

# Recent results on $\phi$ meson production in d+Au collisions at RHIC

***Chitrasen Jena***

for the STAR Collaboration

*Lawrence Berkeley National Laboratory, Berkeley, USA  
Institute of Physics, Bhubaneswar, INDIA*



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# Outline

- Introduction
- Recent results on  $\phi$  mesons in d+Au collision
- Summary and Outlook



# Rapidity Asymmetry in d+Au Collisions

$$Y_{Asym}(p_T) = \frac{Y_B(p_T)}{Y_F(p_T)}$$

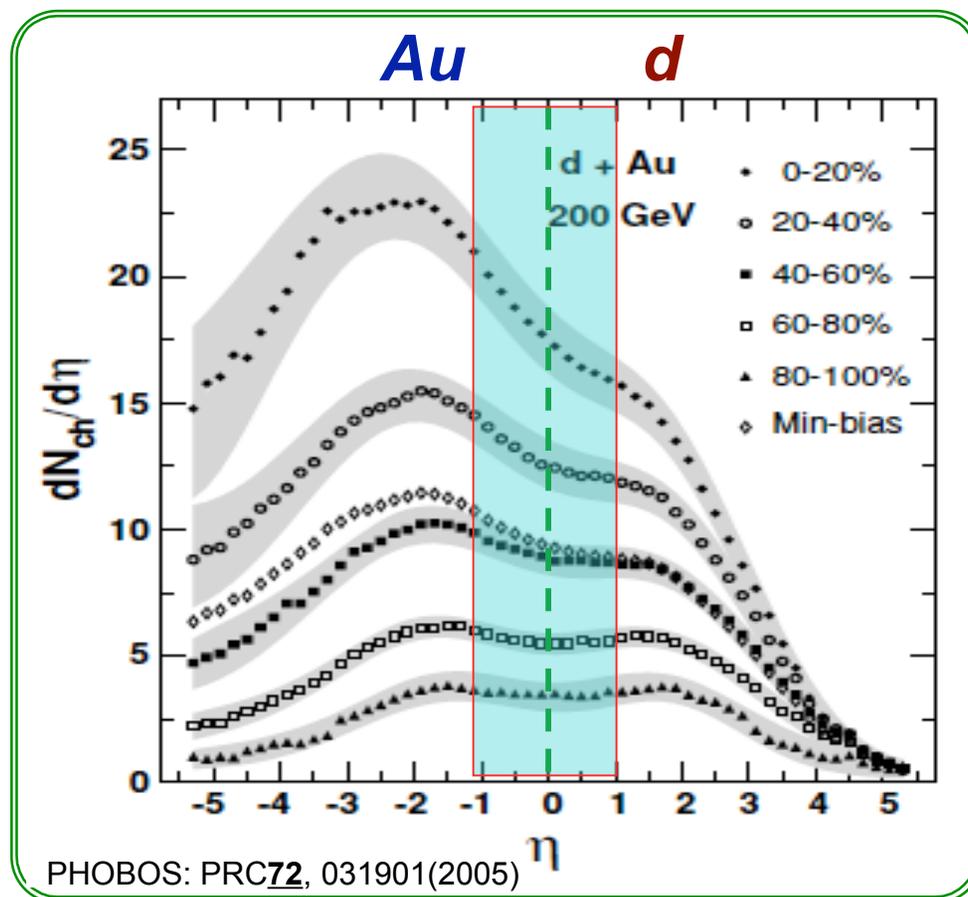
$Y_F$  = particle yields in forward rapidity  
(d beam direction)

$Y_B$  = particle yields in backward rapidity  
(Au beam direction)

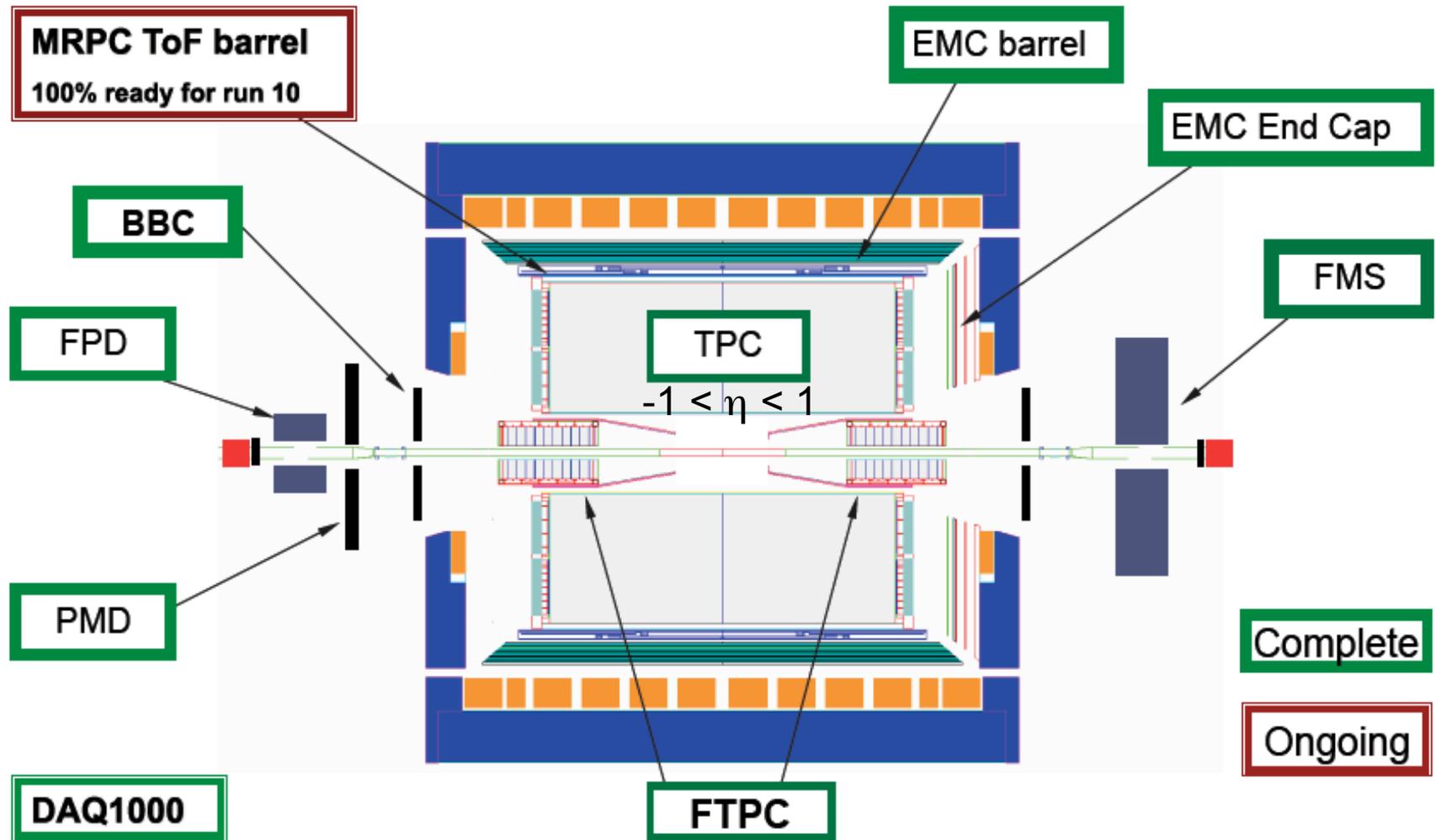
- Possible mechanisms for the particle production in d+Au collisions:
  - ❑ Multiple scattering, Energy loss in cold nuclear matter
  - ❑ Nuclear shadowing, Parton saturation
  - ❑ Recombination of partons

STAR: PRC 76, 054903(2007)

- Being a ratio, most systematic effects get cancelled and only statistical errors dominate.



# STAR Detector



*Full azimuthal particle identification!*



# Data Set

Data: Run 8, d + Au 200 GeV

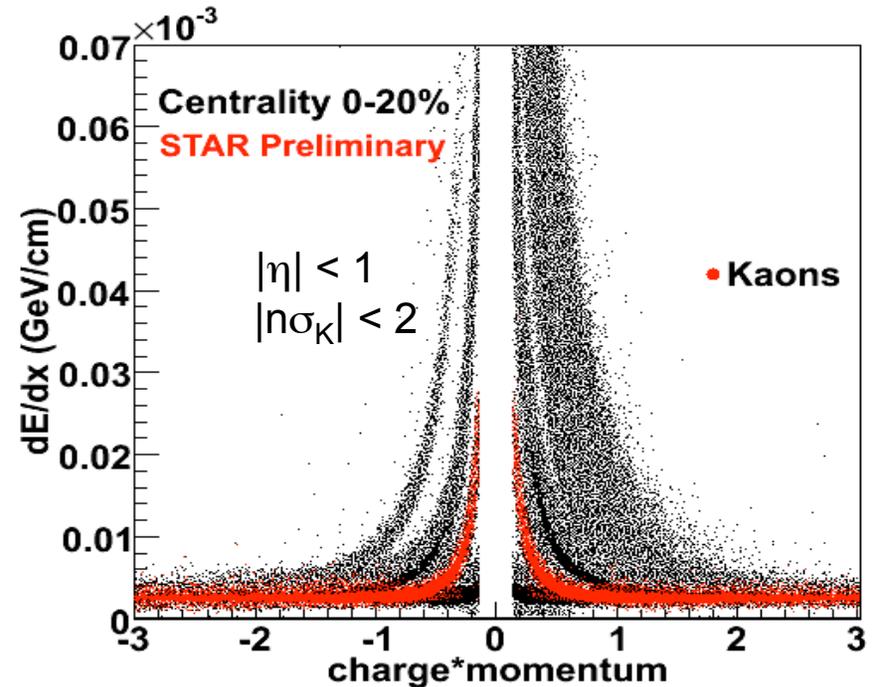
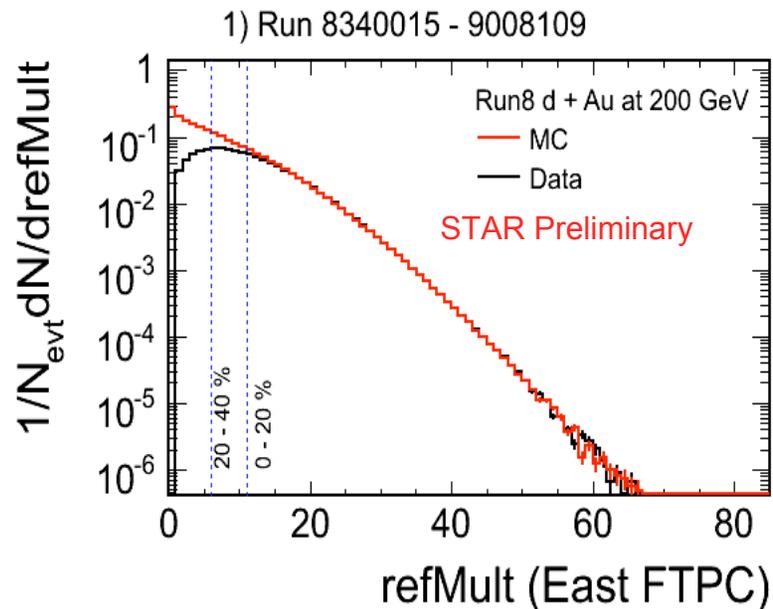
Low material run

(Without any inner tracking detectors)

Total Number of Events: ~32M

(~3 times more statistics compared to previous run)

Event Cut :  $|V_z| < 30$  cm

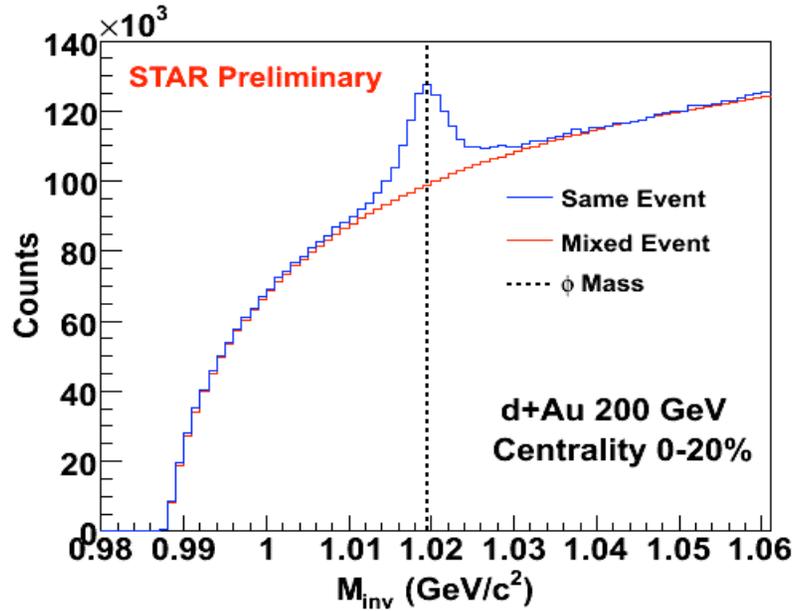


➤ Centrality classes determined using number of uncorrected charged particles in east FTPC ( $-3.8 < \eta < -2.8$ ).

➤ In this talk, results from the most central (0-20%) events are shown.

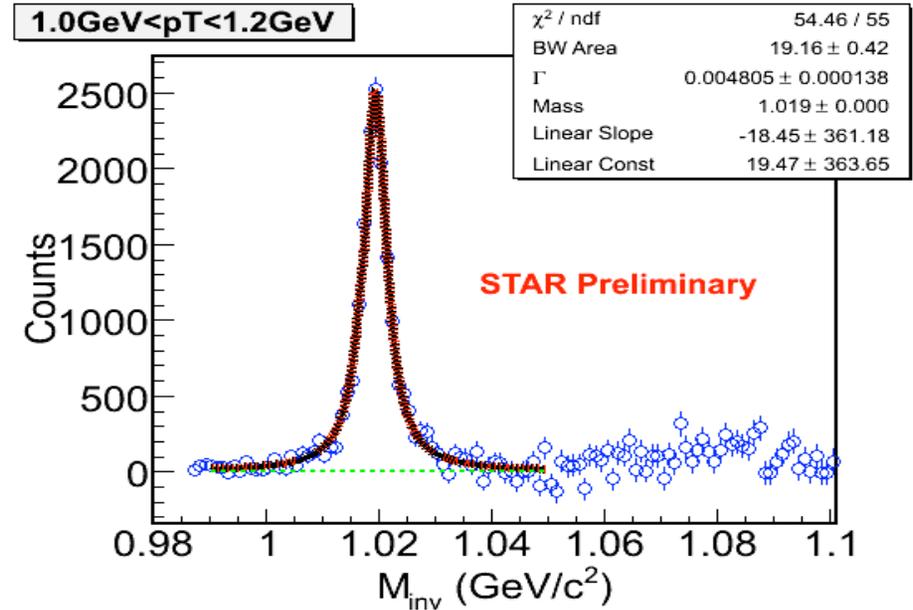


# $\phi \rightarrow K^+K^-$ Reconstruction



Branching Ratio:  $\sim 49.2\%$

- The combinatorial background is estimated using the mixed event technique.



Fit function :

$$f(M_{inv}) = \frac{1}{2\pi} \times \frac{A\Gamma}{(M_{inv} - m_\phi)^2 + (\Gamma/2)^2} + p_0 M_{inv} + p_1$$

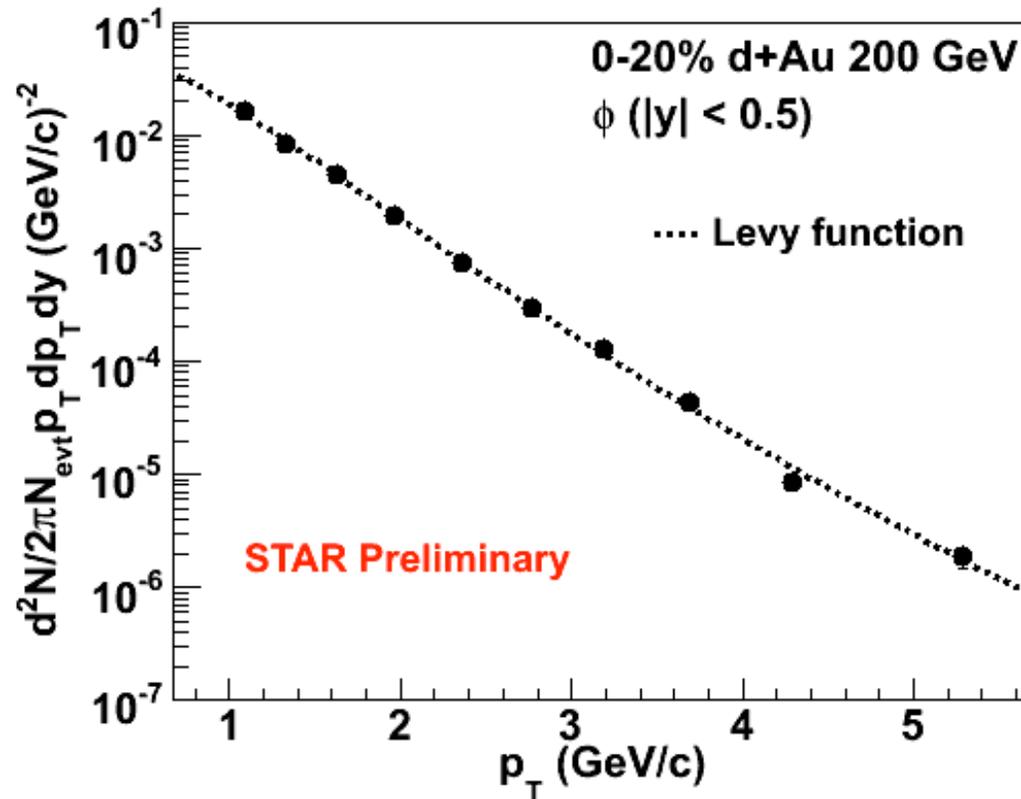
A = Area under the mass peak

$\Gamma$  = Width of the distribution

$m_\phi$  = Mass of the  $\phi$  meson



# $\phi$ Meson Spectrum



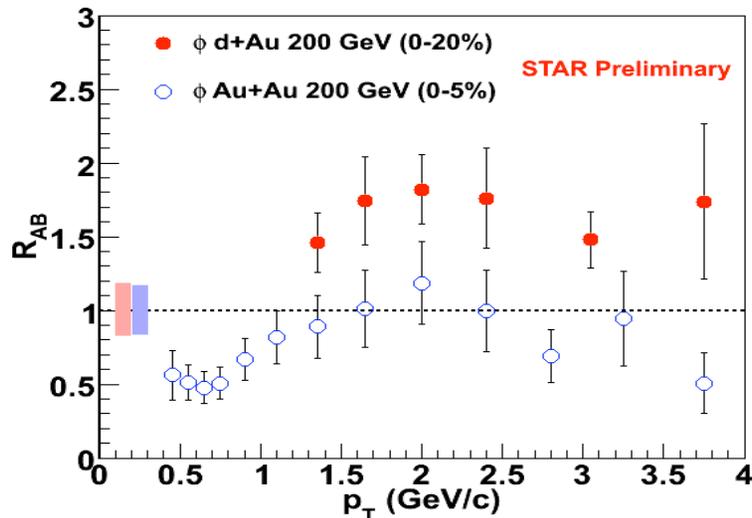
□ Only statistical errors are shown.

- $\phi$  meson spectrum is well described by the Levy function.

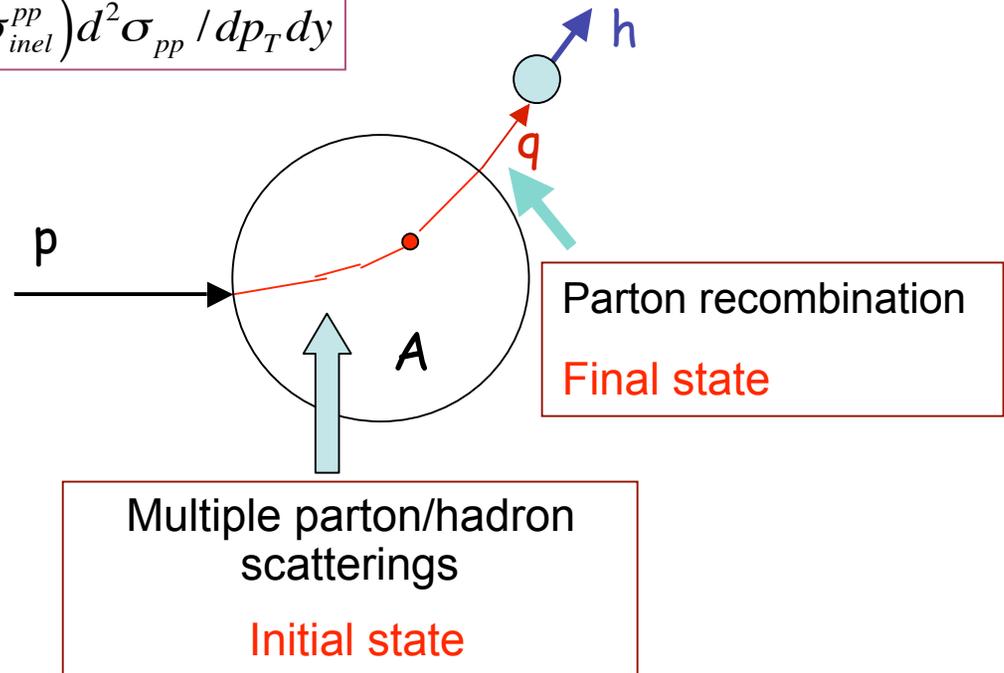


# Nuclear Modification Factor

$$R_{AB}(p_T) = \frac{d^2 N_{AB} / dp_T dy}{(\langle N_{bin} \rangle / \sigma_{inel}^{pp}) d^2 \sigma_{pp} / dp_T dy}$$



$\phi$  Au+Au 200 GeV, STAR: PRC **79** (2009) 064903



X.N. Wang, PRC 61, 064910 (2000)

R.C. Hwa et al., PRL 93, 082302 (2004)

□ Only statistical errors are shown for d+Au 200 GeV

➤  $R_{dAu}$  of  $\phi$  meson is different from  $R_{AuAu}$ .

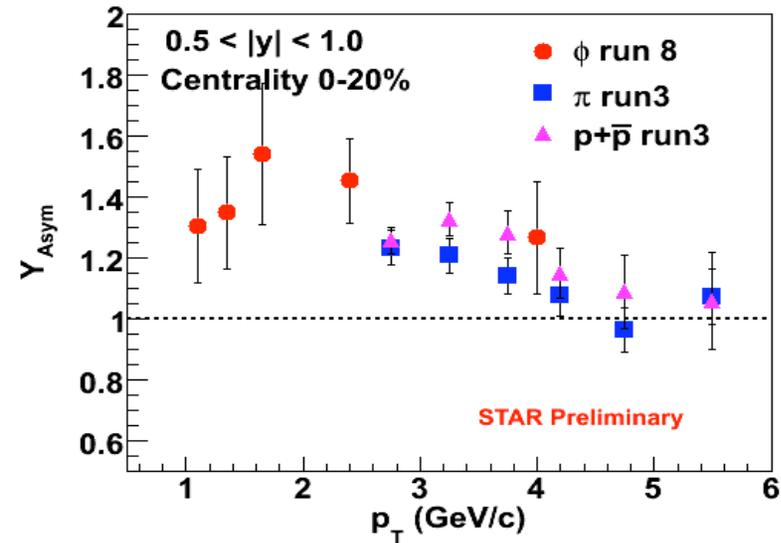
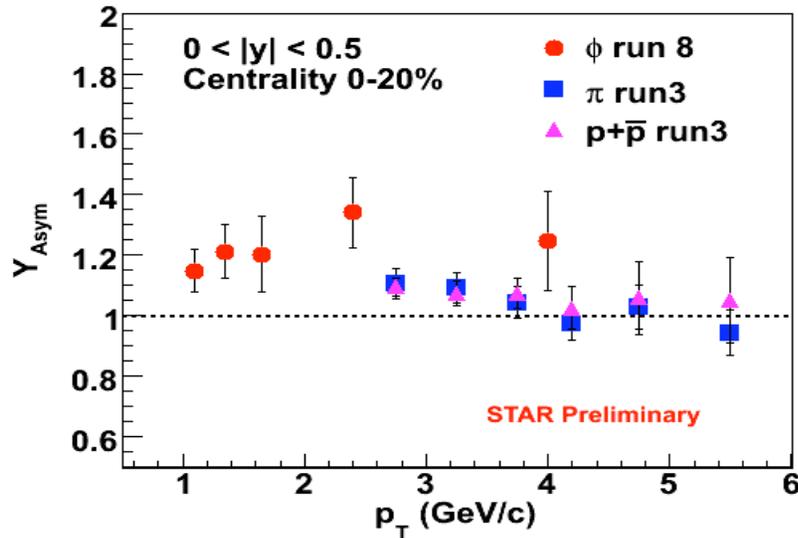
➤ Enhancement of  $R_{dAu}$  at intermediate  $p_T$  could be due to **Cronin effect**.

J.W. Cronin et al., PRD **11**, 3105(1975)



# Rapidity Asymmetry

$\pi$ ,  $p$  data: STAR, PRC 76, 054903 (2007)



- Error bars shown for  $Y_{Asym}$  for  $\phi$  mesons are statistical only.
- Systematic uncertainty under study.

- 1) In the Au direction more hadrons, including  $\phi$ -meson, are produced,  $Y_{asym} > 1$  in 0-20% dAu collisions at 200 GeV.
- 2) Within statistics, no strong particle type dependence can be identified.



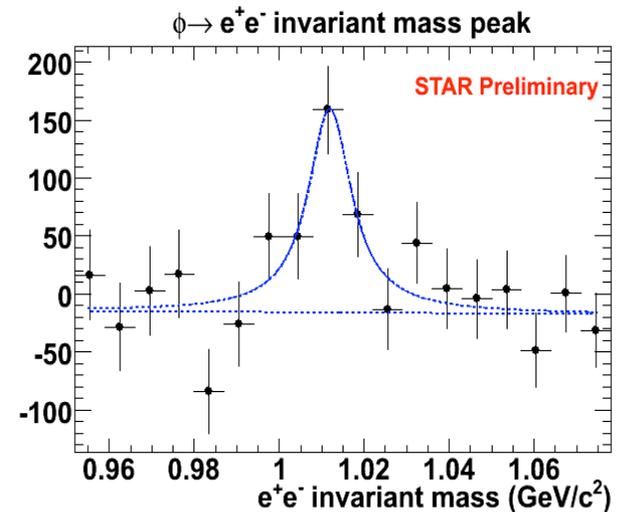
# Summary

- Preliminary results for  $\phi \rightarrow K^+K^-$  from 200 GeV  $d+Au$  collisions have been obtained.
- Enhancement of  $R_{dAu}$  at intermediate  $p_T$  could be due to Cronin effect.
- Within statistics, no strong particle type dependence can be identified in  $Y_{asym}$  in the 200 GeV  $dAu$  collisions.

## Outlook:

- $\phi \rightarrow e^+e^-$  decay channel study as an independent check will provide more information on  $d+Au$  collisions.
- Time of Flight detector upgrade will greatly enhance the electron identification.

Work in progress...



STAR Collaboration, QM 2009 Poster



# Back up



# Cronin effect at RHIC

STAR Collaboration, Phys. Lett. B 616, (2005) 8

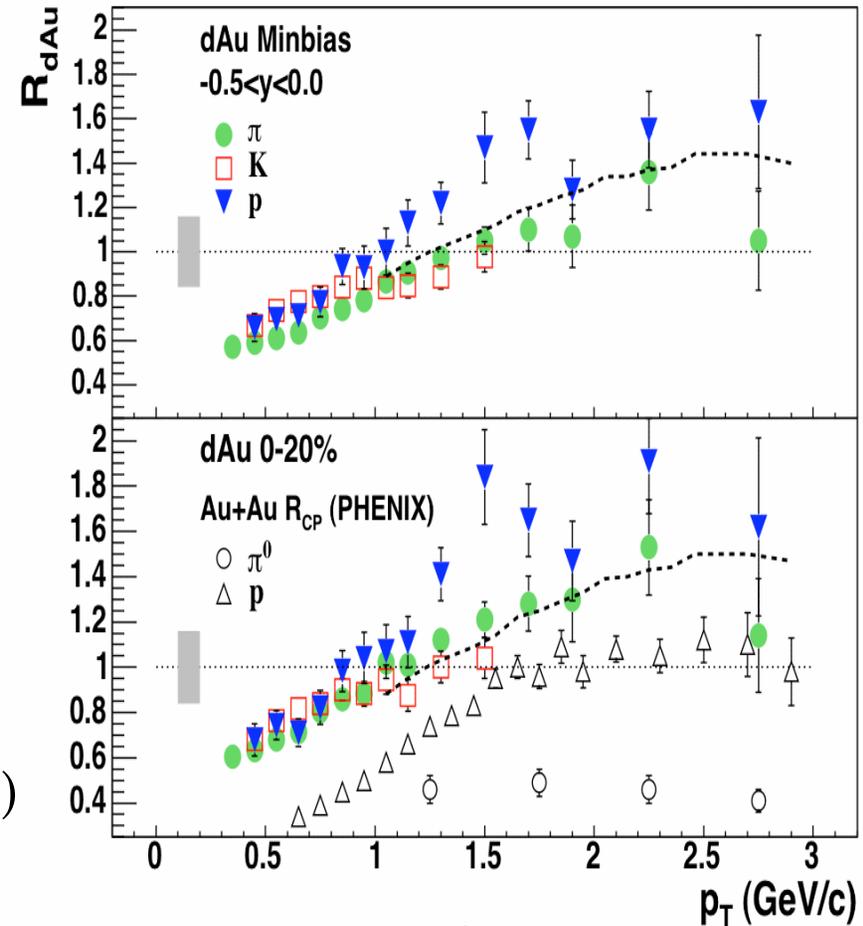
Nuclear modification factor:

$$R_{dAu}(p_T) = \frac{d^2 N / (2\pi p_T dp_T dy)}{T_{dAu} d^2 \sigma_{inel}^{pp} / (2\pi p_T dp_T dy)}$$

$$T_{dAu} = \langle N_{bin} \rangle / \sigma_{inel}^{pp}$$

- High  $p_T$  hadron production enhanced relative to p+p collisions : Cronin effect
- $R_{dAu}(p) > R_{dAu}(\pi)$
- Will be interesting to see where  $\phi$  meson fits in this picture.

Mass:  $\phi(1.019 \text{ GeV}/c^2)$ ,  $p(0.938 \text{ GeV}/c^2)$   
 $\phi(s\bar{s})$ ,  $p(uud)$



Will it follow a Baryon-Meson effect or Mass effect?



# Rapidity Asymmetry

