → elliptic flow momentum pattern in the final state

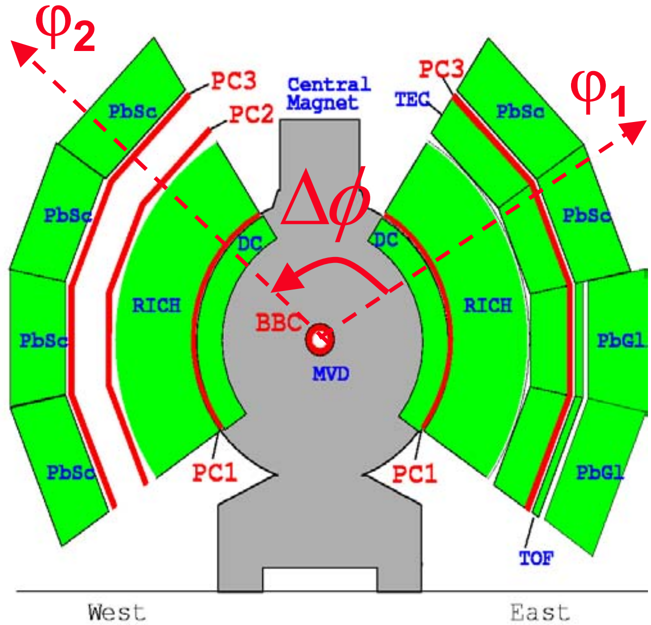
Correlation Functions in p-p Collisions

Fixed-$p_\perp$ correlation function (mixed event technique):

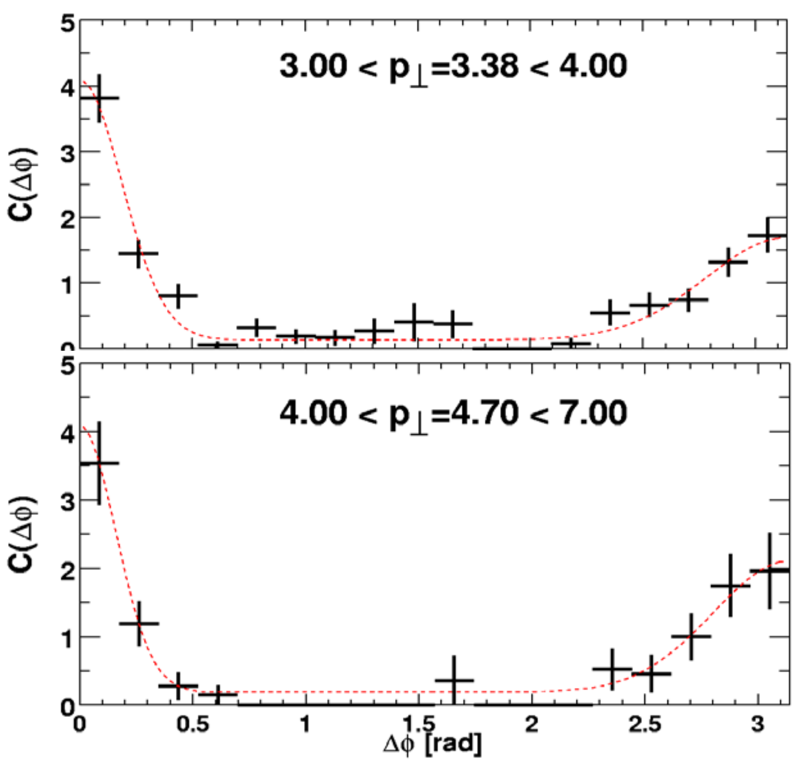
$$C(\Delta\phi) = \frac{N_{real}(\Delta\phi)}{N_{mixed\ events}(\Delta\phi)} \quad (3)$$

$$\Delta\varphi \equiv |\varphi_1 - \varphi_2|$$

$$\langle p_{\perp 1}\rangle = \langle p_{\perp 2}\rangle$$

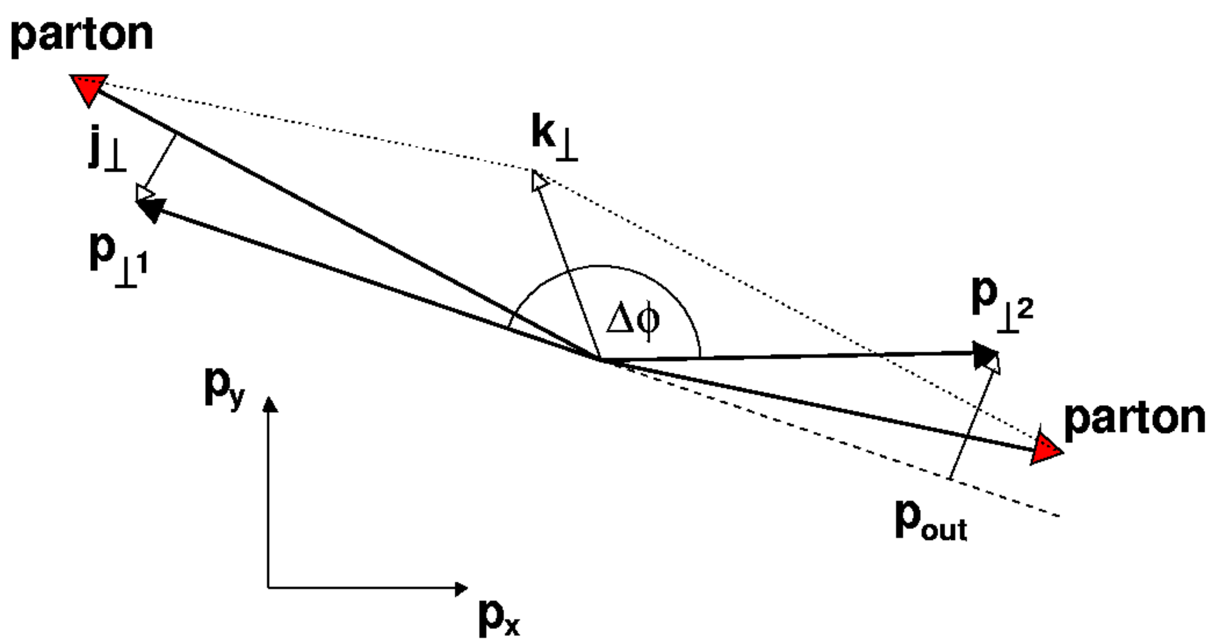


Run2 p-p: 120M min-bias events and 50M events triggered on energy deposited in the Electromagnetic Calorimeter.



$$N + Gaus\ (\Delta\varphi = 0, \sigma_N) + Gaus\ (\Delta\varphi = \pi, \sigma_F)$$

Jet Shape Parameters



Which are fitted to extract the near-angle width σ_N and far-angle width σ_F. Then, jet-shape parameters are extracted (we give here only the high $p_\perp$ formulae):

- jet fragmentation transverse momentum

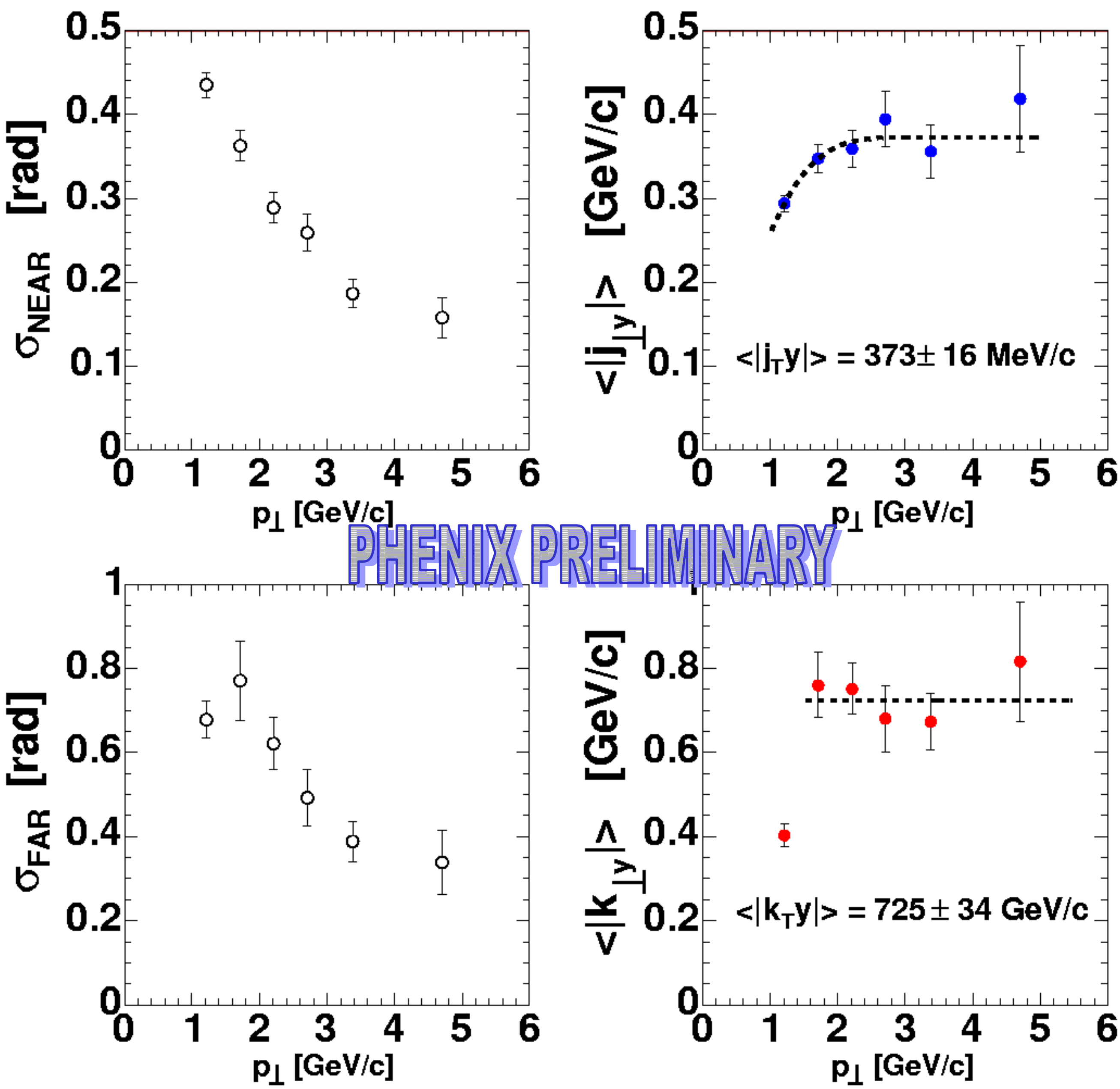
$$\langle |j_{\perp y}| \rangle \approx \frac{1}{\sqrt{\pi}} \langle p_\perp \rangle \sigma_N$$

- parton transverse momentum

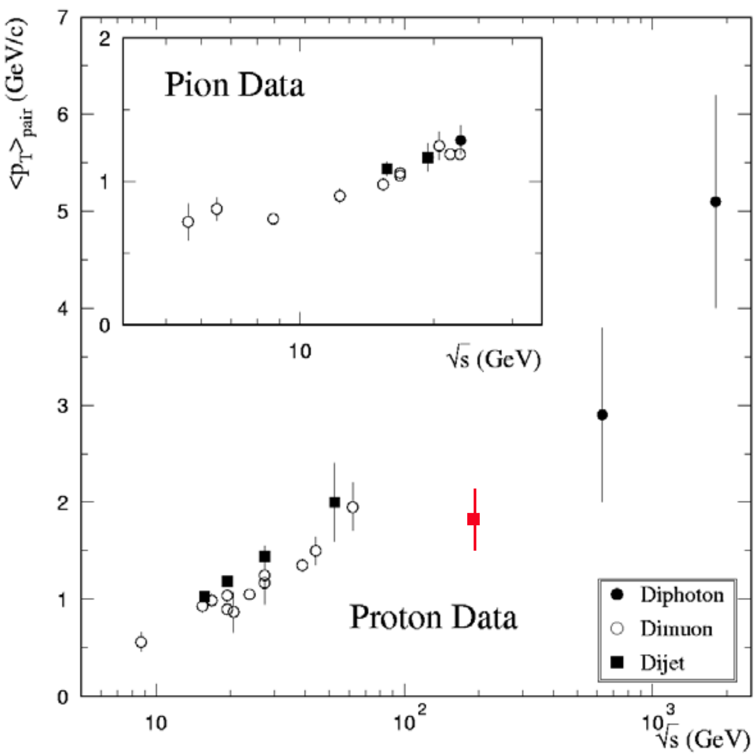
$$\langle |k_{\perp y}| \rangle \approx \frac{1}{\sqrt{\pi}} \langle p_\perp \rangle \sqrt{\sigma_F^2 - \sigma_N^2}$$

New developments of the $<|k_{\perp y}|>(\sigma_F)$ formula indicate that we actually measure $<z><|k_{\perp y}|>$…

Jet Shape Parameters in pp collisions

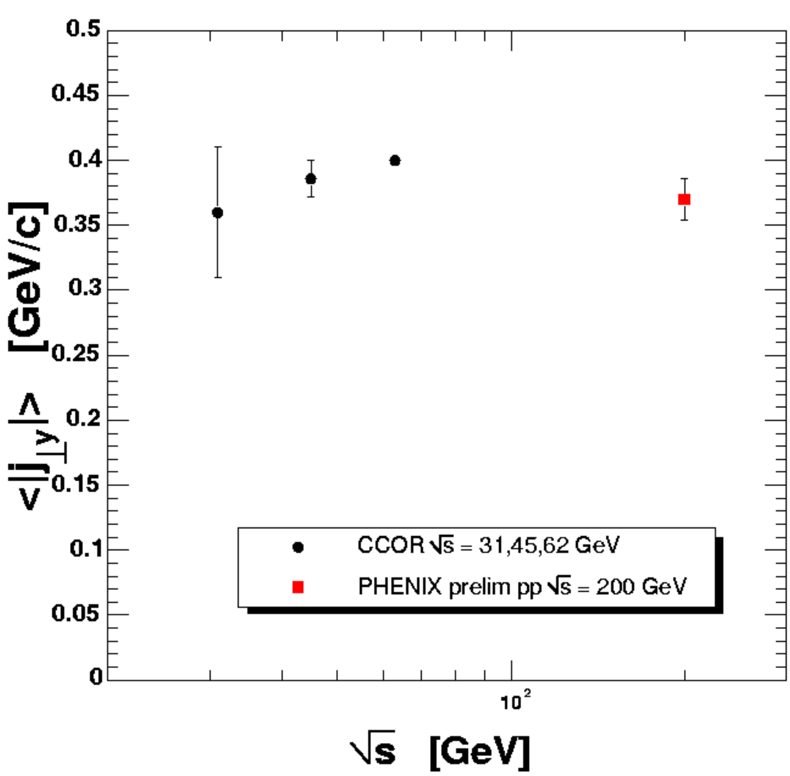


pp - Comparison with other measurements



Compilation of $<p_\perp>_{pair}$ results:
Apanasevich et al
Phys. Rev. D59(1999)074007

$$\langle p_\perp \rangle_{pair} \approx \sqrt{2}\langle k_\perp \rangle = \frac{\pi}{\sqrt{2}} \langle |k_{\perp y}| \rangle$$



CCOR Collaboration
Phys. Lett. 97B(1980)163

$<|j_{Ty}|>$ = 400 MeV/c,
independent of $p_{\perp Trig}$
for $\sqrt{s} = 31, 45, 63\, GeV$

pp Jet Shapes

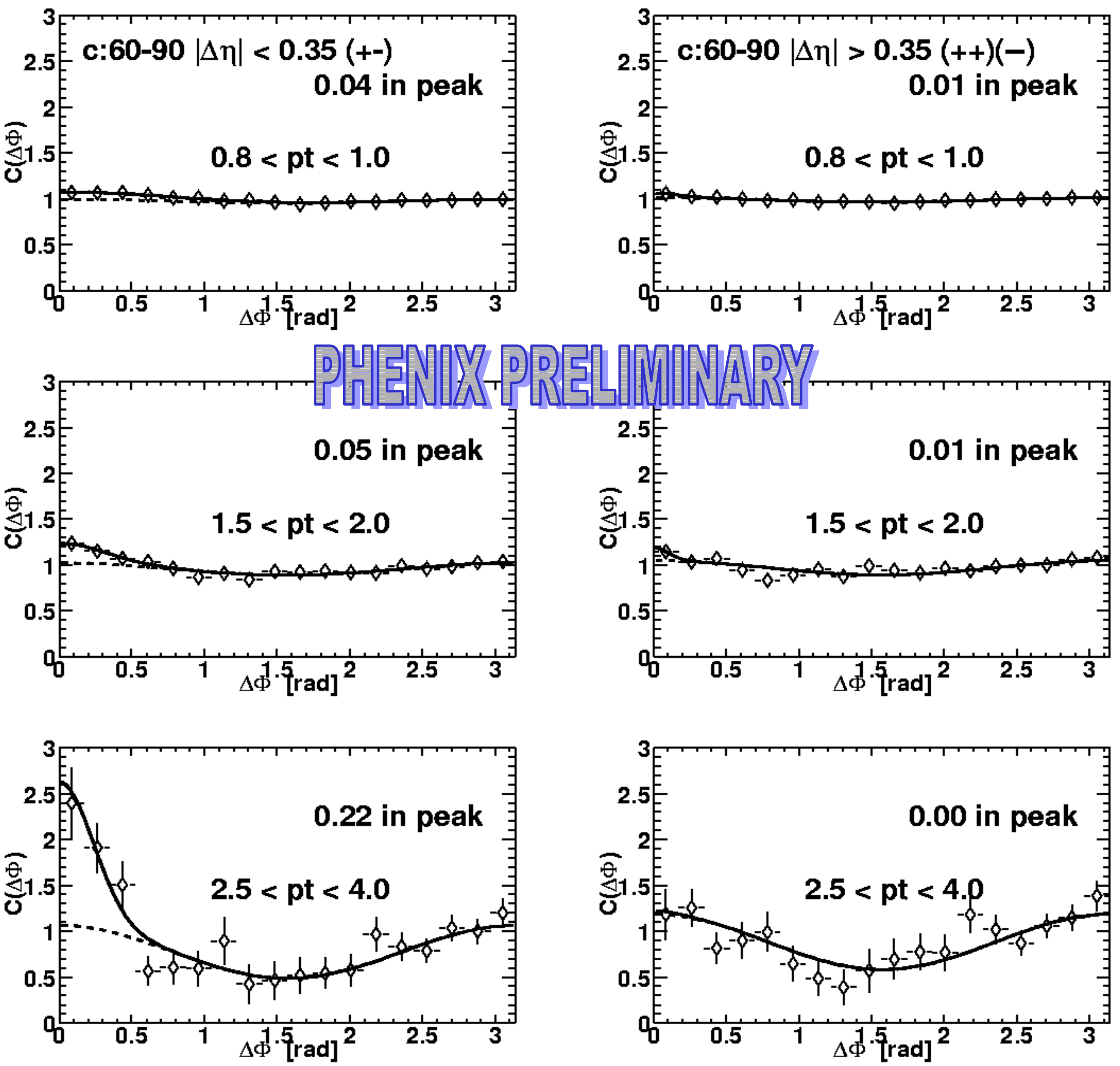
- The jet shape parameters $\langle|j_{Ty}|\rangle$ and $\langle|k_{Ty}|\rangle$ have been derived

- Comparisons with existing data show that
  - j_T-scaling in pp collisions is also observed at RHIC energy (with $\langle|j_{TY}|\rangle \approx 400$MeV)
  - $\langle|k_{TY}|\rangle$ follows the general trend of previous measurements

AuAu - Peripheral Fixed $p_\perp$ Correlation Function

Run2 Au-Au: 30M min-bias events.

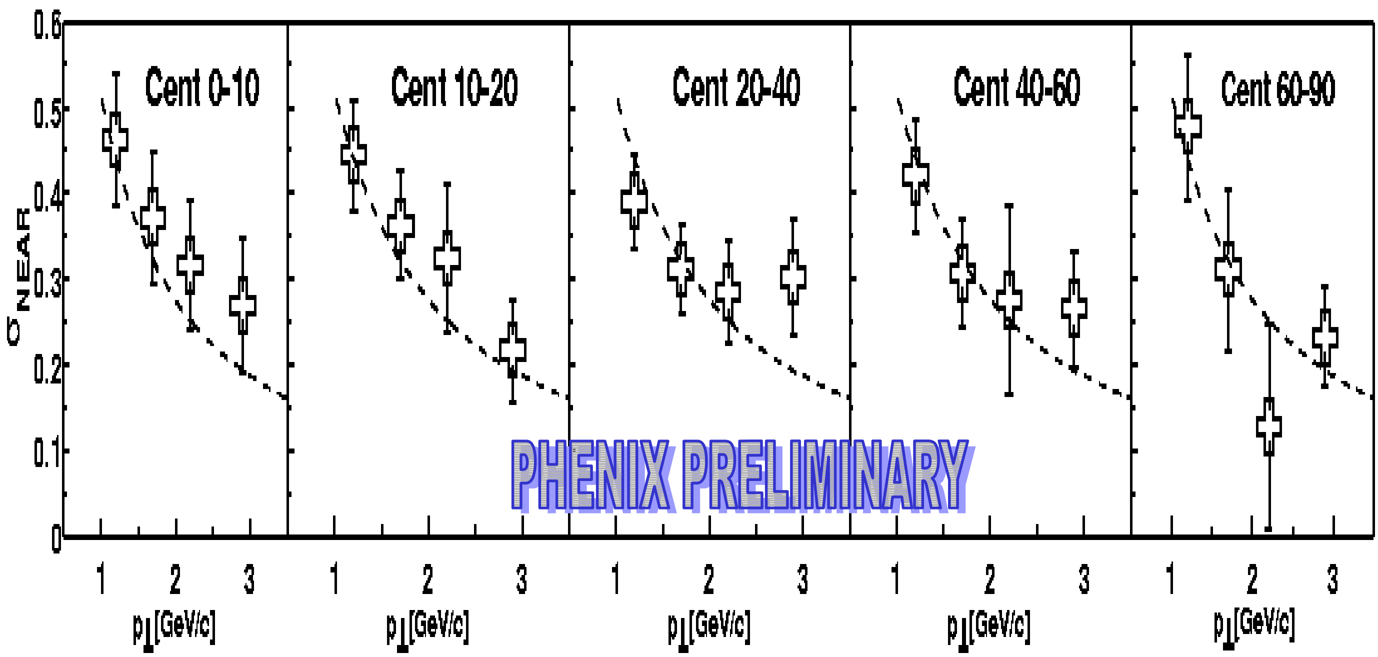
Kinematically favoured near-angle peak ($|\Delta\eta|<0.35$, $(q_1q_2)=(+\,-)$)	Kinematically disfavoured near-angle peak ($|\Delta\eta|>0.35$, $(q_1q_2)=(+\,+)(-\,-)$)

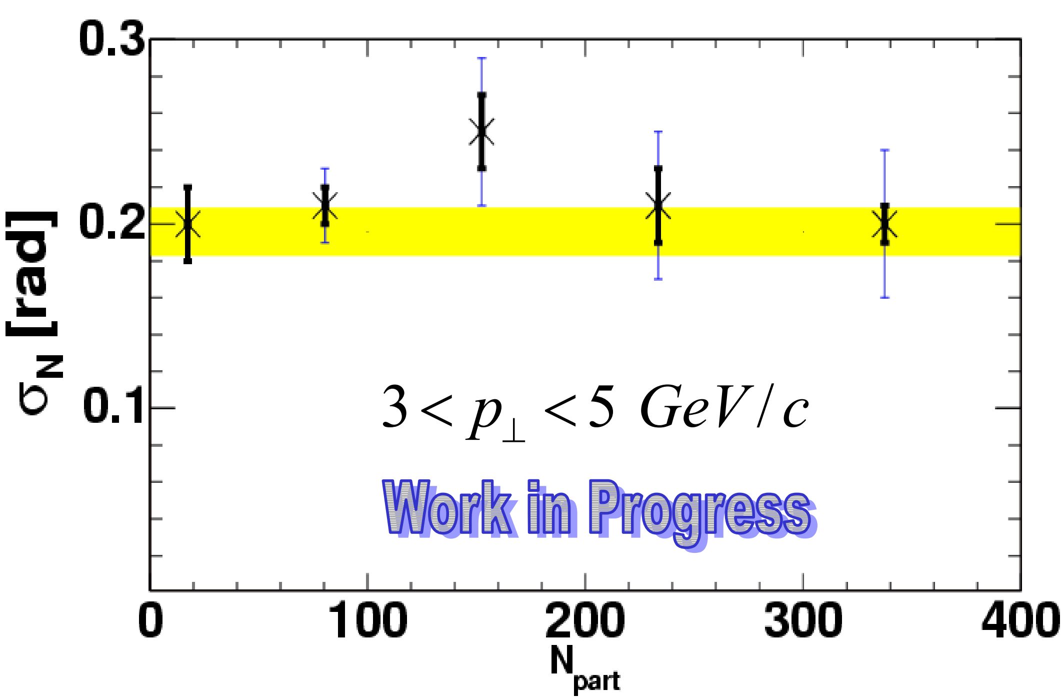


$$Fit : N\left[1 + 2v_2^2 \cos(2\Delta\varphi)\right] + Gaus(\Delta\varphi = 0, \sigma_N)$$

AuAu Near-Angle Widths

The extracted width of the gaussian term (the dashed line - not a fit - corresponds to a constant $j_\perp$=400 MeV):





Blue lines – statistical errors

Black bars – systematic errors from v_2 variation

Yellow band – p-p value

No Evidence of Broadening – Jet Vacuum Fragmentation?

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AuAu Jet Shapes

- Jet-like near-angle structure is observed in two-particle correlations in Au-Au collisions at $\sqrt{s}$ =200AGeV

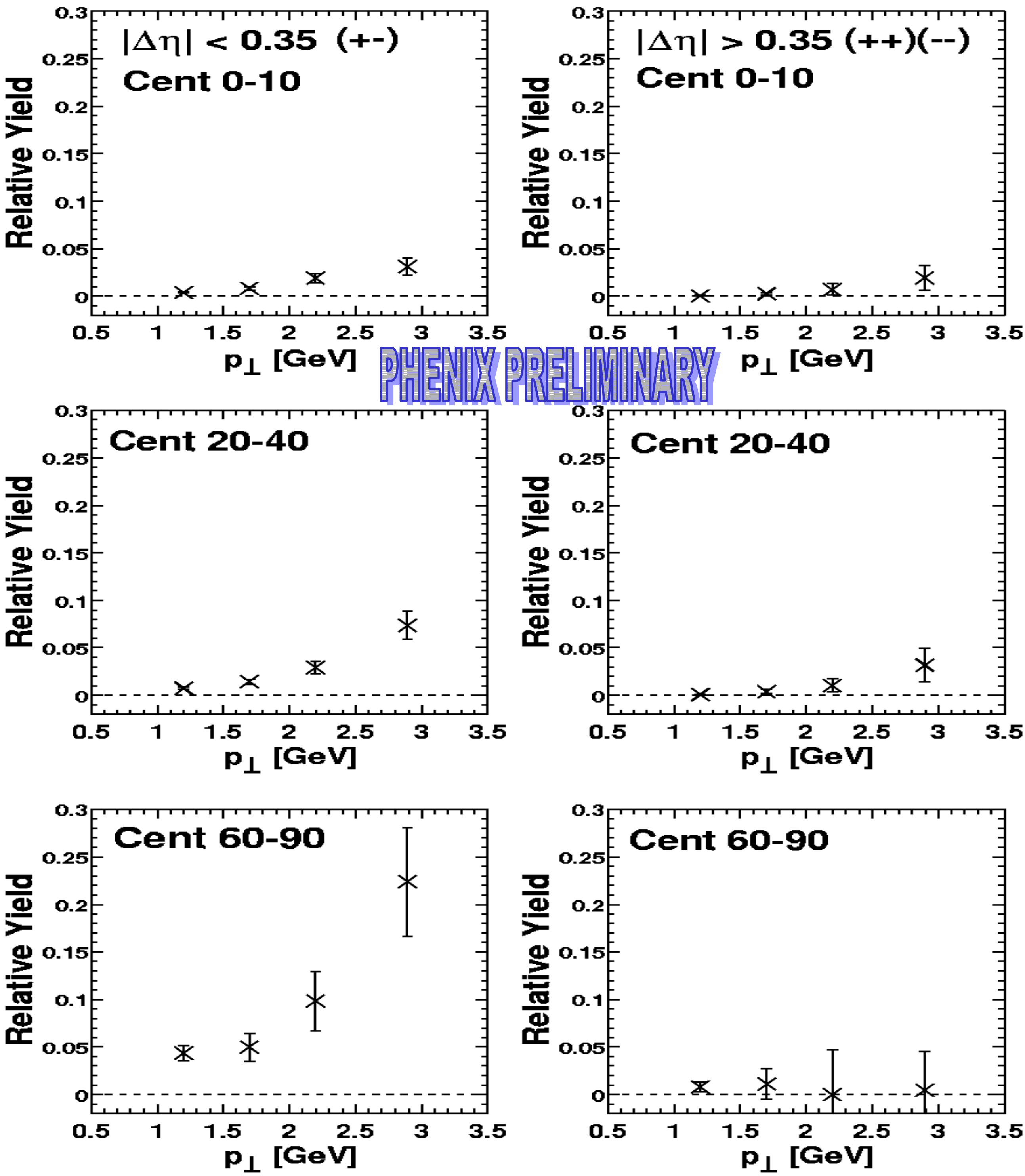
- Near-angle widths also show a $p_\perp$ dependence characteristic for jets: $j_\perp$-scaling.

- No centrality dependence within current errors: no jet broadening, indicative of vacuum fragmentation.

Back-Up Slides

Relative Yields

Relative yield ≡ area of near-angle gaussian / total area



Centrality and $p_{\perp}$ dependence indicative of jet-like source