PHENIX PLHF PWG
Three particle Bose-Einstein correlation

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Details of analysis

- PPG194 generalized to three particle
- Same event-mixing method to measure correlation as in PPG194
- Same global, track and pair cuts as PPG194
- Coulomb-correction from Generalized Riverside
- Goal: three particle correlation strength:

$$\lambda_3 \equiv C_3(k_{12} = k_{13} = k_{23} = 0) - 1$$

Quantum statistical correlation function

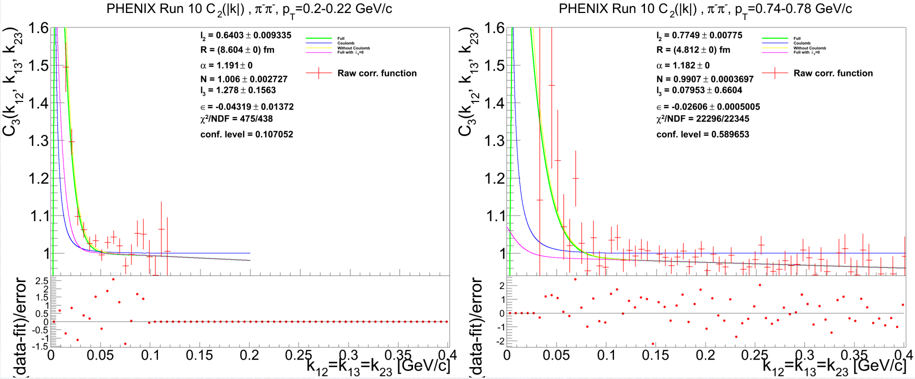
- Correlation function: $C_3(\boldsymbol{k_1}, \boldsymbol{k_2}, \boldsymbol{k_3}) = C_3^{(0)}(\boldsymbol{k_1}, \boldsymbol{k_2}, \boldsymbol{k_3}) K(\boldsymbol{k_1}, \boldsymbol{k_2}, \boldsymbol{k_3})$
- Approximation for $C_3^{(0)}$ can be derived (similar as in PPG194):

$$C_3^{(0)}(k_{12}, k_{13}, k_{23}) = 1 + \ell_3 e^{-0.5(|2k_{12}R|^\alpha + |2k_{13}R|^\alpha + |2k_{23}R|^\alpha)} + \ell_2 \left(e^{|2k_{12}R|^\alpha} + e^{|2k_{13}R|^\alpha} + e^{|2k_{23}R|^\alpha} \right) \quad (1)$$

- Background: $N(1+\epsilon k_{12})(1+\epsilon k_{13})(1+\epsilon k_{23})$
- Fitted parameters: $\ell_2, \ell_3, \epsilon, N$
- We already know (from PPG194): R, α
- We are looking for: $\lambda_3 \equiv C_3(k_{12} = k_{13} = k_{23} = 0) - 1 = \ell_3 + 3\ell_2$

Diagonal visualization of fits

- Visualization in $k_{12} = k_{13} = k_{23}$ subspace (3D not possible): shows good fits
- Fitted: ℓ_2, ℓ_3, ϵ, N; Fixed (PPG194): R, α
- Consistency check: fit α, R $\rightarrow$ same as in PPG194

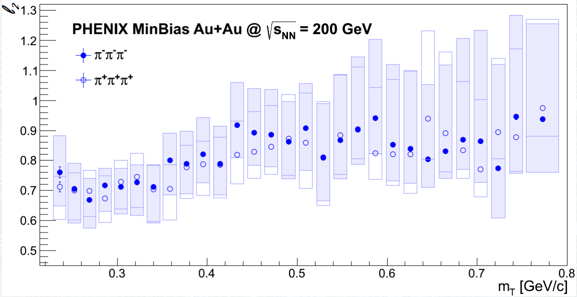


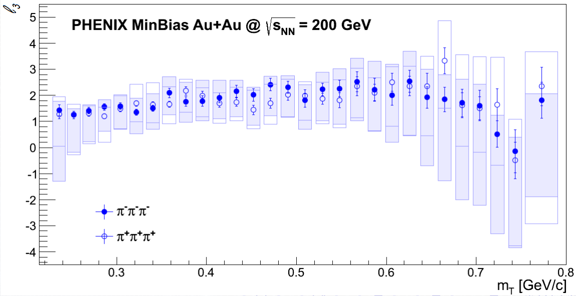
Systematic error analysis

- Same cuts as in PPG 194
- PID arm: East, West, Both
- Fit range: 3 ranges
- PID cut: 3 cut settings
- PID det. matching cut: 3 cut settings
- PC3 matching cut: 3 cut settings
- PID det. pair cut: 3 cut settings
- DC pair cut: 3 cut settings

Fit parameter ℓ_2 and ℓ_3

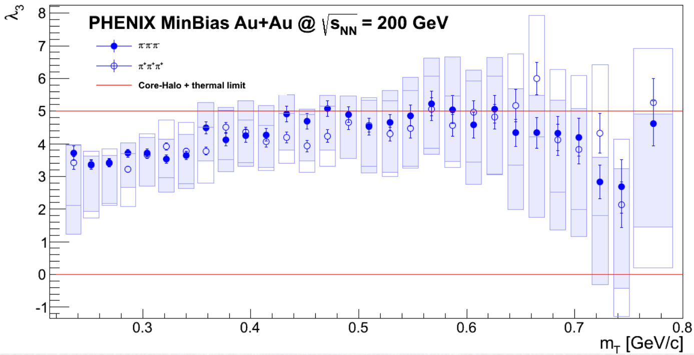
- Fitted: ℓ_2, ℓ_3, ϵ, N;
  Fixed (PPG194): R, α
- ℓ_3 true three particle correlation strength
- ℓ_2 two particle correlation (part of three particle corr.) strength





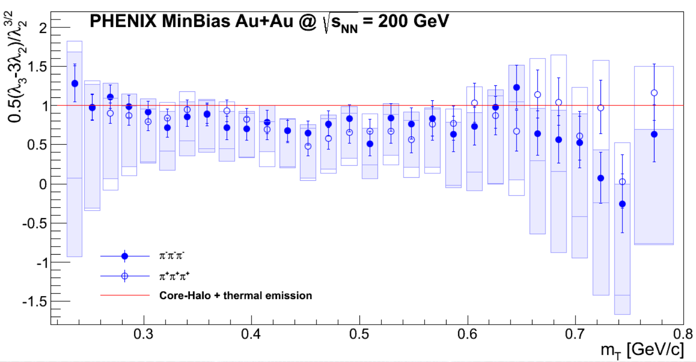
Derived parameter: λ_3

- Fitted: ℓ_2, ℓ_3, ϵ, N; Fixed (PPG194): R, α
- $\lambda_3 \equiv C_3(k_{12} = k_{13} = k_{23} = 0) - 1 = \ell_3 + 3\ell_2$
- Fully thermal emission, no Halo: $\lambda_3 = 5$
- Core-Halo + thermal: $0 < \lambda_3 < 5$



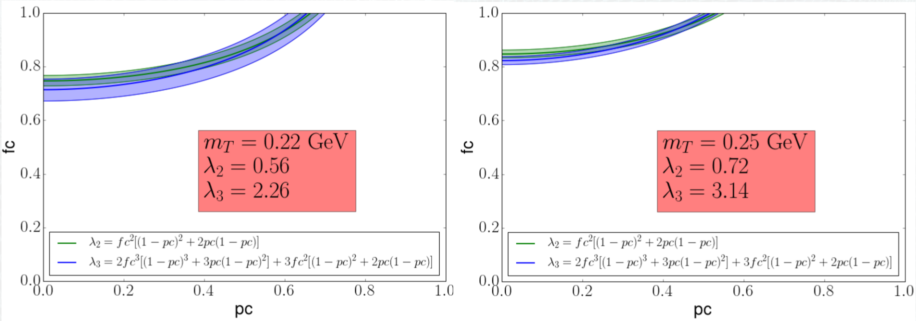
Core-Halo independent parameter

- $\kappa_3 \equiv \frac{\lambda_3 - 3\lambda_2}{2\sqrt{\lambda_2^3}}$ not depend on f_c ($f_c = \text{core}/(\text{core} + \text{halo})$)
- λ_2 from PPG194
- Real systematic error: cut modification applied to λ_2
- Core-Halo + thermal emission: $\kappa_3 = 1$
- additional effect (eg. not fully thermal): $\kappa_3 \neq 1$



f_c vs p_c

- Partial coherence (p_c = coherent/(coherent + incoherent), f_c = core/(core + halo)):
  $\lambda_2 = f_c^2\left[(1-p_c)^2 + 2p_c(1-p_c)\right]$
  $\lambda_3 = 2f_c^3\left[(1-p_c)^3 + 3p_c(1-p_c)^2\right] + 3f_c^2\left[(1-p_c)^2 + 2p_c(1-p_c)\right]$



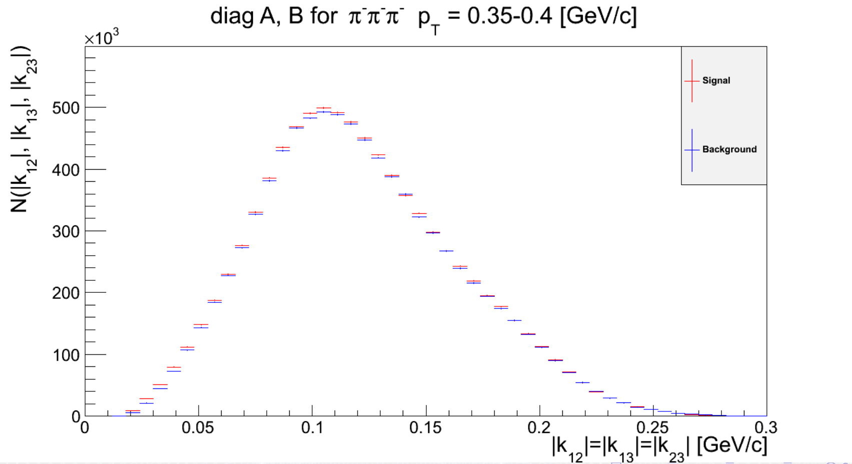
Summary

- We will ask perliminary for: diagonal visualization of fit (1), λ_3, κ_3, 1-2 $f_c - p_c$ plot
- Same cuts for systematic error analysis as in PPG194
- Systematic error shows λ_3, κ_3 in Core-Halo model range
- Analysis note in progress, soon will be finished

Details of measurement

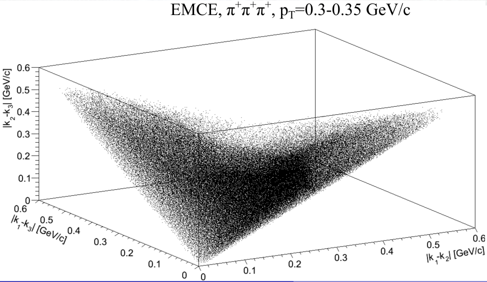
- Low bin behavior:

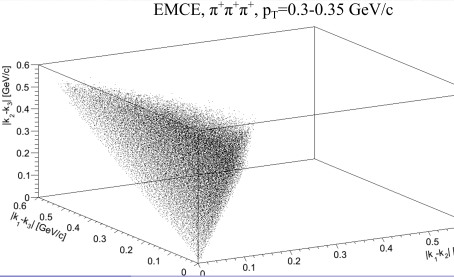
$$k_{ij} \to 0 \quad \overset{?}{\Longrightarrow} \quad A, B \to 0 \tag{2}$$



Details of measurement

- The correlation: $C_3(k_{12}, k_{13}, k_{23}) = \frac{A(k_{12},k_{13},k_{23})}{B(k_{12},k_{13},k_{23})} \frac{\int B}{\int A}$
- Triangle inequality for $\vec{k}_{12},\ \vec{k}_{13},\ \vec{k}_{23}$
- Order within triplet doesn't matter
- But when we measure do matter $\Rightarrow$ we have to fold the histogram
  $A(5,6,7) += \ A(6,7,5)\ +\ A(7,5,6)\ +\ A(5,7,6)\ + \ldots$





Coulomb correction

- Corrected model:

$$C_3(k_{12}, k_{13}, k_{23}) = C_3^{(0)}(k_{12}, k_{13}, k_{23}) \cdot K_3(k_{12}, k_{13}, k_{23}) \tag{3}$$

- "Generalized Riverside" method for 3 particle Coulomb problem

$$K_3(k_{12}, k_{13}, k_{23}) \approx K_1(k_{12})K_1(k_{13})K_1(k_{23}) \tag{4}$$