Pion-Kaon Femtoscopy in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV

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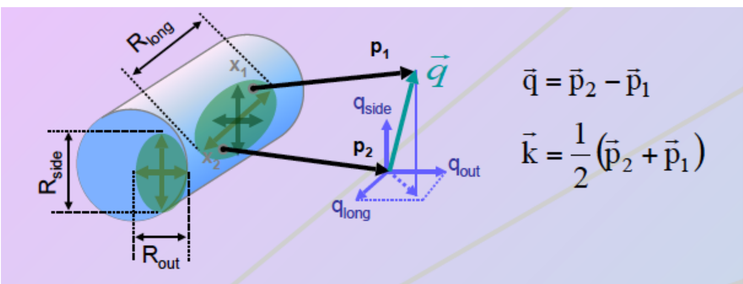
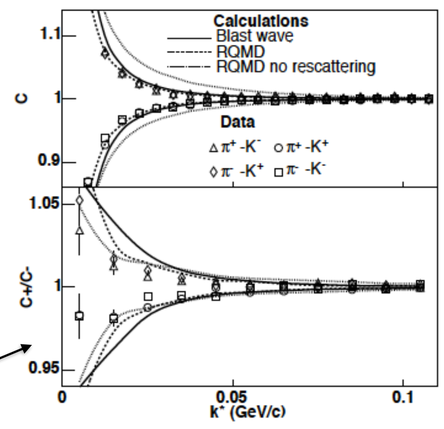
Introduction

Non-identical particle femtoscopy is sensitive to both source size and emission asymmetry in heavy ion collisions.

Probes asymmetry due to radial flow and emission shift due to resonance decays.

Direct and unambiguous test for presence of collectivity





STAR, PRL, 91 (2003) 262301
Au+Au@130 GeV

Correlation function

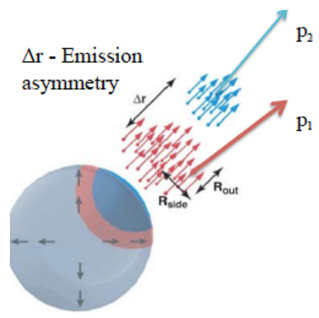
$$C(\mathbf{k}^*) = \frac{\int \mathbf{S}(\mathbf{r}^*, \mathbf{k}^*)|\psi_{\mathbf{XY}}(\mathbf{r}^*, \mathbf{k}^*)|^2}{\int \mathbf{S}(\mathbf{r}^*, \mathbf{k}^*))} \qquad \mathbf{r}^* = \mathbf{x_1} - \mathbf{x_2}$$

Source emission function

final state interactions (coulomb and strong)

Experimentally one measures

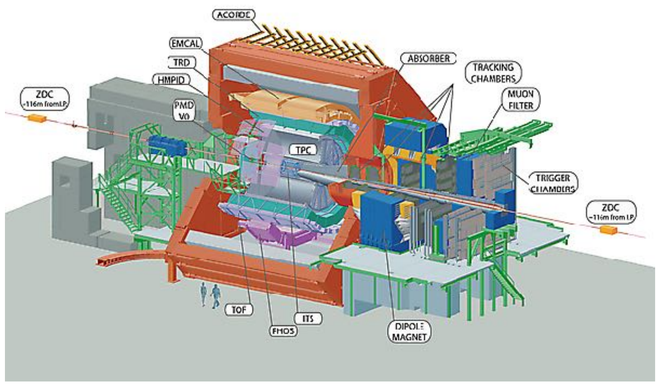
$$C(\mathbf{q}) = \mathbf{A_{XY}}(\mathbf{q})/\mathbf{B_{XY}}(\mathbf{q})$$

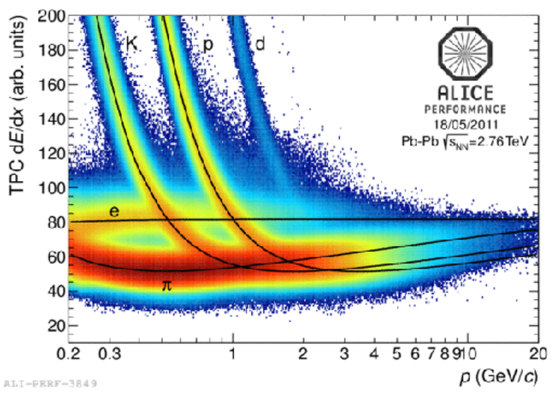


distribution of pairs of particle types X and Y with relative momentum q from same event

distribution of pairs of particle types X and Y with relative momentum q from different events

ALICE Experiment





Dedicated heavy ion experiment at the LHC

Excellent tracking and momentum information

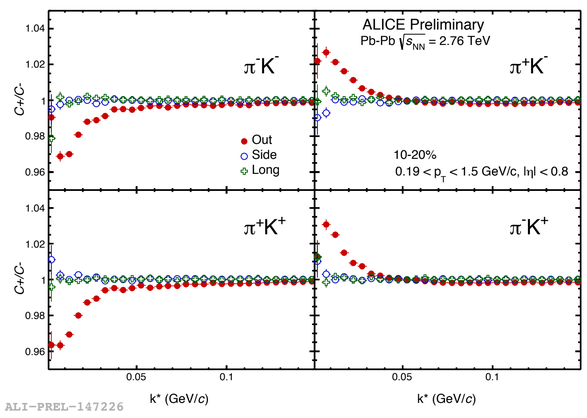
Efficient particle identification at low momentum

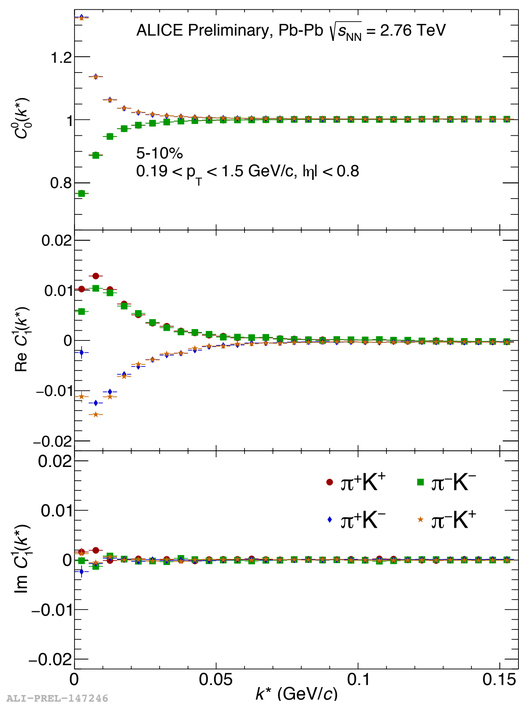
Results(I)

Double ratio : C^+/C^-

C^+ : **k*.v > 0**

C^- : **k*.v <0**





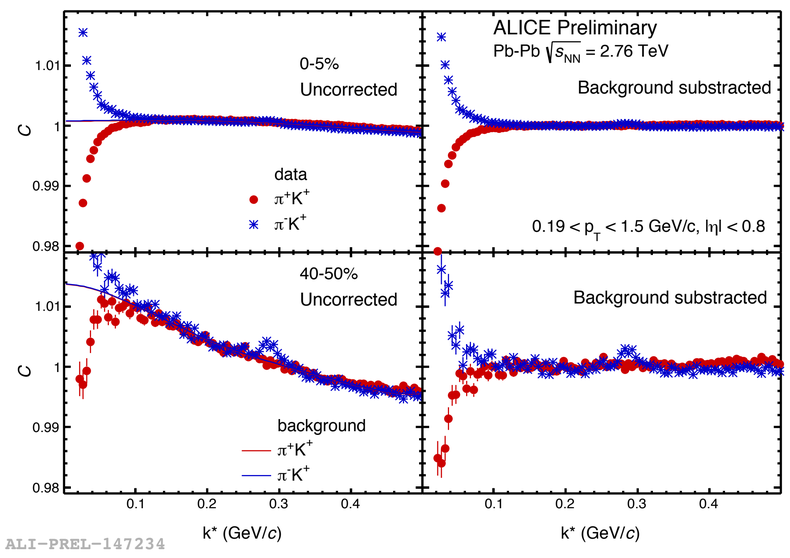
deviates from unity in out direction while consistent with unity in long and side directions

$\mathbb{R}C_1^1$ **: significantly deviates from unity**

$$C(\vec{\mathbf{k}}^*) = \sqrt{4\pi}\sum_{lm} C_{lm}(\vec{\mathbf{k}}^*)Y_{lm}(\theta,\phi)$$

Correlation function

Non- femtoscopic background present due to elliptic flow, global conservation of energy and momentum, residual correlations etc.



$$C^{ij}_{exp} = B^{ij} + |\psi^{ij}|^2$$

$$B^{ij} = a_0^{ij} + \sum_{i=1}^{5} x^{(l+1)}$$

$$C^{ij}_{real} = C^{ij}_{exp} - B^{ij}$$

where i, j are +,-

C^{ij}_{exp} experimental correlation function

B^{ij} polynomial background function

attractive for unlike -sign pairs

repulsive for like-sign pairs

Results (II)

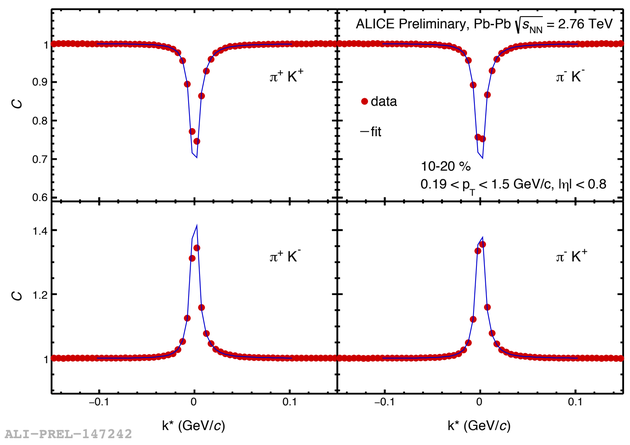
$$S(\mathbf{r}) = \exp\left(-\frac{(\mathbf{r_{out}} - \mu_{\mathbf{out}})^2}{\mathbf{R^2_{out}}} - \frac{\mathbf{r^2_{side}}}{\mathbf{R^2_{side}}} - \frac{\mathbf{r^2_{long}}}{\mathbf{R^2_{side}}}\right)$$

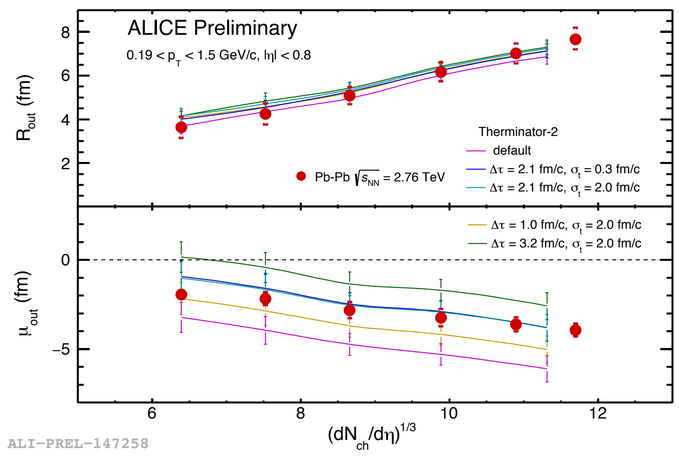
$\mathbf{R_{out}}, \mathbf{R_{side}}, \mathbf{R_{long}}$

↓

radii in out, side and long direction

μ_{out} **: emission asymmetry**





System size increases with event multiplicity and source size

Finite emission asymmetry observed. Pions are emitted closer to the centre of system than kaons

Conclusion

First measurement of pion-kaon femtoscopy in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV.

Significant and finite emission asymmetry observed which increases with centrality.

Strong indication of hydrodynamic evolution of the system created.

References

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