

# $\phi$ -meson Global Spin Alignment Update

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# Dataset and Cuts

System	Trigger IDs
Au+Au 14.6 GeV BES-II (2019)	650000

## Event Level Cuts

$$|v_z| < 70 \text{ cm}$$

$$|v_r| < 70 \text{ cm}$$

$$\text{nBToFMatch} > 2$$

## TPC Track Cuts for $K^{+/-}, \pi^{+/-}$

$$0.1 < p_T < 10.0 \text{ GeV}/c$$

$$|\text{DCA}| < 2 \text{ cm}$$

$$\text{No. TPC hits} > 15$$

$$\text{TPC hit ratio} > 0.52$$

$$|\eta| < 1.5$$

## PID Cuts for $\phi$ -meson $K^{+/-}$

$$\text{TPC: } |n\sigma_K| < 2.5$$

$$\&\& \text{ TOF: } 0.16 < M^2 < 0.36$$

## PID Cuts for $K^{*0} K^{+/-}$

$$\text{if TOF: } 0.16 < M^2 < 0.36$$

$$\text{else TPC: } |n\sigma_K| < 2.0$$

## PID Cuts for $K^{*0} \pi^{+/-}$

$$\text{if TOF: } -0.2 < M^2 < 0.15$$

$$\text{else TPC: } |n\sigma_\pi| < 2.0$$

# 2<sup>nd</sup> order TPC EP

AuAu 14.6 GeV

## TPC Event Plane Cuts (2<sup>nd</sup> order)

Sub-event plane method with  $\eta$ -gap = 0.1.  
Apply run-by-run, centrality, and  $v_z$  wise  
re-centering and shift calibrations.

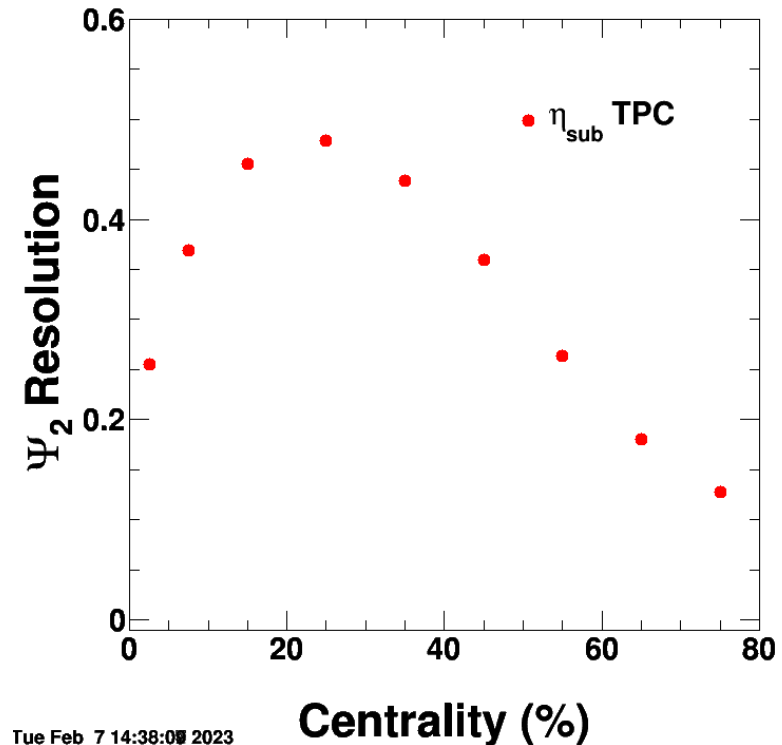
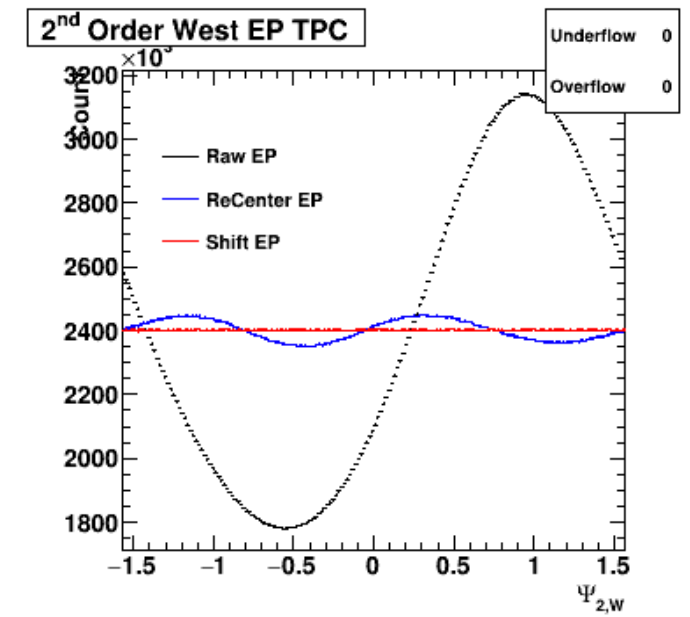
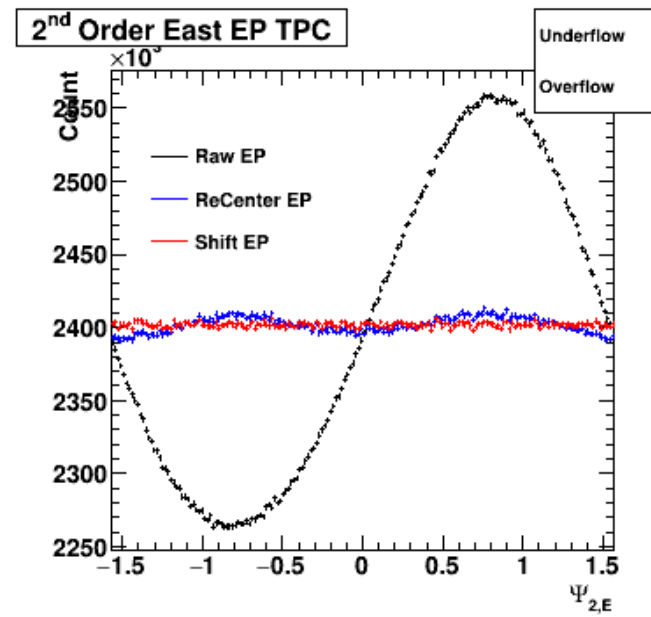
$0.15 < p_T < 2$  GeV/c

$|DCA| < 1$  cm

No. TPC hits  $> 15$

TPC hit ratio  $> 0.52$

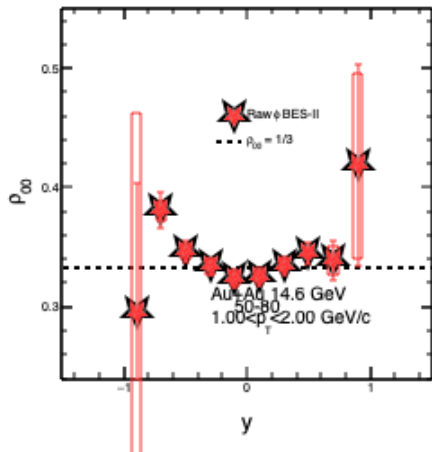
$|\eta| < 1.5$



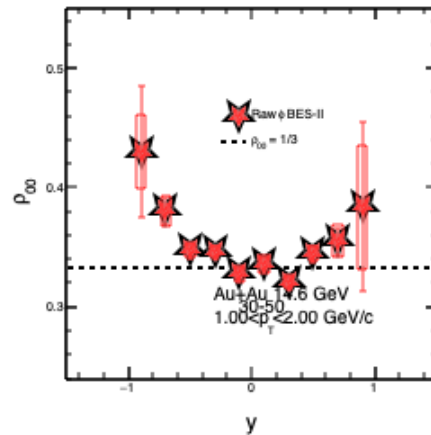
AuAu 14.6 GeV

# Raw $\phi$ -meson $\rho_{00}$ (rapidity)

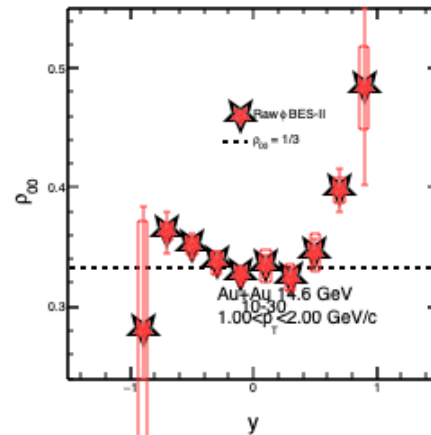
40-80%,  $1.0 < p_T < 2.0$  GeV/c



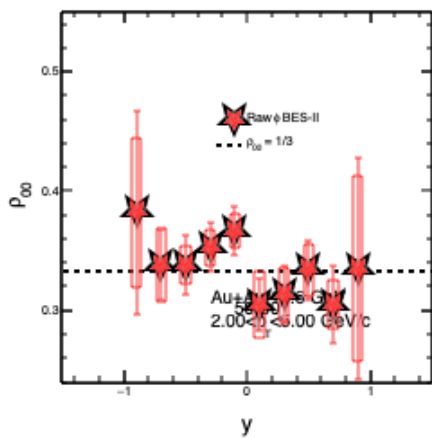
10-40%,  $1.0 < p_T < 2.0$  GeV/c



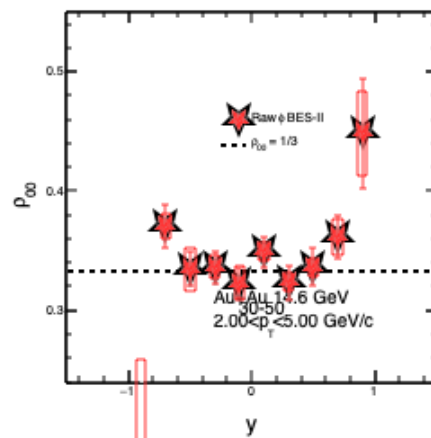
0-10%,  $1.0 < p_T < 2.0$  GeV/c



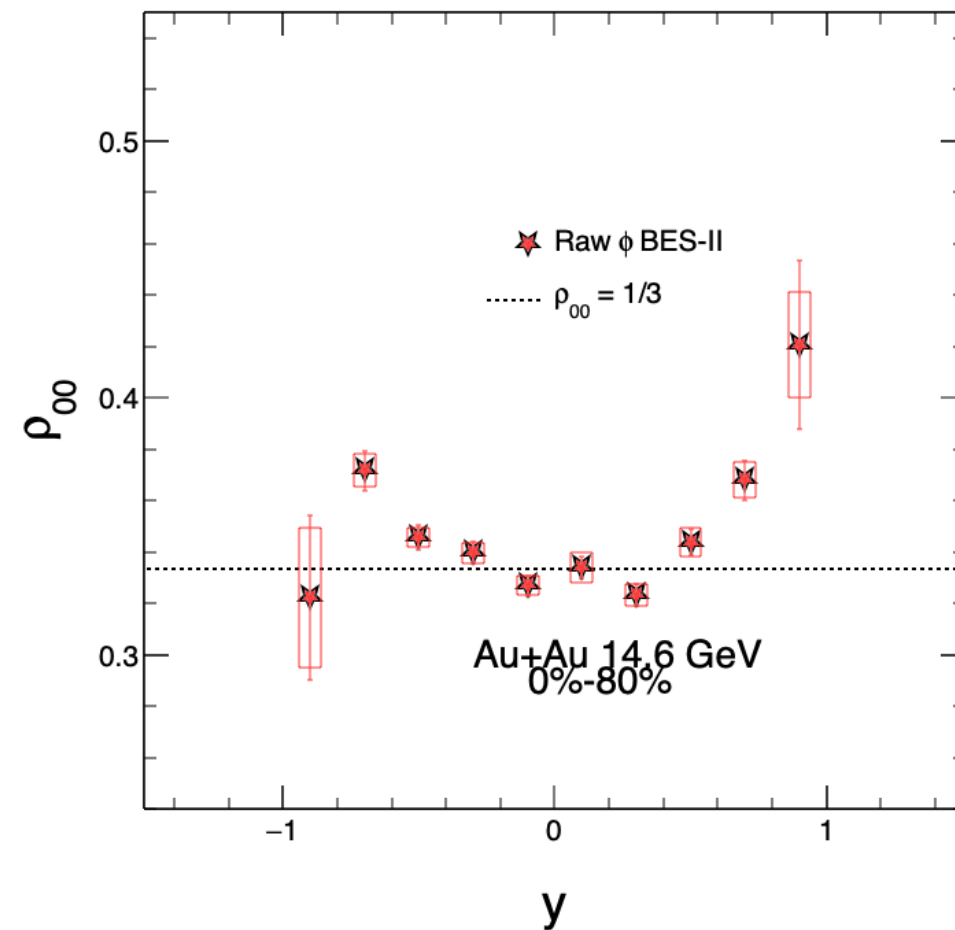
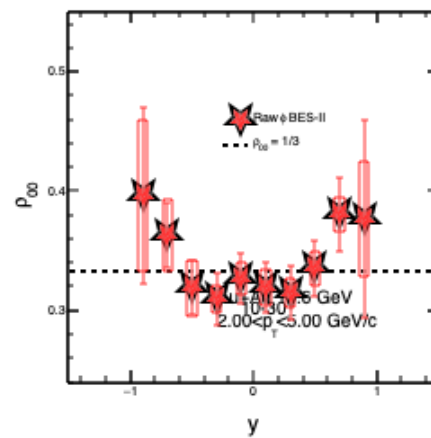
40-80%,  $2.0 < p_T < 5.0$  GeV/c



10-40%,  $2.0 < p_T < 5.0$  GeV/c

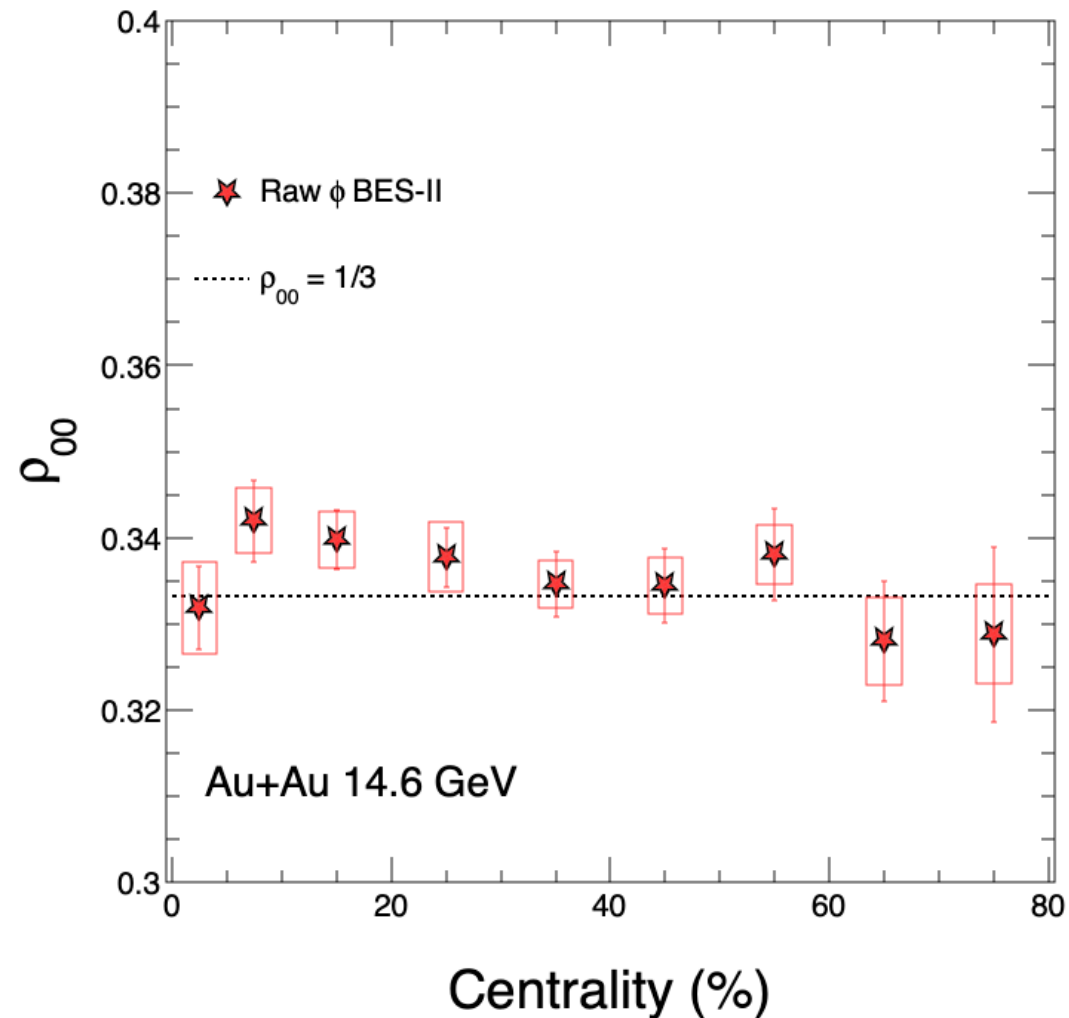
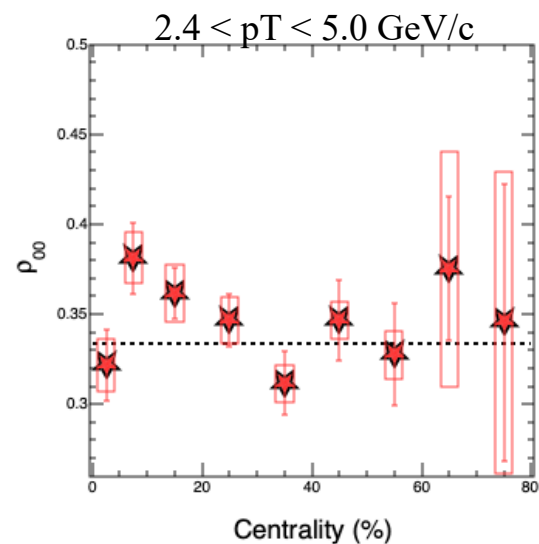
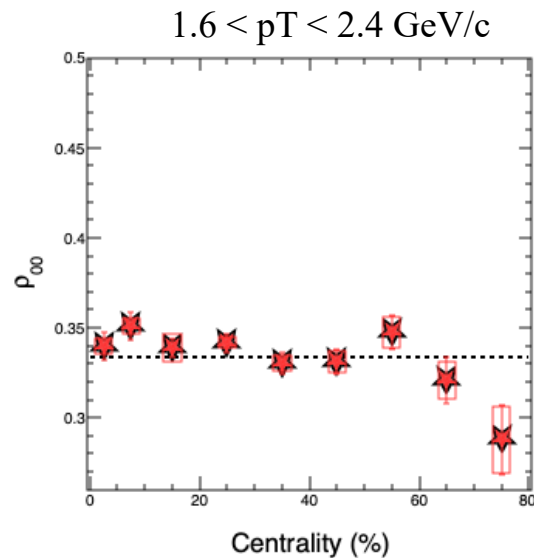
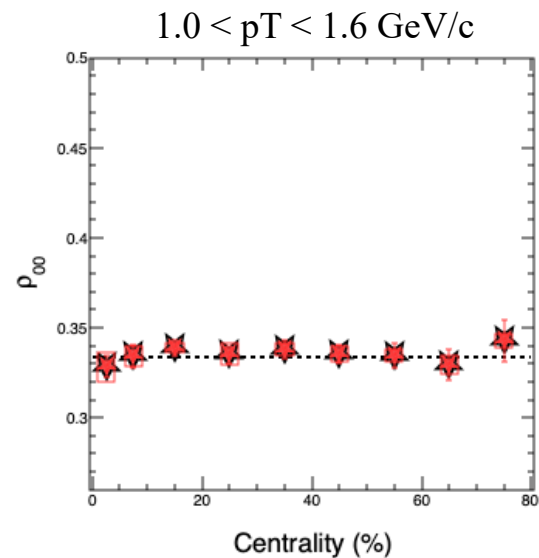


0-10%,  $2.0 < p_T < 5.0$  GeV/c



AuAu 14.6 GeV  
 $|y| < 1.5$

# Raw $\phi$ -meson $\rho_{00}$ (centrality)



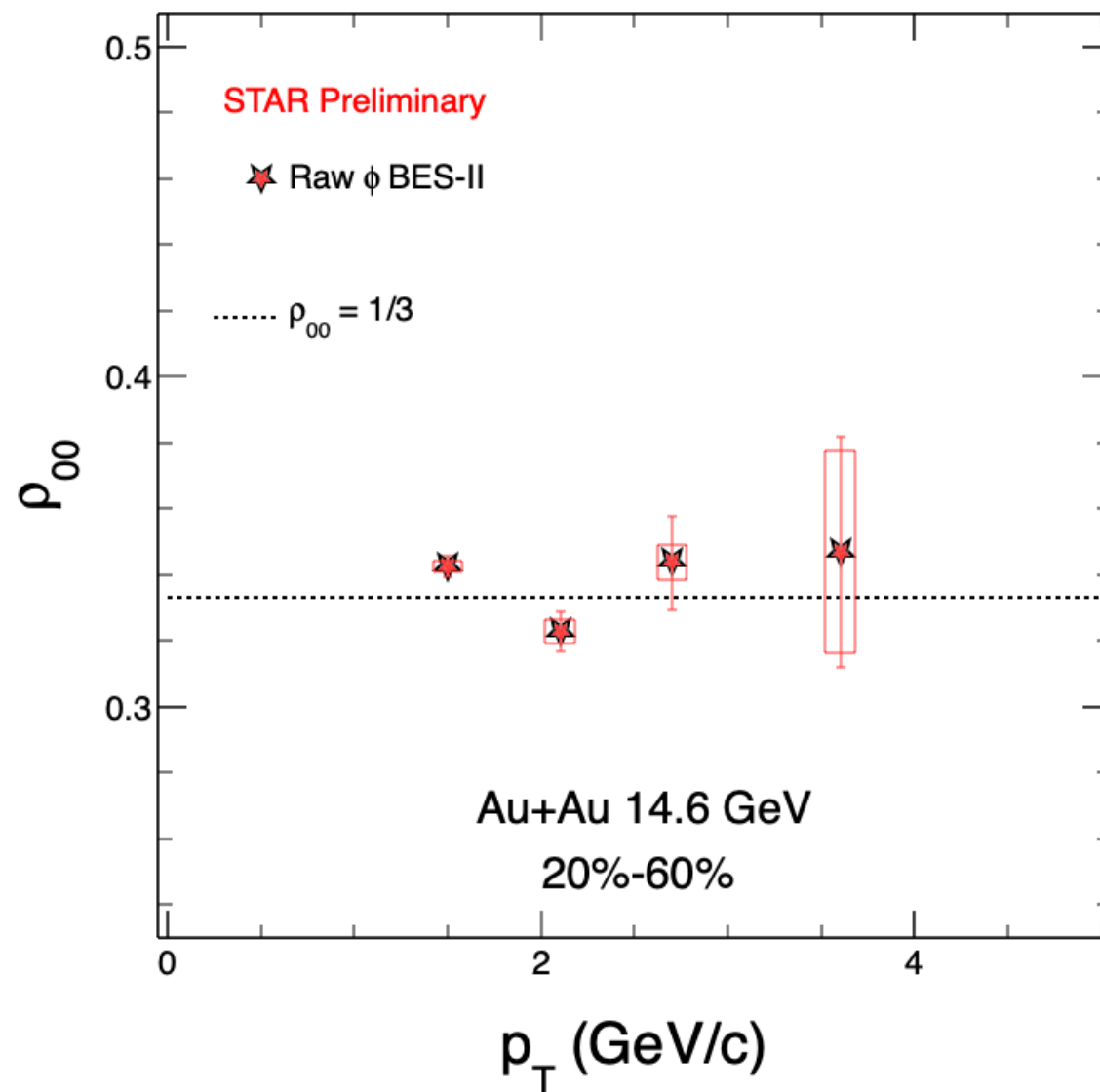
AuAu 14.6 GeV

$|y| < 1.5$

20-60%

$|\eta| < 1.0$  on daughters

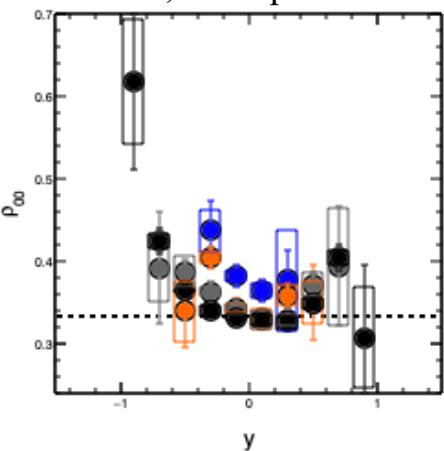
# Raw $\phi$ -meson $\rho_{00}(p_T)$



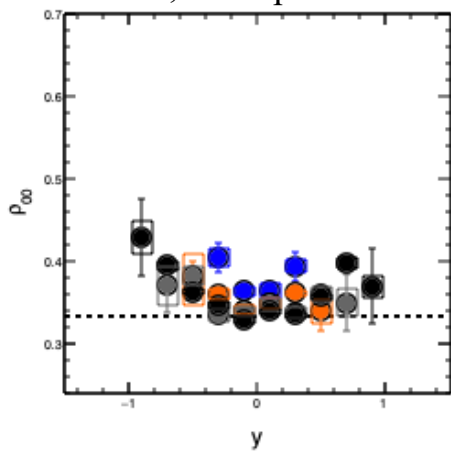
AuAu 19.6 GeV

# $|\eta|$ cut study (rapidity)

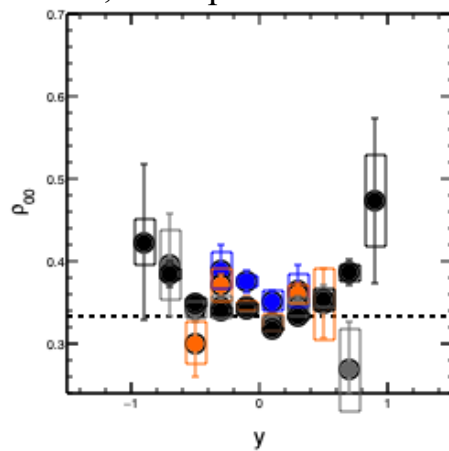
40-80%,  $1.0 < p_T < 2.0$  GeV/c



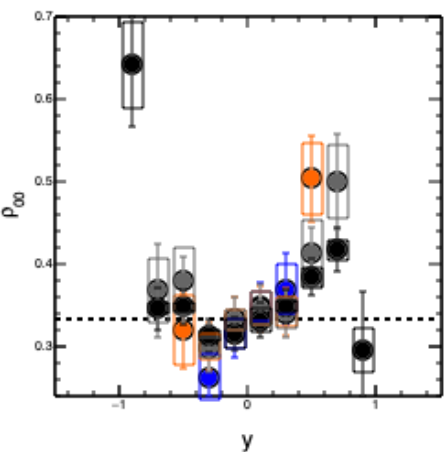
10-40%,  $1.0 < p_T < 2.0$  GeV/c



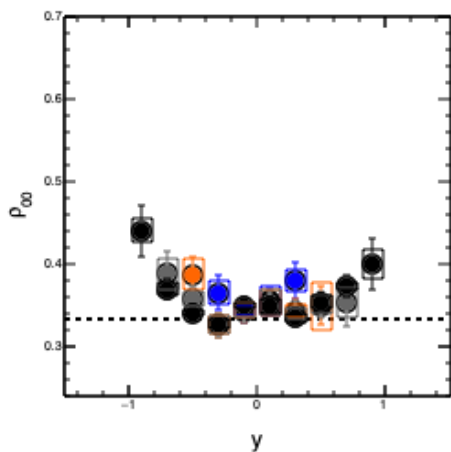
0-10%,  $1.0 < p_T < 2.0$  GeV/c



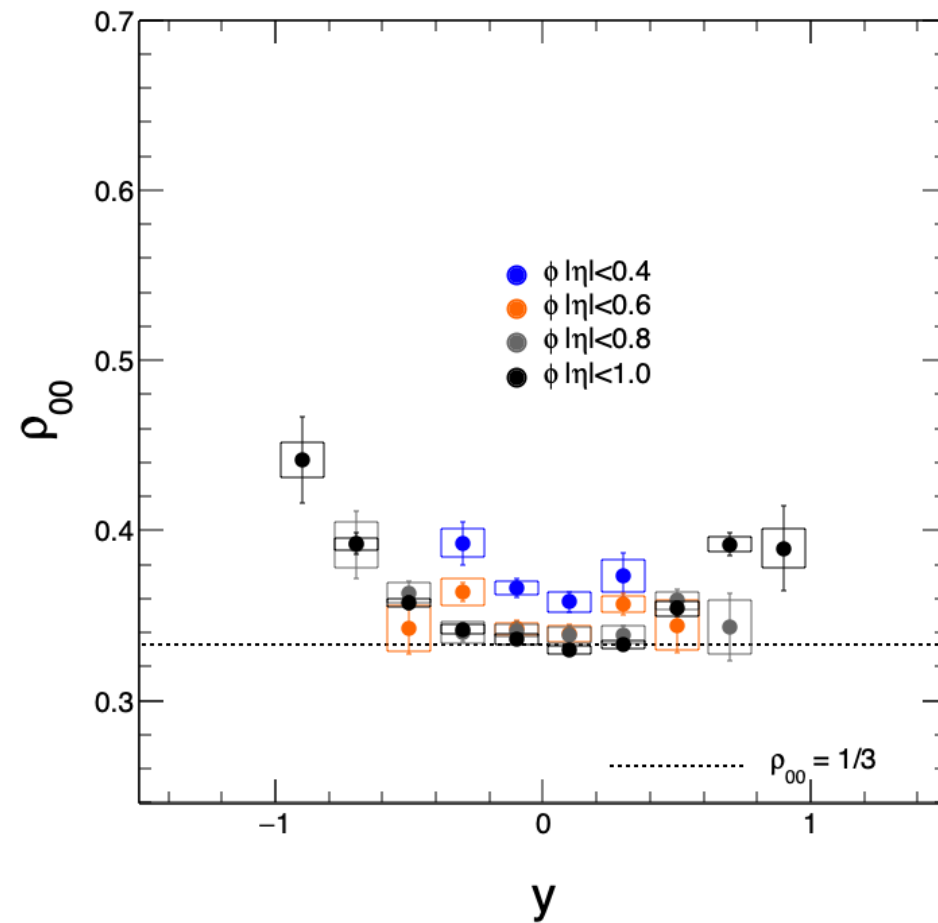
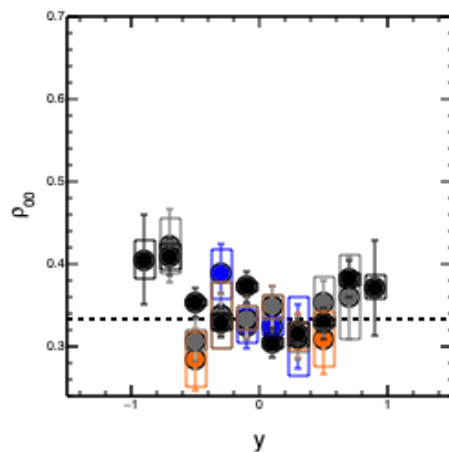
40-80%,  $2.0 < p_T < 5.0$  GeV/c



10-40%,  $2.0 < p_T < 5.0$  GeV/c

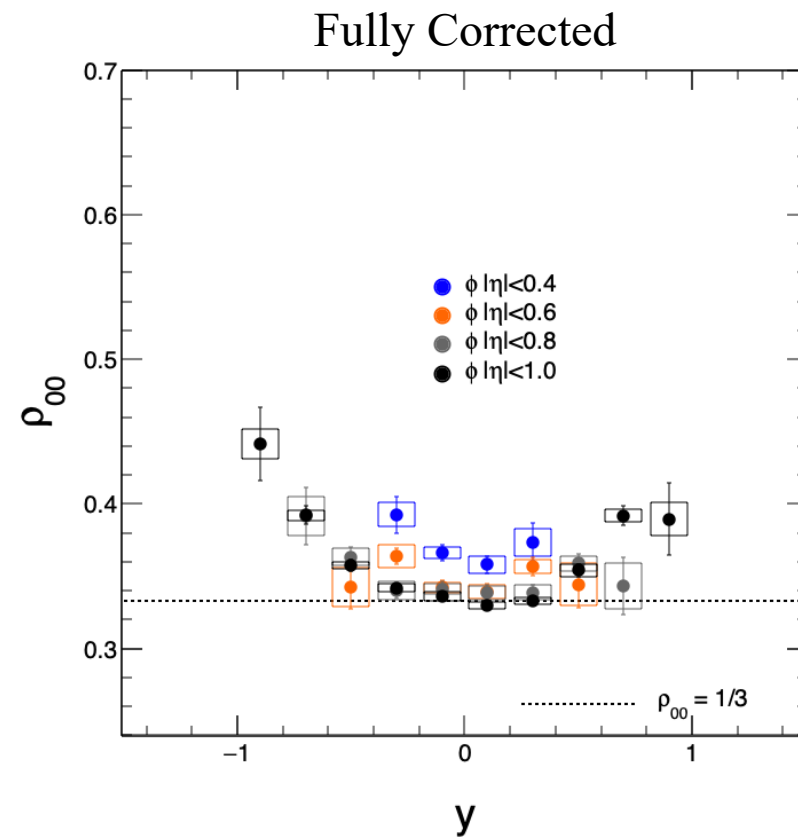
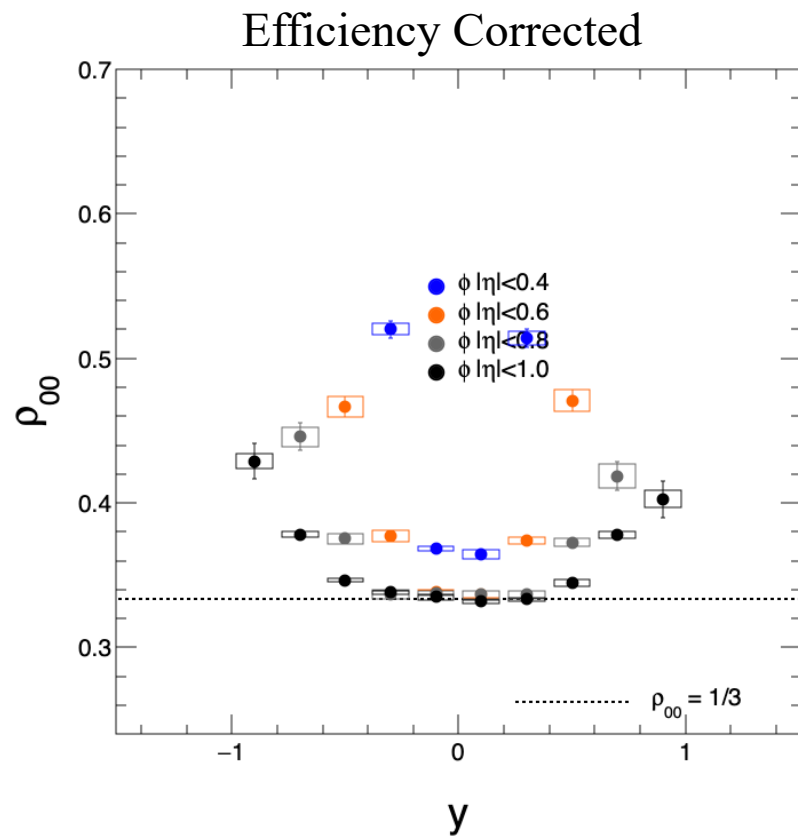
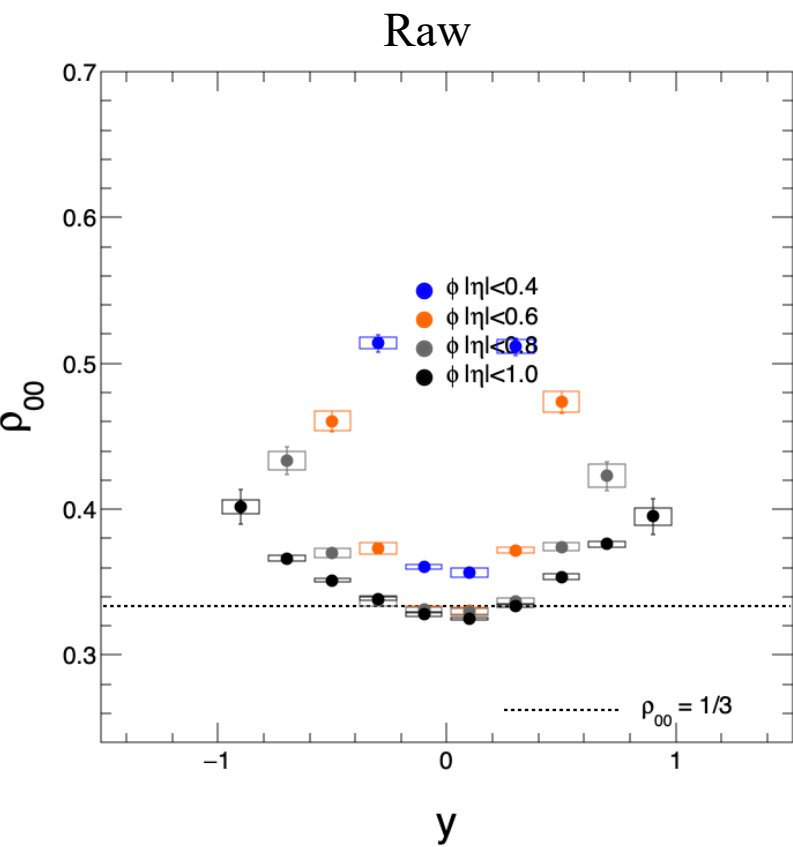


0-10%,  $2.0 < p_T < 5.0$  GeV/c



AuAu 19.6 GeV

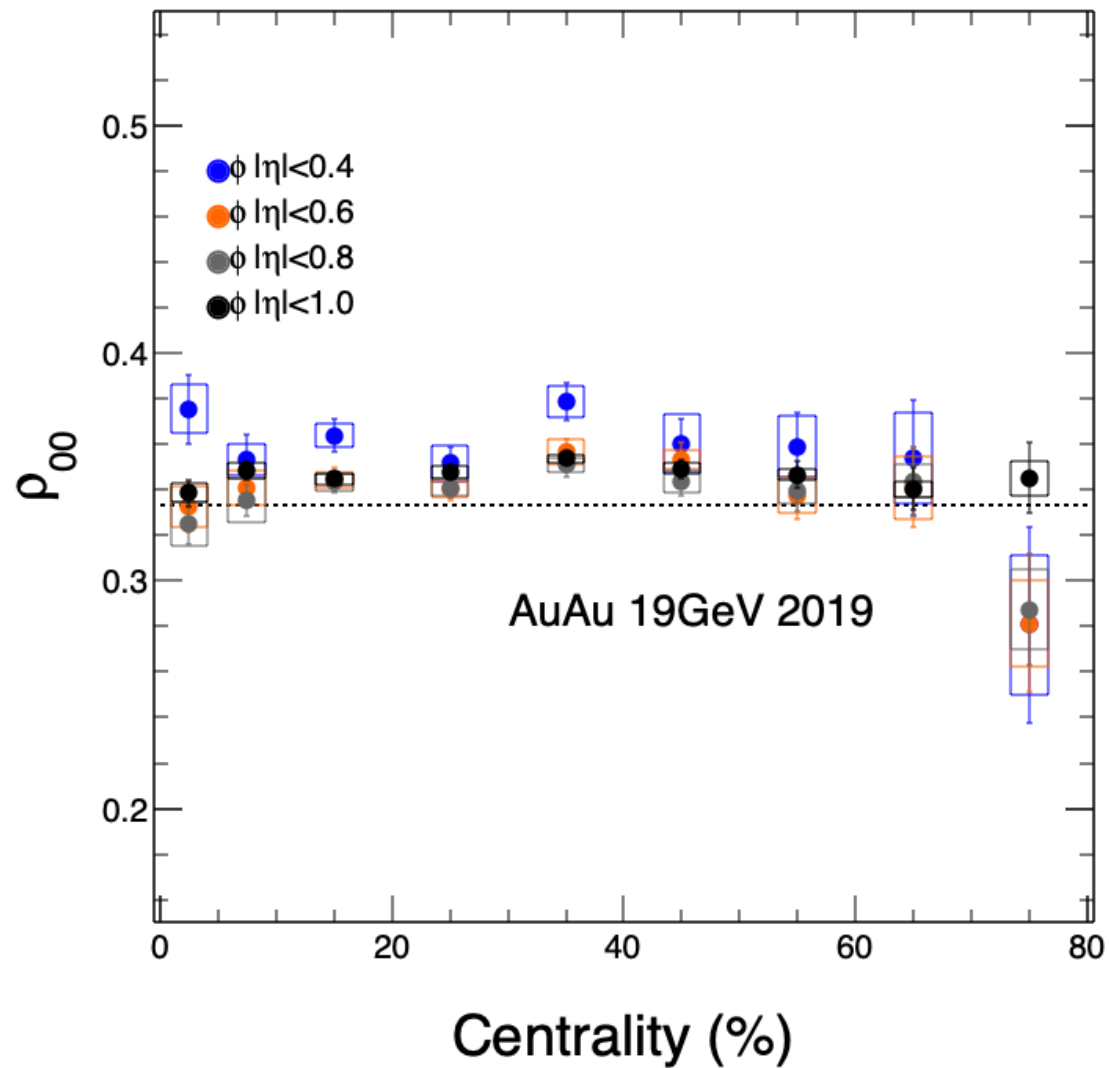
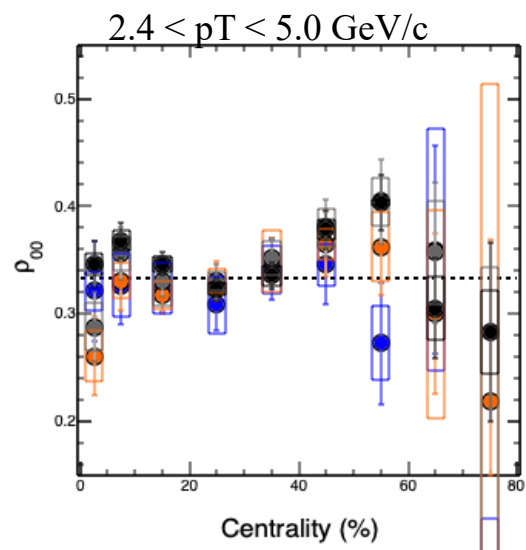
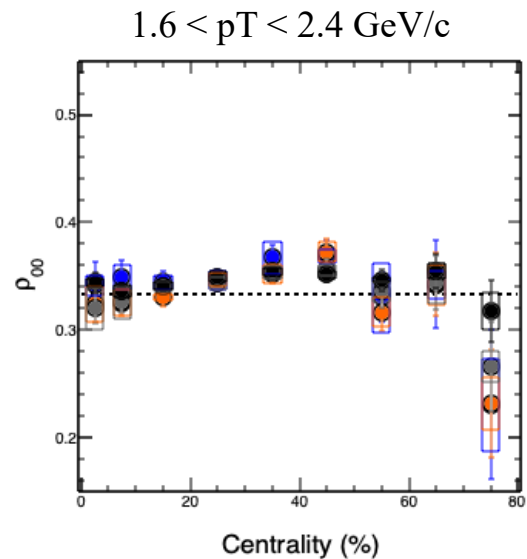
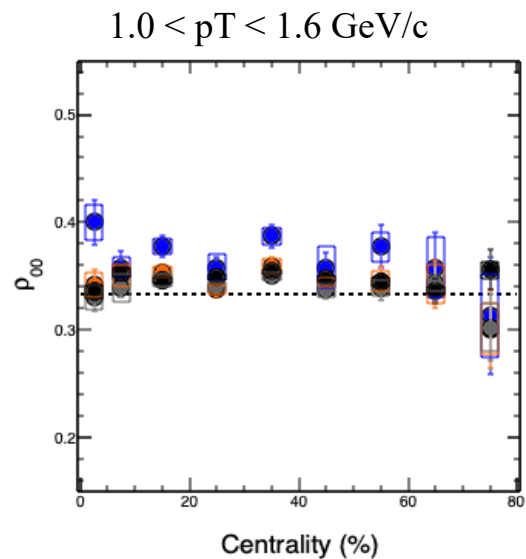
# $|\eta|$ cut study (rapidity)





AuAu 19.6 GeV  
 $|y| < 1.5$

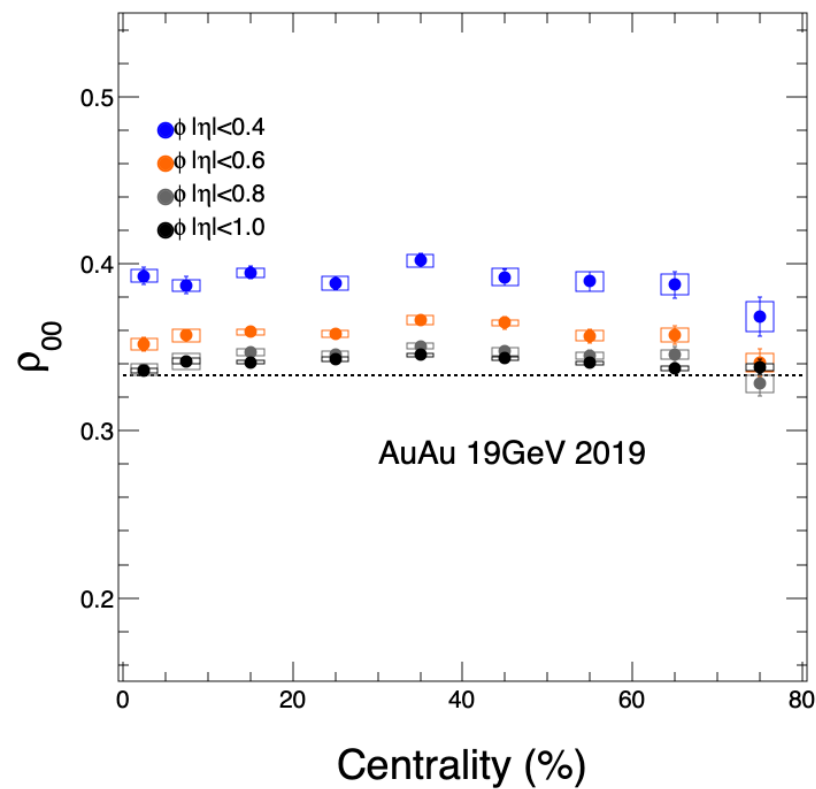
# $|\eta|$ cut study (centrality)



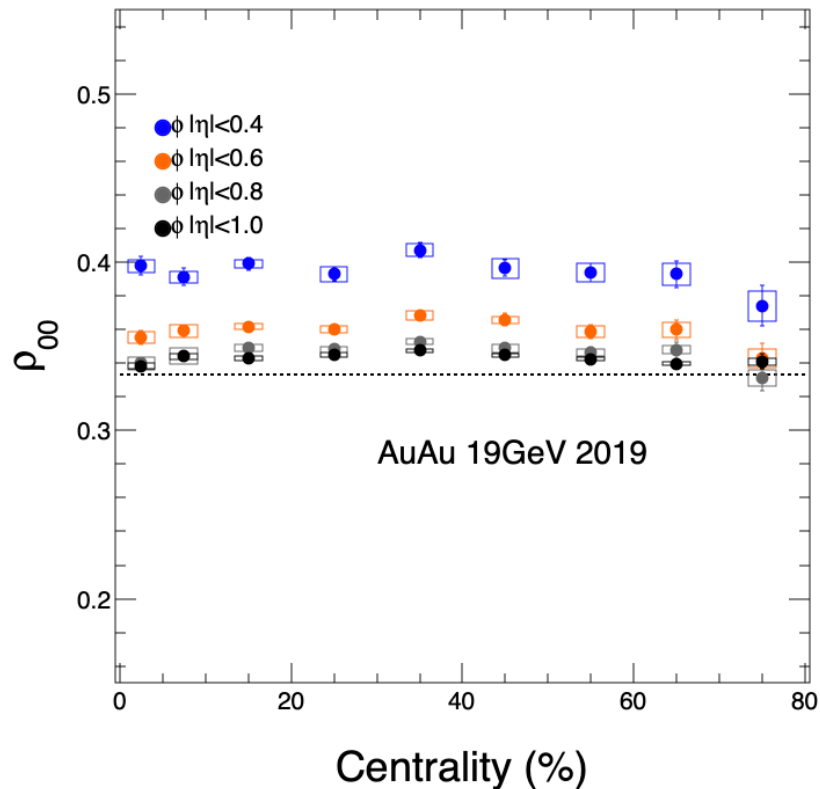
AuAu 19.6 GeV  
 $|y| < 1.5$

# $|\eta|$ cut study (centrality)

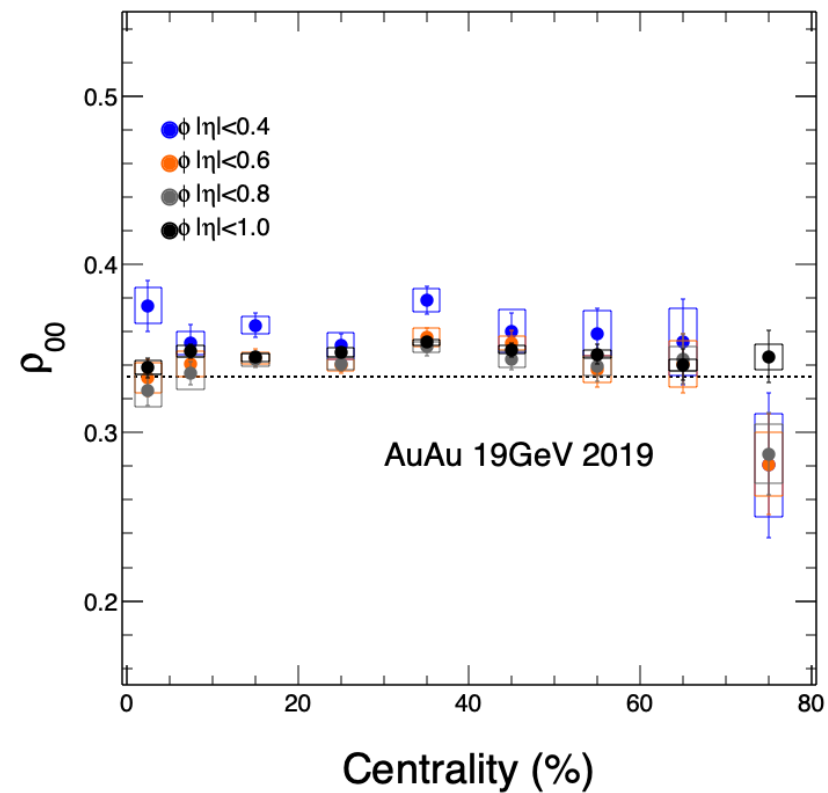
Raw



Efficiency Corrected



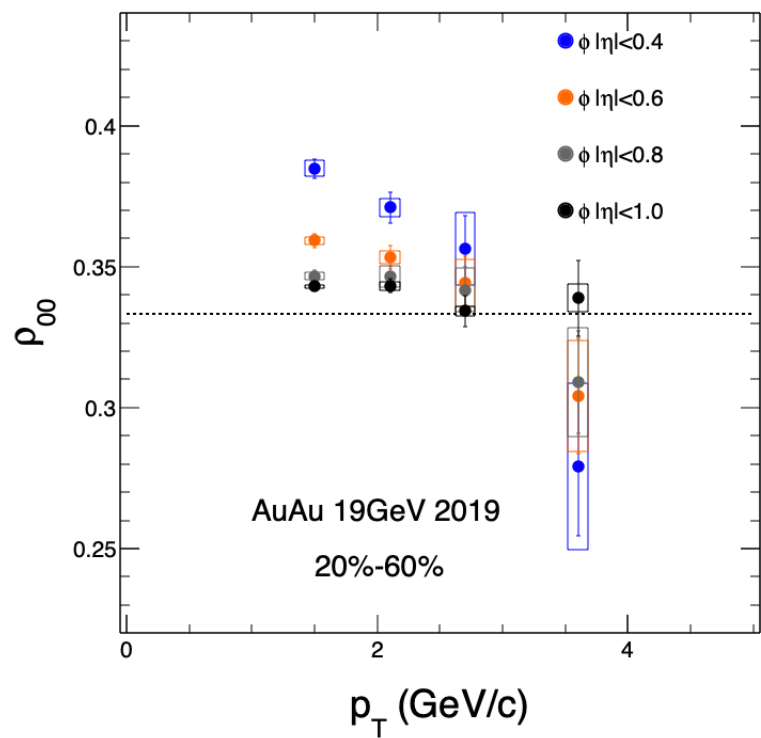
Fully Corrected



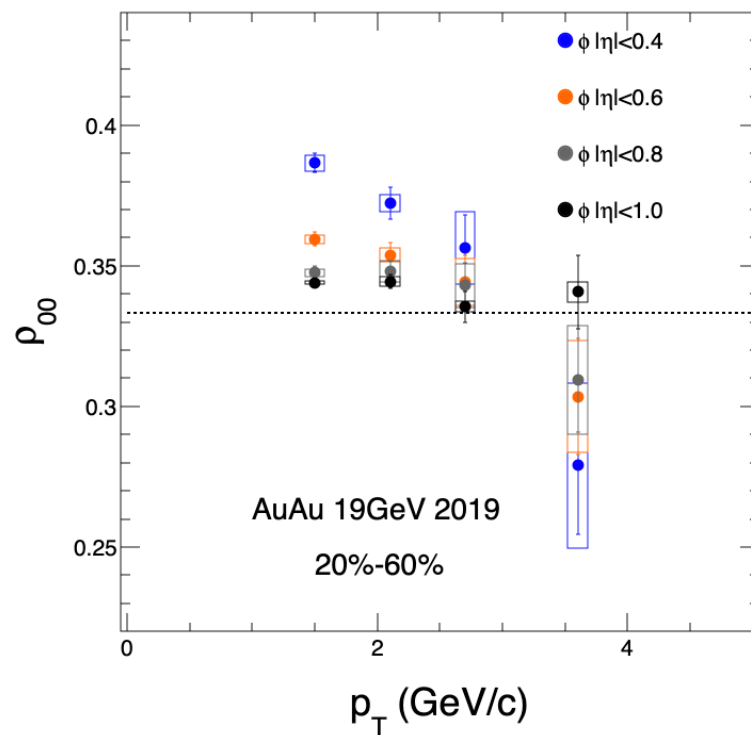
AuAu 19.6 GeV  
 $|y| < 1.5$   
20-60%

# $|\eta|$ cut study ( $p_T$ )

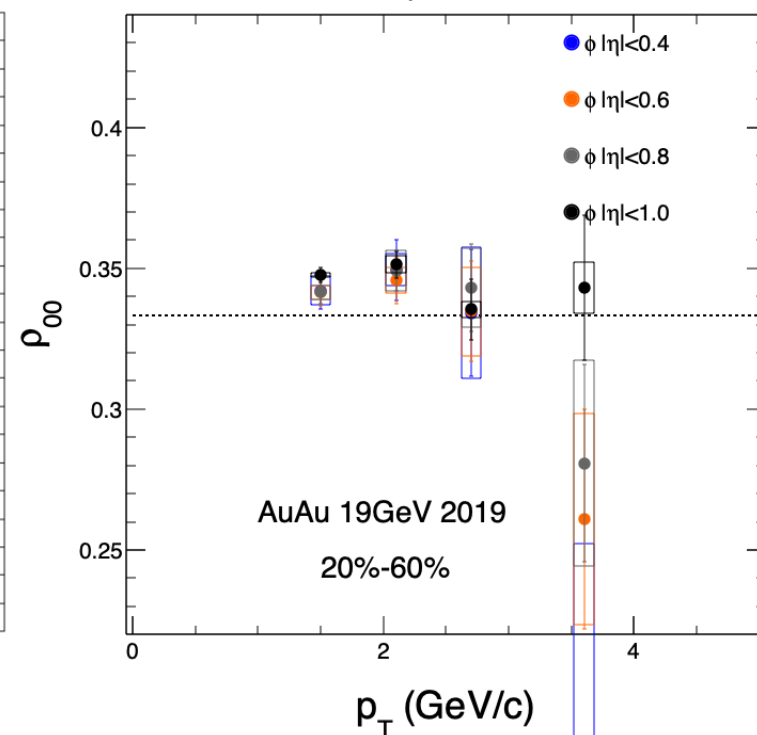
Raw



Efficiency Corrected



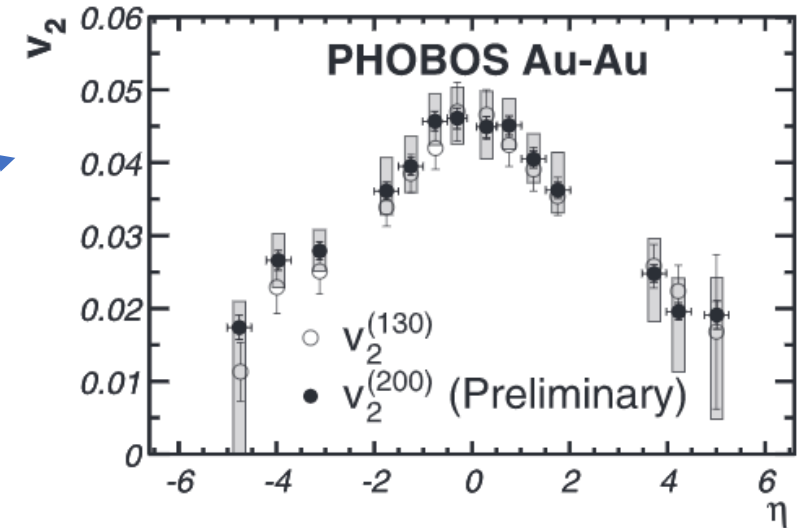
Fully Corrected



# $|\eta|$ cut study

Possible Issues:

- Flat input rapidity distribution?
- $v_2$  higher for smaller  $|\eta|$  cut?
  - Current input  $v_2$  is from BES-I with  $|\eta| < 1$



# Summary and Outlook

## 19.6 GeV $\rho_{00}$

- $\eta$  cut study for pT, centrality, and y dependence.
  - Still appears to be some discrepancy between  $\eta$  cuts ( $< 0.4$  most obvious).
  - What could cause this?
- EP Resolution study (simulate EP effect)  $\rightarrow$  delayed by scheduler
- EP Resolution + Acceptance study  $\rightarrow$  delayed by scheduler

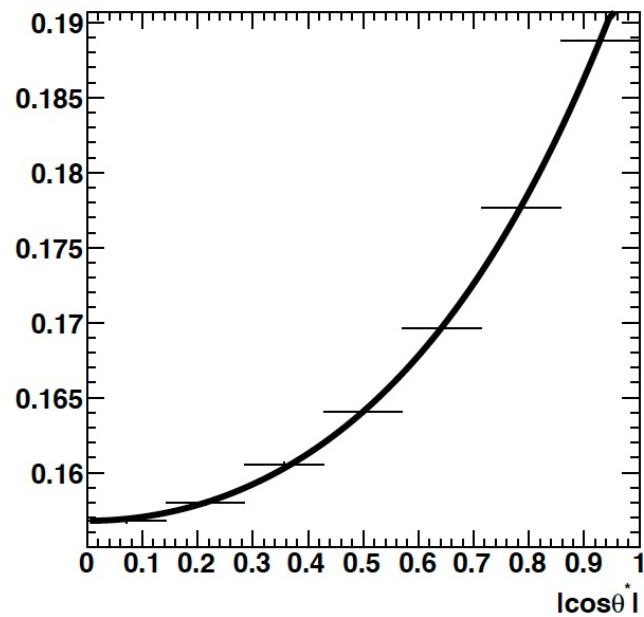
## 14.6 GeV $\rho_{00}$

- Need  $p_T$  spectra and  $v_2$  for efficiency and acceptance simulation.
- ToF Matching fits  $\rightarrow$  had to reproduce data set (scratch auto-deleted)

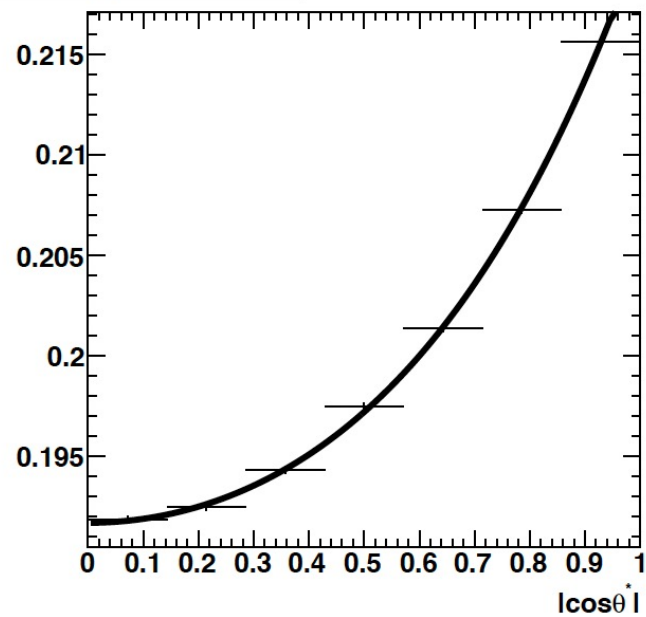
# BACKUP

$$|\eta| < 0.4$$

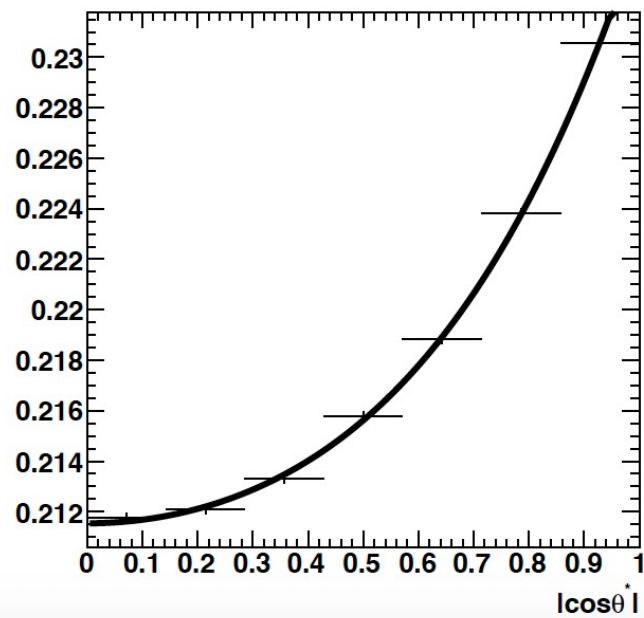
$1.2 < p_T < 1.8 \text{ GeV}/c$



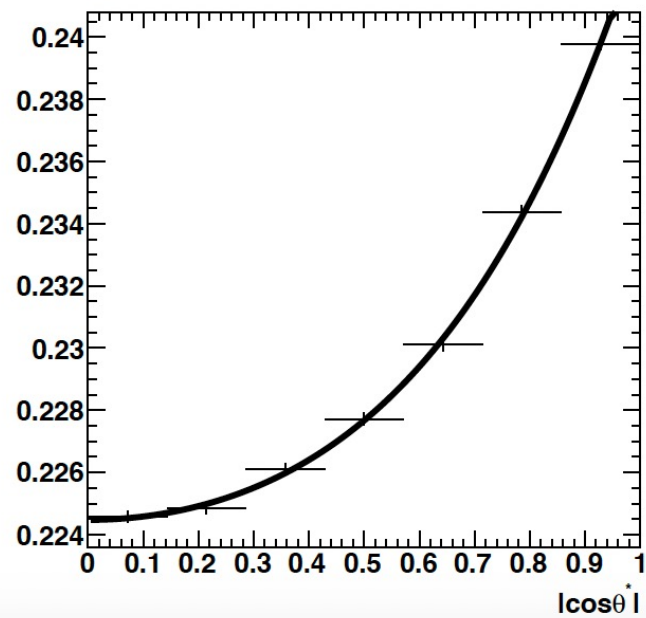
$1.8 < p_T < 2.4 \text{ GeV}/c$



$2.4 < p_T < 3.0 \text{ GeV}/c$

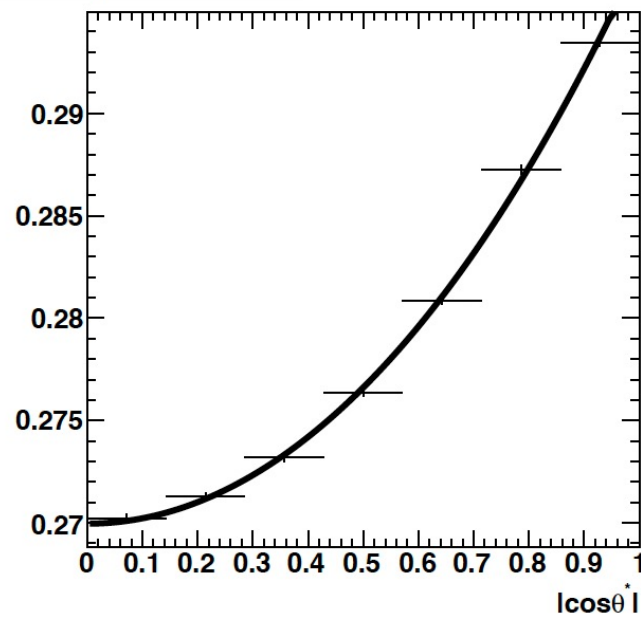


$3.0 < p_T < 4.2 \text{ GeV}/c$

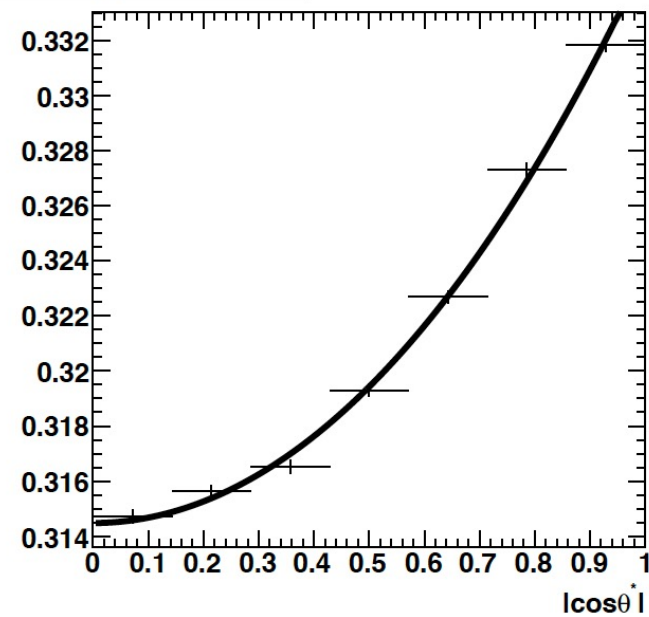


$$|\eta| < 0.6$$

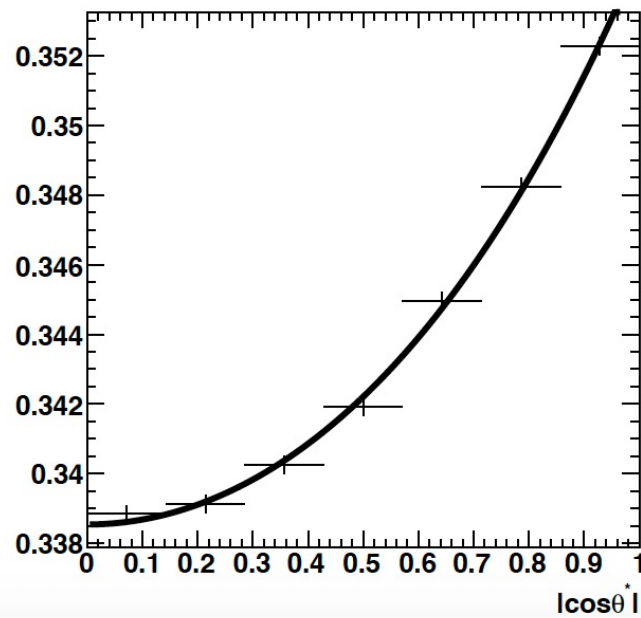
$1.2 < p_T < 1.8 \text{ GeV}/c$



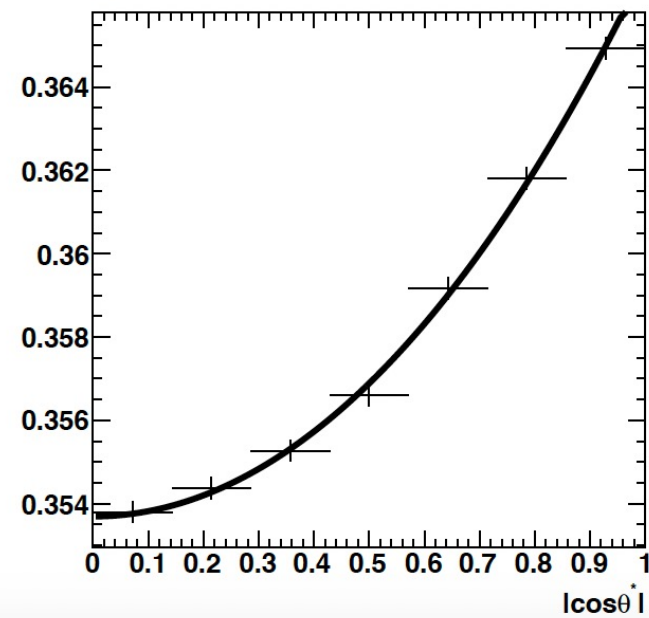
$1.8 < p_T < 2.4 \text{ GeV}/c$



$2.4 < p_T < 3.0 \text{ GeV}/c$



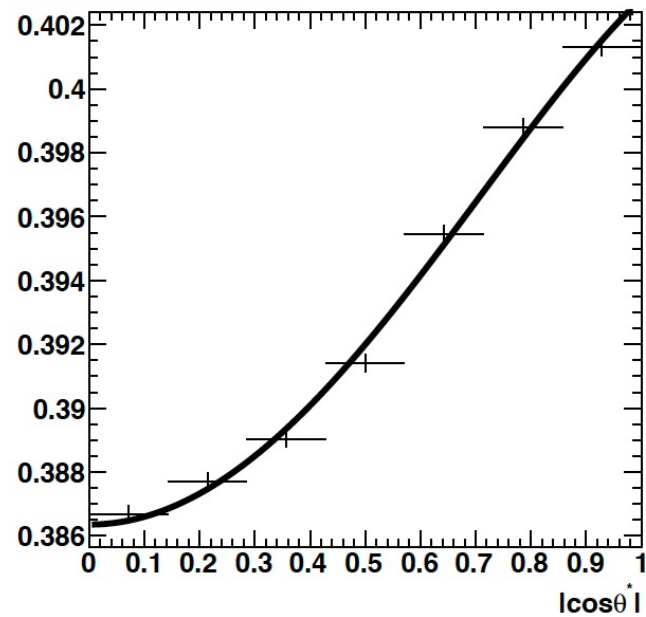
$3.0 < p_T < 4.2 \text{ GeV}/c$



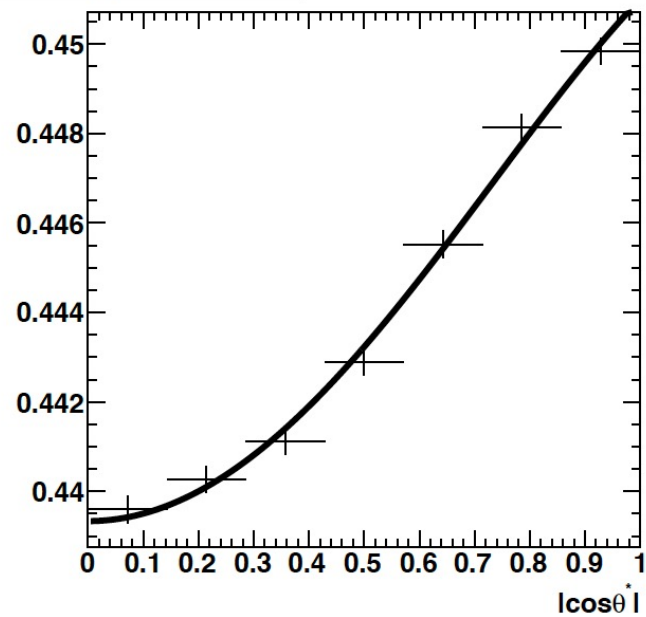


$$|\eta| < 0.8$$

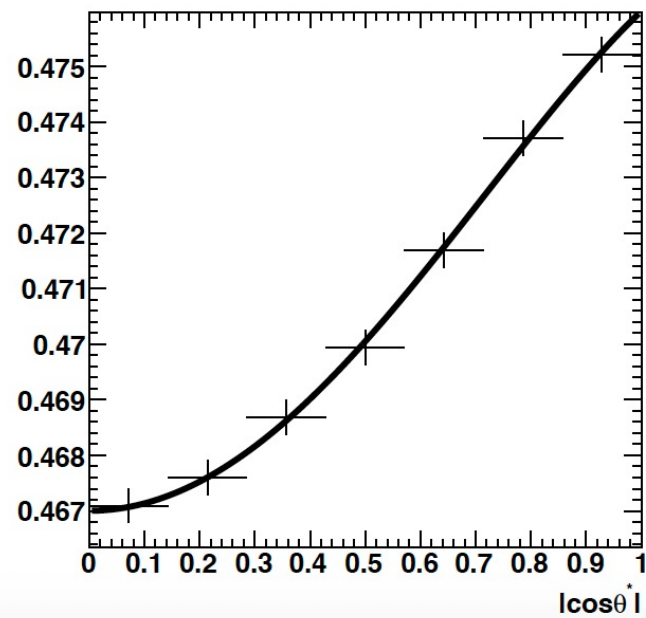
$1.2 < p_T < 1.8 \text{ GeV}/c$



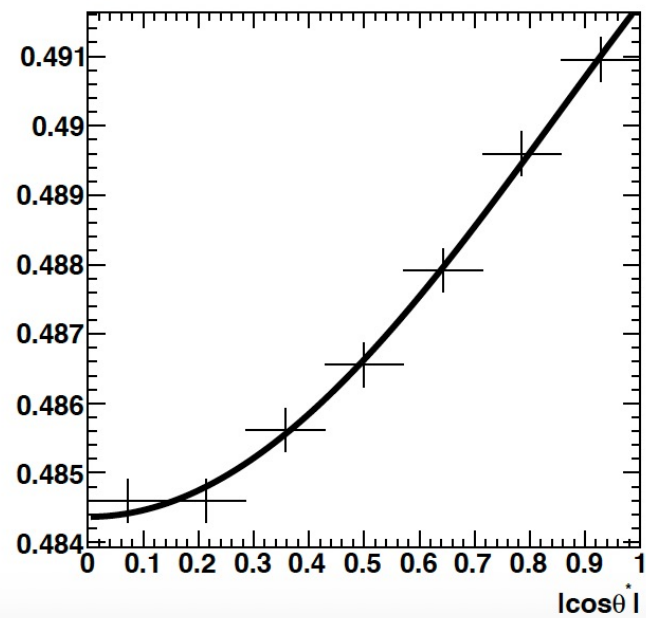
$1.8 < p_T < 2.4 \text{ GeV}/c$



$2.4 < p_T < 3.0 \text{ GeV}/c$

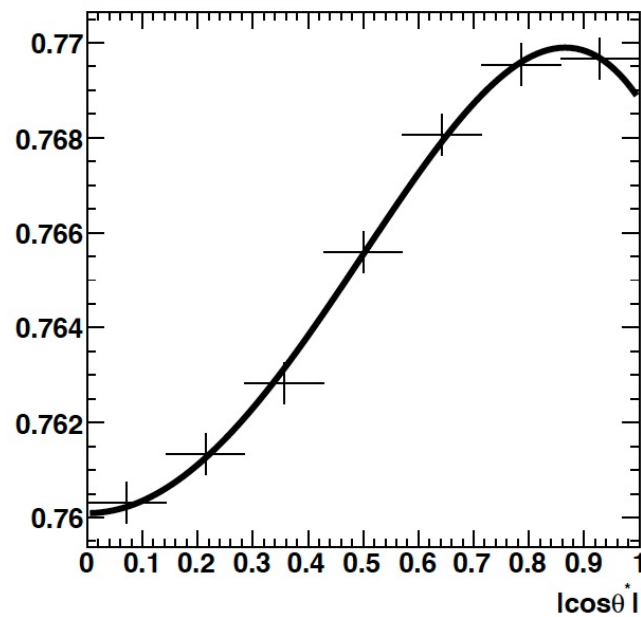


$3.0 < p_T < 4.2 \text{ GeV}/c$

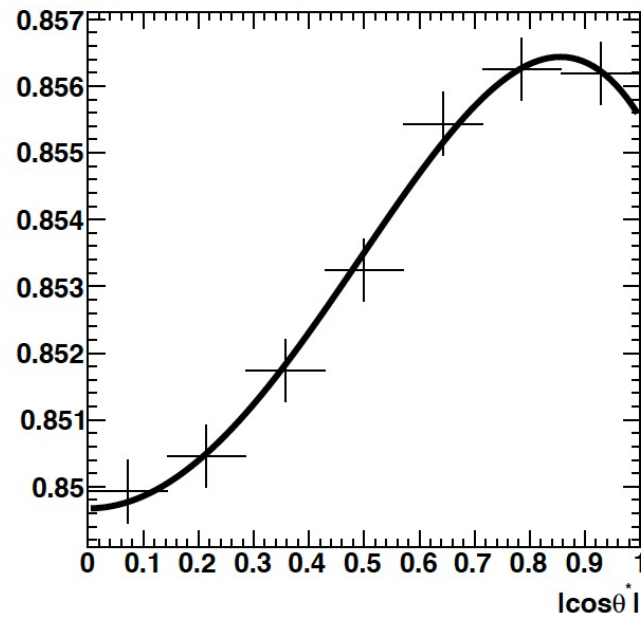


$$|\eta| < 1.0$$

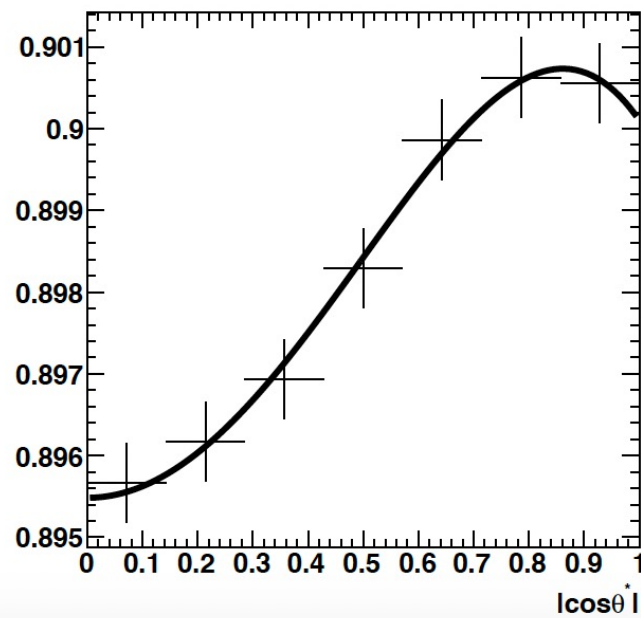
$1.2 < p_T < 1.8 \text{ GeV}/c$



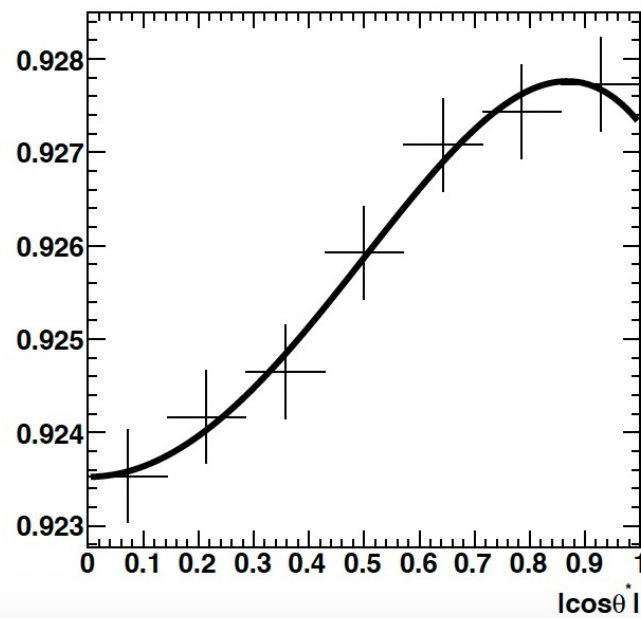
$1.8 < p_T < 2.4 \text{ GeV}/c$



$2.4 < p_T < 3.0 \text{ GeV}/c$



$3.0 < p_T < 4.2 \text{ GeV}/c$



# Deriving 4<sup>th</sup> Order Acceptance Correction

$$\left[ \frac{dN}{d \cos \theta^* d\beta} \right]_{|\eta|} = \frac{dN}{d \cos \theta^* d\beta} \times g(\theta^*, \beta).$$

$$g(\theta^*, \beta) = 1 + F \cos^2 \theta + G \cos^4 \theta$$

$$\begin{aligned} &= 1 + \left( \frac{4F + 3G}{8} \right) - \left( \frac{2F + 3G}{4} \right) \cos^2 \theta^* + \frac{3G}{8} \cos^4 \theta^* \\ &\quad - \frac{\cos 2\beta}{2} [F(1 - \cos^2 \theta^*) + G(1 - \cos^2 \theta^* + \cos^4 \theta^*)] \\ &\quad + \frac{G \cos 4\beta}{8} [1 - \cos^2 \theta^* + \cos^4 \theta^*], \end{aligned}$$

$$\int_0^{2\pi} d\beta g(\theta^*, \beta) = g(\theta^*) \propto 1 + \left( \frac{4F+3G}{8} \right) - \left( \frac{2F+3G}{4} \right) \cos^2 \theta^* + \frac{3G}{8} \cos^4 \theta^*.$$

# Deriving 4<sup>th</sup> Order Acceptance Correction

$$\frac{dN}{d \cos \theta^* d\beta} \propto 1 + A \cos^2 \theta^* + B \sin^2 \theta^* \cos 2\beta + C \sin 2\theta^* \cos \beta .$$

$$\begin{aligned} \left[ \frac{dN}{d \cos \theta^* d\beta} \right]_{|\eta|} &\propto 2 + F - \frac{BF}{2} + \frac{3G}{4} - \frac{BG}{2} \\ &+ \left[ 2A - F(1 - A - B) - G \left( \frac{3}{2} - \frac{3A}{4} - \frac{3B}{2} \right) \right] \cos^2 \theta^* \\ &+ \left[ -F \left( A + \frac{B}{2} \right) + G \left( \frac{3}{4} - \frac{3A}{2} - \frac{3B}{2} \right) \right] \cos^4 \theta^* \\ &+ \left[ G \left( \frac{3A}{4} + \frac{B}{2} \right) \right] \cos^6 \theta^* . \end{aligned}$$

$$A = \frac{A'(1 + 3R)}{4 + A'(1 - R)} , \quad B = \frac{A'(1 - R)}{4 + A'(1 - R)} , \quad A' = \frac{3\rho_{00} - 1}{1 - \rho_{00}}$$

