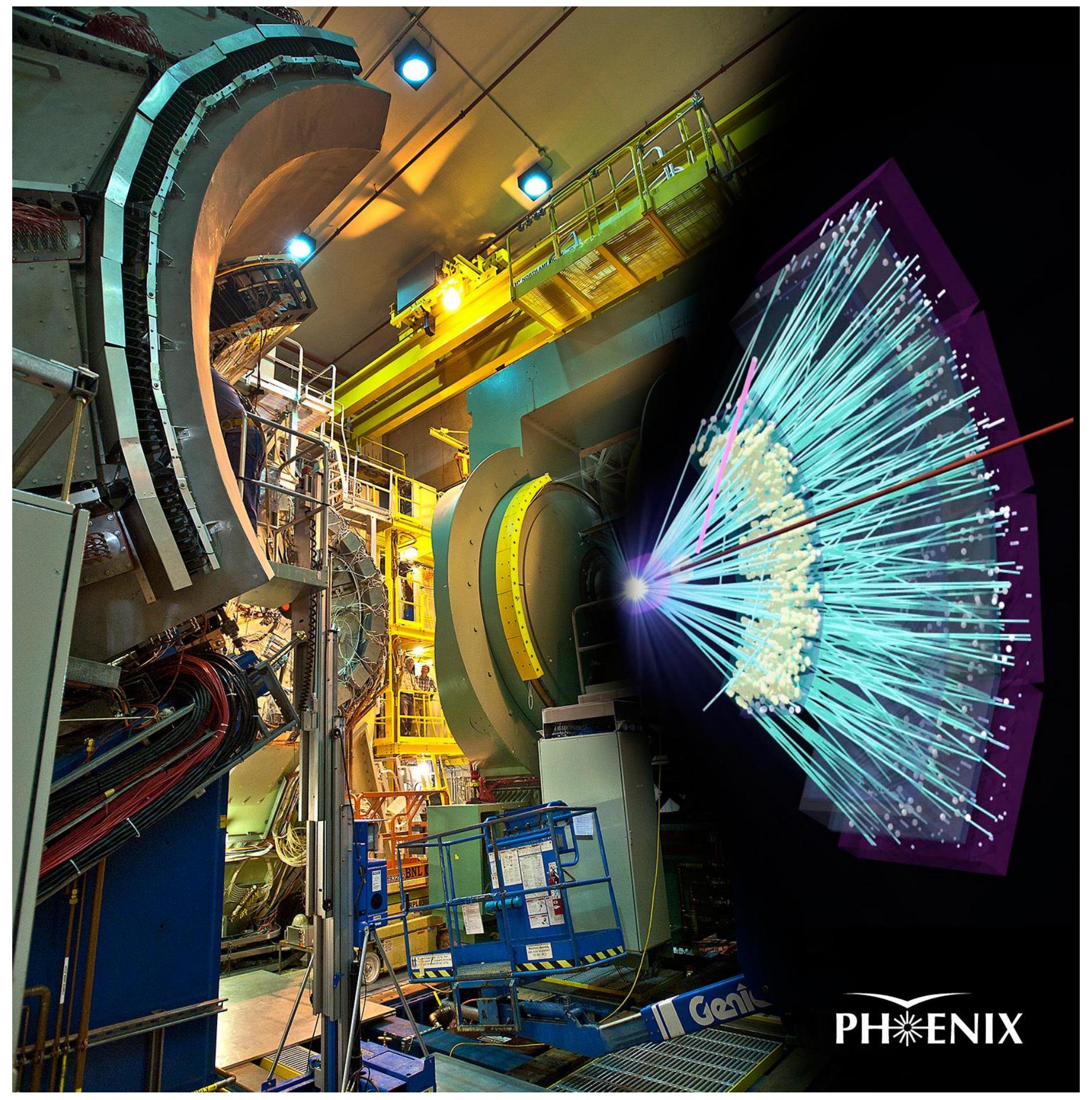


Bálint Kurygis (Eötvös University, Budapest) for the PHENIX Collaboration

## The PHENIX experiment at RHIC



PHENIX

- Collisions of various nuclei,  $\sqrt{s_{NN}} = 7.7 - 200$  GeV
- Charged pion ID from  $\sim 0.2$  to  $2$  GeV/c

## Bose-Einstein correlations map out the femtometer source

- Invariant single particle distributions:  $N_1(p_1), N_1(p_2)$ , and pair momentum distribution:  $N_2(p_1, p_2)$
- The definition of the correlation function:
$$C_2(p_1, p_2) = \frac{N_2(p_1, p_2)}{N_1(p_1)N_1(p_2)}, \quad N_2(p_1, p_2) = \int S(x_1, p_1)S(x_2, p_2)|\Psi_2(x_1, x_2)|^2 d^4x_2 d^4x_1$$
- $S(x, p)$  source function (usually assumed to be Gaussian - Levy if more general, c.f. anomalous diffusion)
- $\Psi_2$  two-particle wave function - interaction free case:  $|\Psi_2|^2 = 1 + \cos(qx)$
- Leads to  $\tilde{S}$ , the Fourier-transformed of  $S$ 

$$C_2(q, K) \simeq 1 + \left| \frac{\tilde{S}(q, K)}{\tilde{S}(0, K)} \right|^2, \quad \tilde{S}(q, p) = \int S(x, p) e^{iqx} d^4x$$

$$K = (p_1 + p_2)/2$$

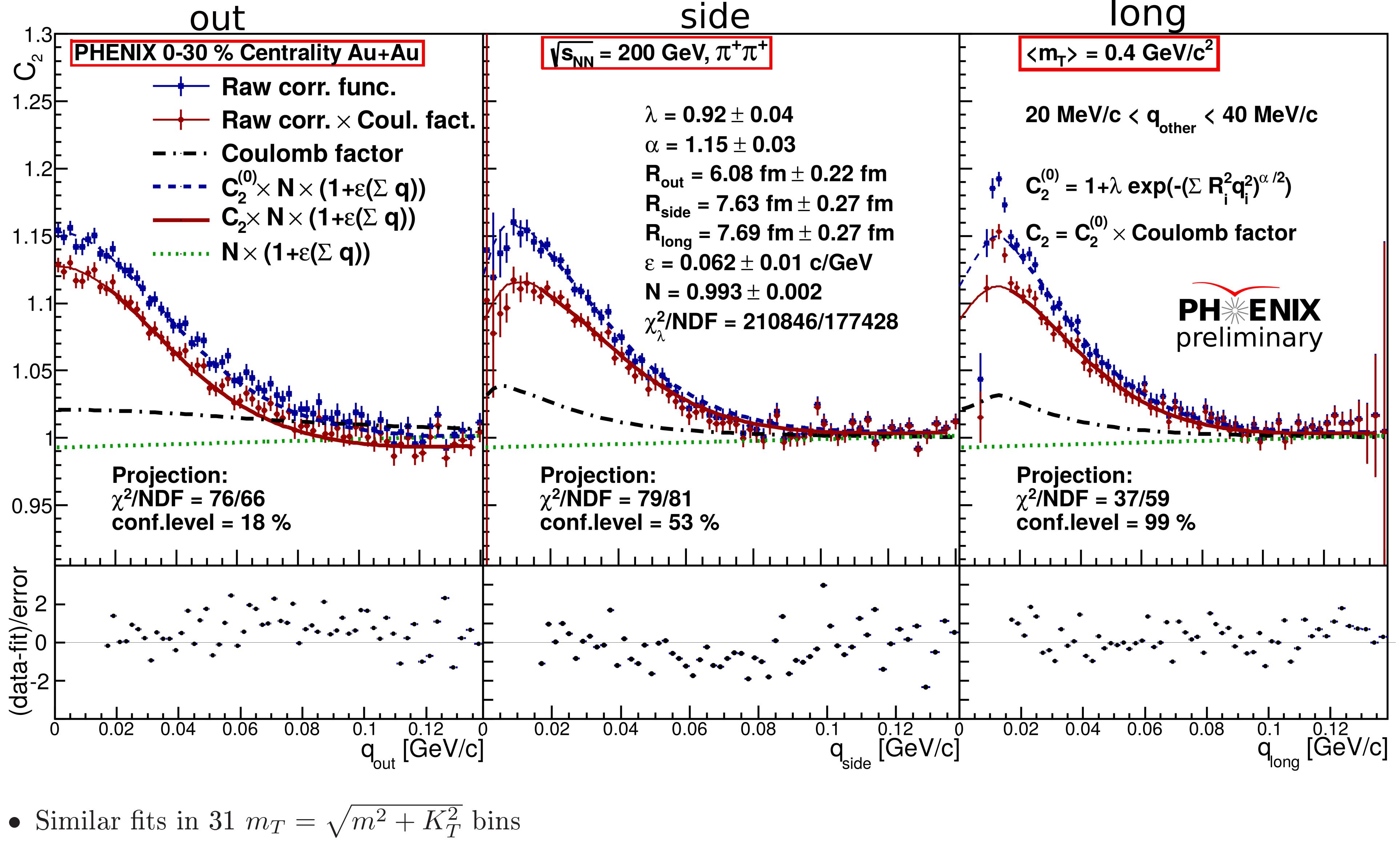
$$q = p_1 - p_2, \quad q \ll K$$
- Identical charged pions - Coulomb interaction distorts the simple picture
  - Method of handling: Coulomb-correction factor:  $C_2^{\text{pure Bose-Einstein}}(q) = K^{\text{Coulomb}}(q) \cdot C_2^{\text{meas.}}(q)$
  - In this analysis: iterative handling with spherically symmetric source approximation
- Two-component pion source:  $S = S_{\text{core}} + S_{\text{halo}}$ 
  - Correlation strength measures core fraction:  $\sqrt{\lambda} = \text{core}/(\text{core+halo})$

## The Levy-distribution as source function

- Expanding hadron resonance gas, increasing mean free path  $\rightarrow$  Levy-flight
- Anomalous diffusion, generalized central limit theorem  $\rightarrow$  Levy-distribution
- Source function:  $\mathcal{L}(\alpha, \mathbf{R}, \mathbf{r}) = (2\pi)^{-3} \int d^3q e^{i\mathbf{qr}} e^{-\frac{1}{2}|\mathbf{qR}|^\alpha}, \alpha = 1 : \text{Cauchy}, \alpha = 2 : \text{Gauss}$
- Shape of the correlation function:  $C_2(\mathbf{q}) = 1 + \lambda \cdot e^{-(\sum R_i^2 q_i^2)^{\alpha/2}}$

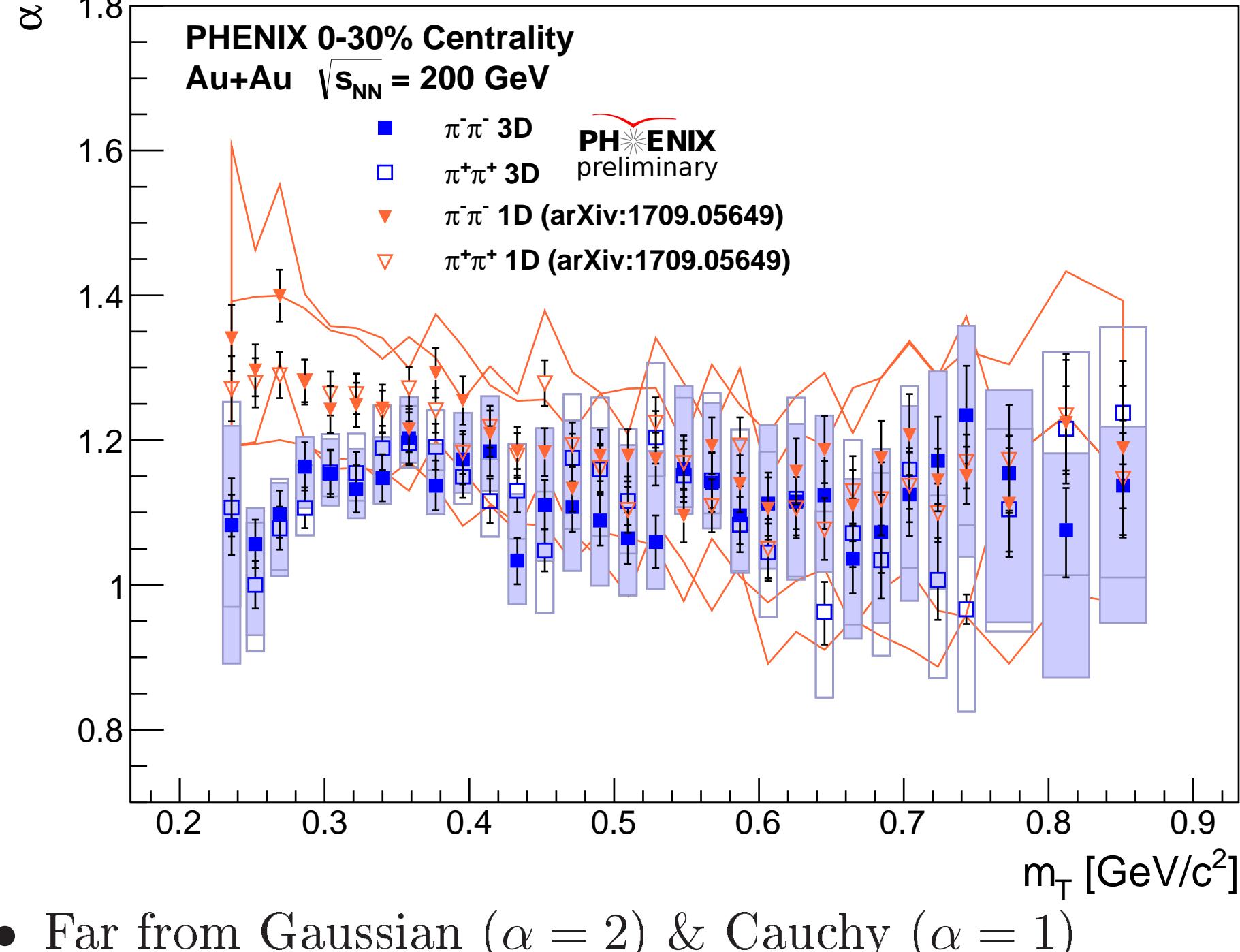
T. Csörgő et al., Eur.Phys.J. C36 (2004) 67

## Example correlation function

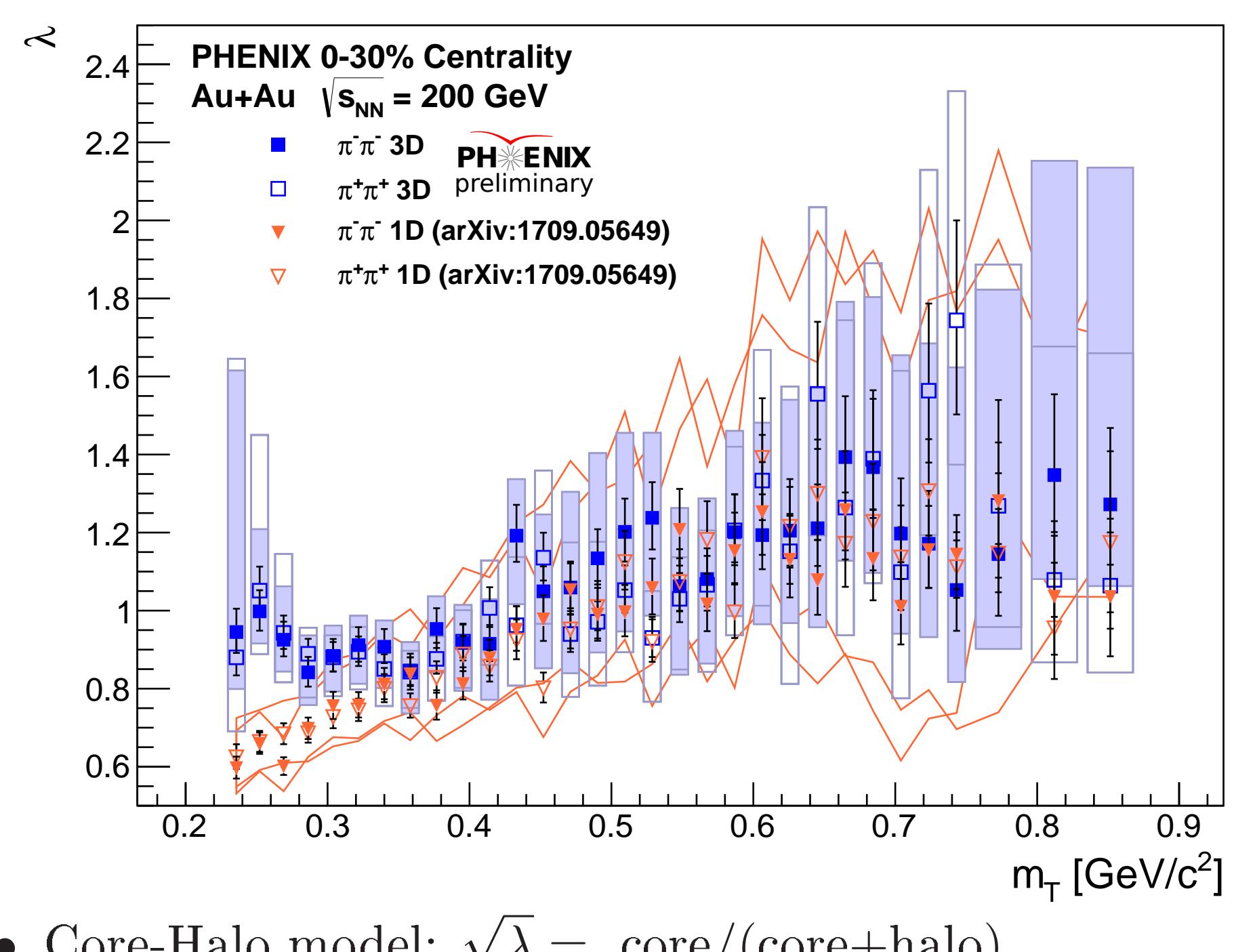


- Similar fits in 31  $m_T = \sqrt{m^2 + K_T^2}$  bins

## Levy exponent $\alpha$ vs. $m_T$



## Correlation strength $\lambda$ vs. $m_T$



## Summary

- Bose-Einstein correlations with Levy source
  - Hint for anomalous diffusion
  - Hydro not invalid even with  $\alpha \neq 2$
- Preliminary 3D Levy HBT results
  - $\alpha$  and  $\lambda$  same as if measured in 1D arXiv:1709.05649
  - Source is not spherical
- Future plans
  - Three-pion correlations
  - Pion-kaon comparison

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## Levy scale $R$ vs. $m_T$

