

# Kaon femtoscopy using THERMINATOR model

$K^+K^+$  and  $K^-K^-$  correlation functions

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# Outline

1. THERMINATOR

2. Femtoscopy

3. Result

4. Conclusion

# THERMINATOR

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# THERMal heavy-IoN generATOR

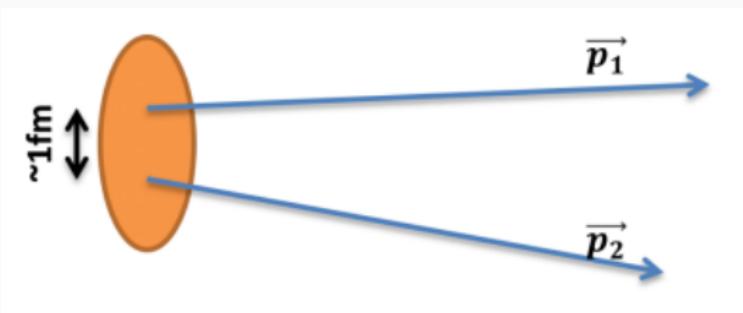
**THERMINATOR** (Monte Carlo generator) is used to simulate collisions of relativistic heavy ions.

Implements thermal models of particle production, assuming single freeze-out, which means that chemical and thermal freeze-out happen at the same time.

# Femtoscopy

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## Correlation function



$$C(\vec{p}_1, \vec{p}_2) = \frac{P_2(\vec{p}_1, \vec{p}_2)}{P_1(\vec{p}_1)P_1(\vec{p}_2)}$$

$P_2$  - the probability of finding two particles at the same place

$P_1$  - the probability of finding particle 1 and 2 separately

# Correlation function

$$C(\vec{q}) = \frac{A(\vec{q})}{B(\vec{q})}$$

$$\vec{q} = \vec{p}_2 - \vec{p}_1$$

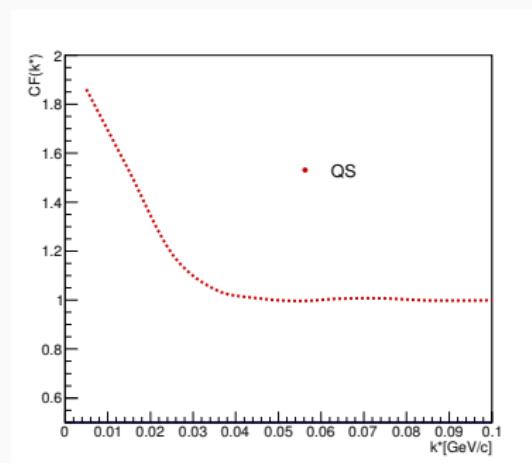
$A(\vec{q})$  - relative momentum distribution built from pairs taken from the same event

$B(\vec{q})$  - similar distribution of pairs from different events  
(mixed-event pairs)

# Correlation function

The shape of the kaons correlation function depends on:

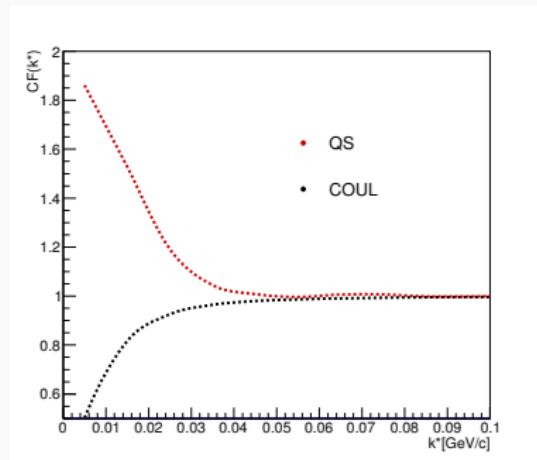
- Quantum Statistic effects (QS)



# Correlation function

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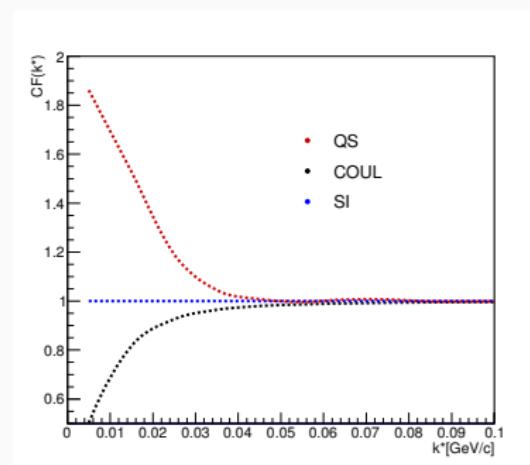
- Quantum Statistic effects (QS)
- Final State Interactions (FSI)
- Coulomb Interaction (COUL)



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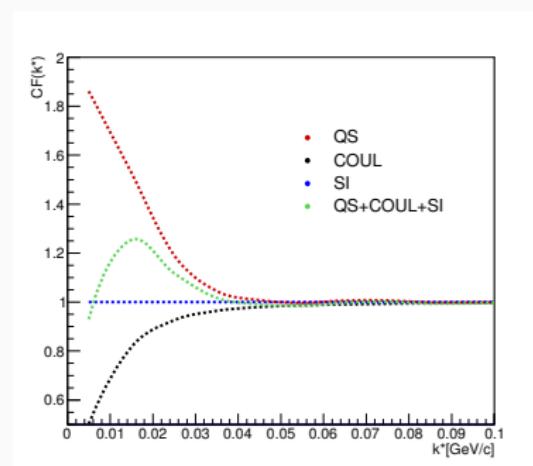
- Quantum Statistic effects (QS)
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  - Strong Interaction (SI)



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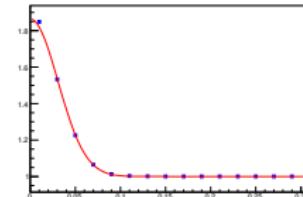
- Quantum Statistic effects (QS)
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# Fitting procedure

- The QS correlation function:

$$C(q_{inv}) = 1 + \lambda \exp[-R^2 q_{inv}^2]$$

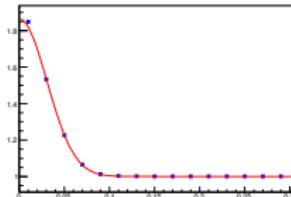


$\lambda$  - the correlation strength

# Fitting procedure

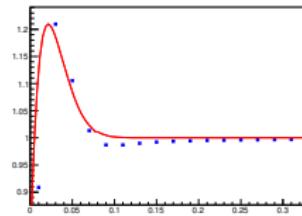
- The QS correlation function:

$$C(q_{inv}) = 1 + \lambda \exp[-R^2 q_{inv}^2]$$



- Bowler-Sinyukov formula:

$$C(q_{inv}) = 1 - \lambda + \lambda K(q_{inv})(1 + \exp[R^2 q_{inv}^2])$$



$\lambda$  - the correlation strength

$K(q_{inv})$  - Coulomb factor (the two-particle Coulomb wavefunction integrated over a static spherical Gaussian source)

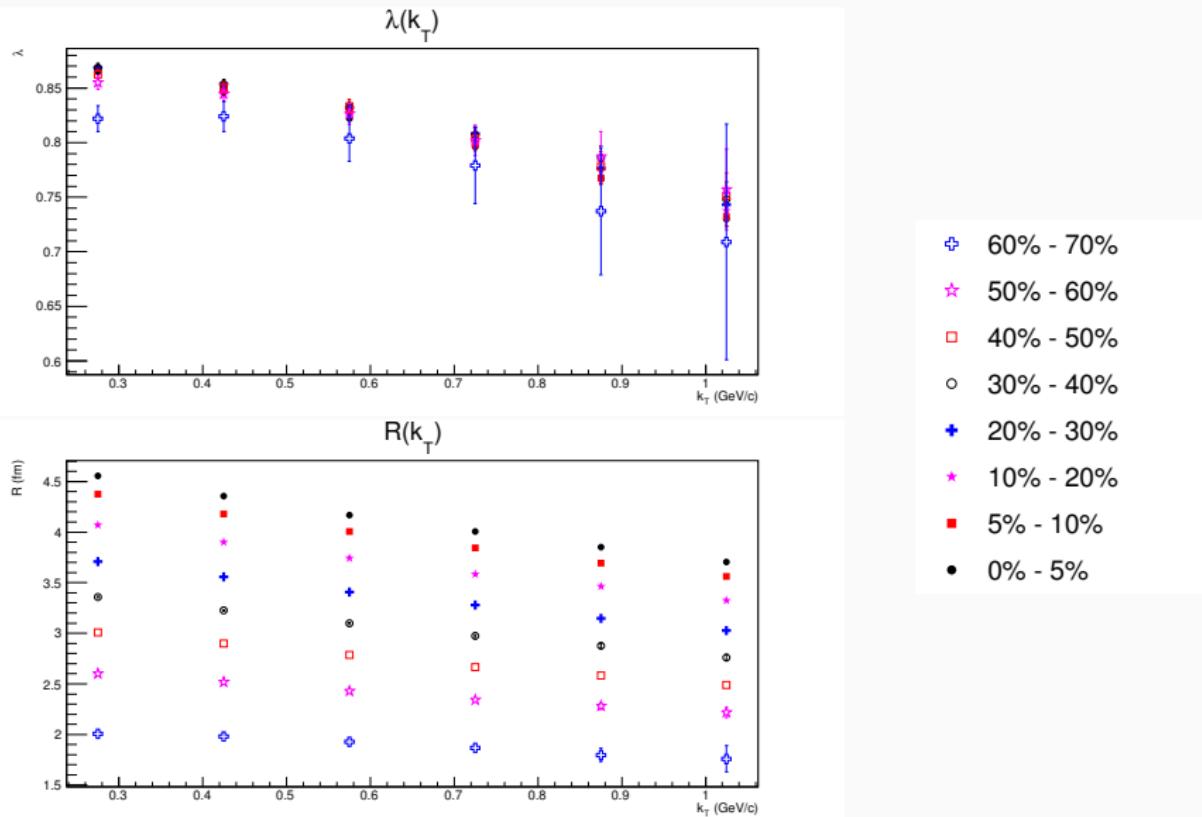
# Result

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- 1D and 3D Femtoscopy  $K^+K^+$  and  $K^-K^-$
- Au+Au collisions at  $\sqrt{s_{NN}} = 200$  GeV
- **8 centralities:** 0-5%, 5-10%, 10-20%, 20-30%, 30-40%, 40-50%, 50-60% and 60-70%
- **6  $k_T$  ranges:** [0.20,0.35], [0.35,0.50], [0.50,0.65], [0.65,0.80], [0.80,0.95] and [0.95,1.10] GeV/c
- number of events: **4 mln** for all centralities

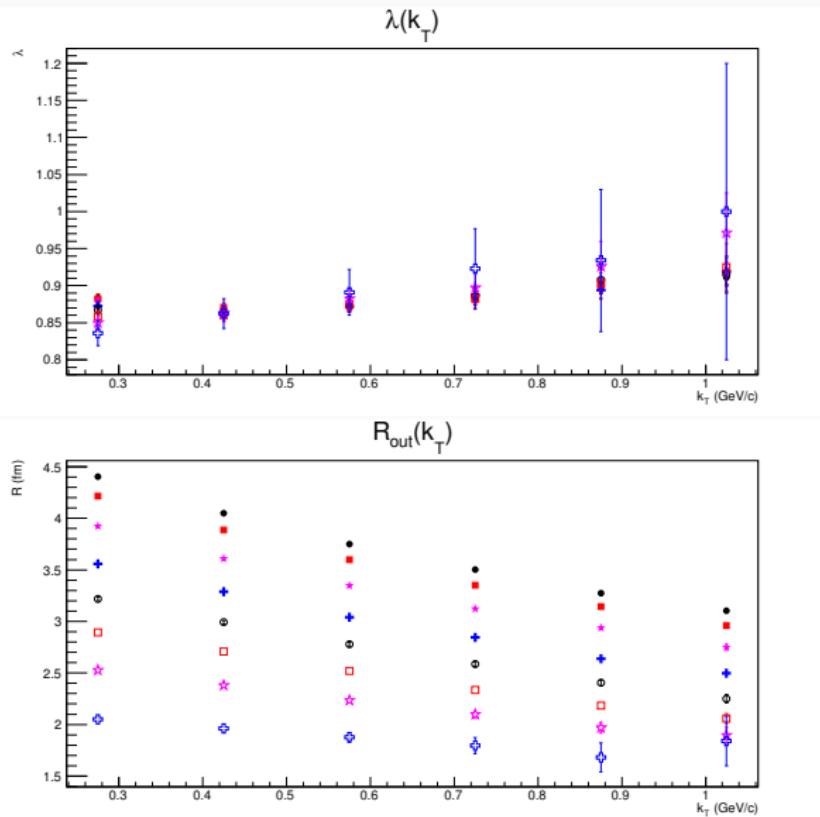
# $K^+K^+$ CF without Coulomb Interaction

## 1D correlation function



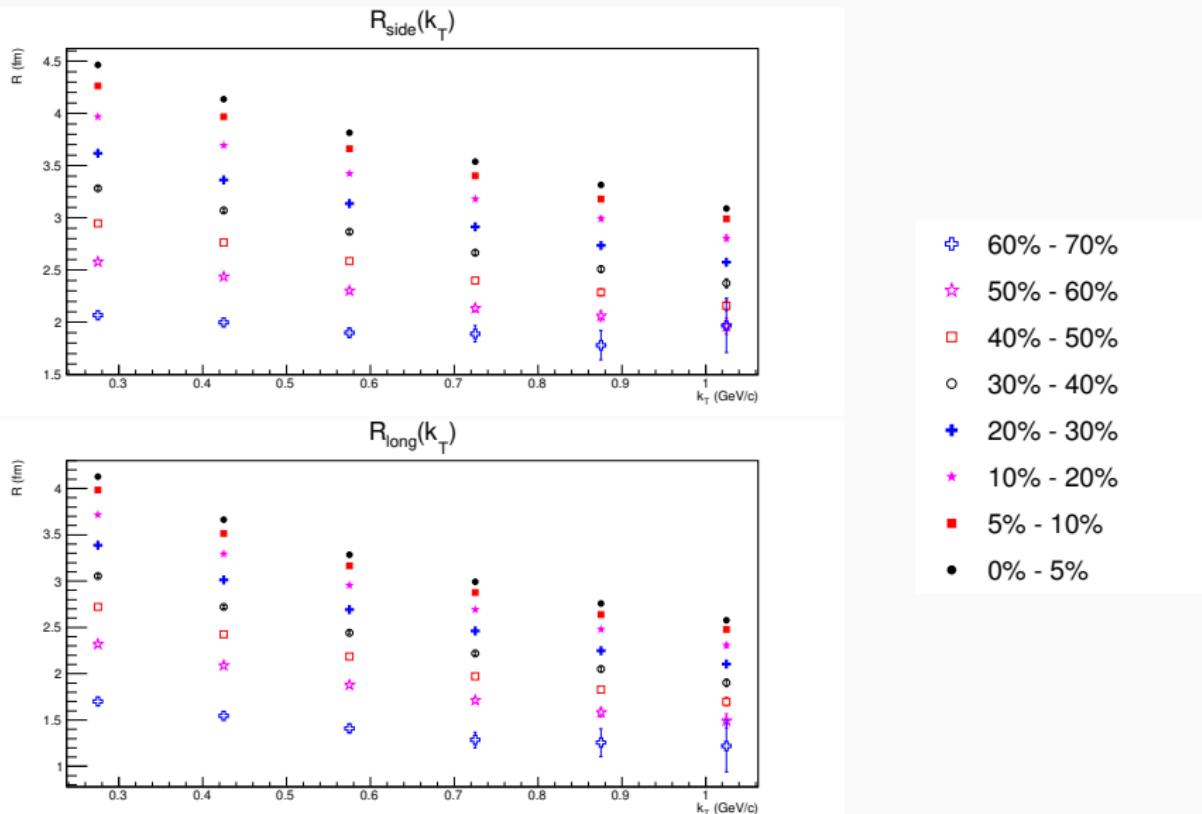
# $K^+K^+$ CF without Coulomb Interaction

## 3D correlation function



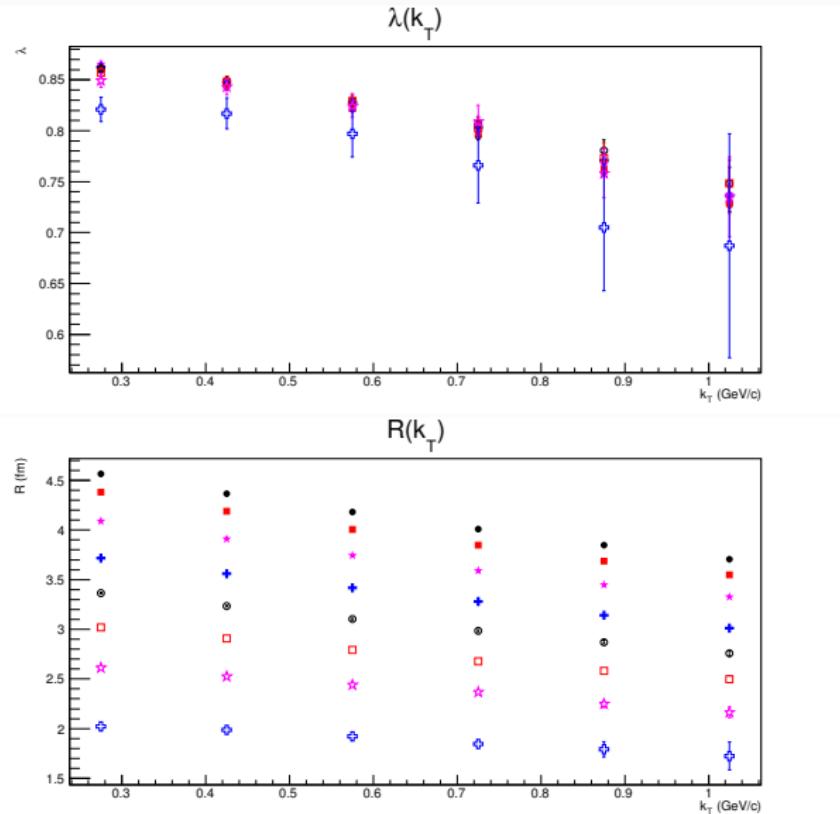
# $K^+K^+$ CF without Coulomb Interaction

## 3D correlation function



# $K^-K^-$ CF without Coulomb Interaction

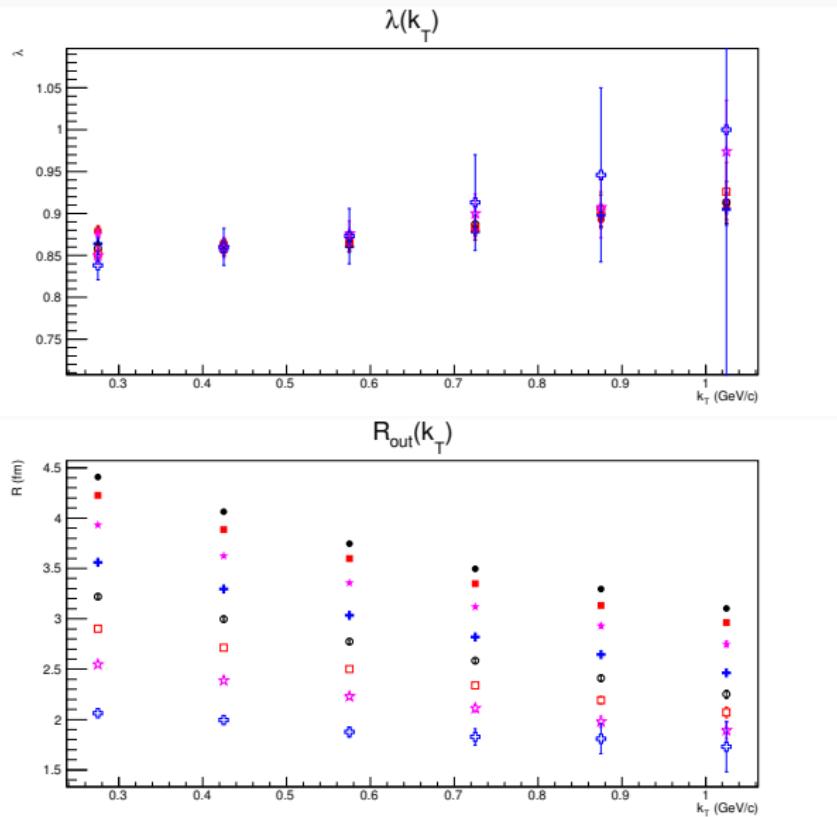
## 1D correlation function



- + 60% - 70%
- ★ 50% - 60%
- 40% - 50%
- 30% - 40%
- ⊕ 20% - 30%
- ★ 10% - 20%
- 5% - 10%
- 0% - 5%

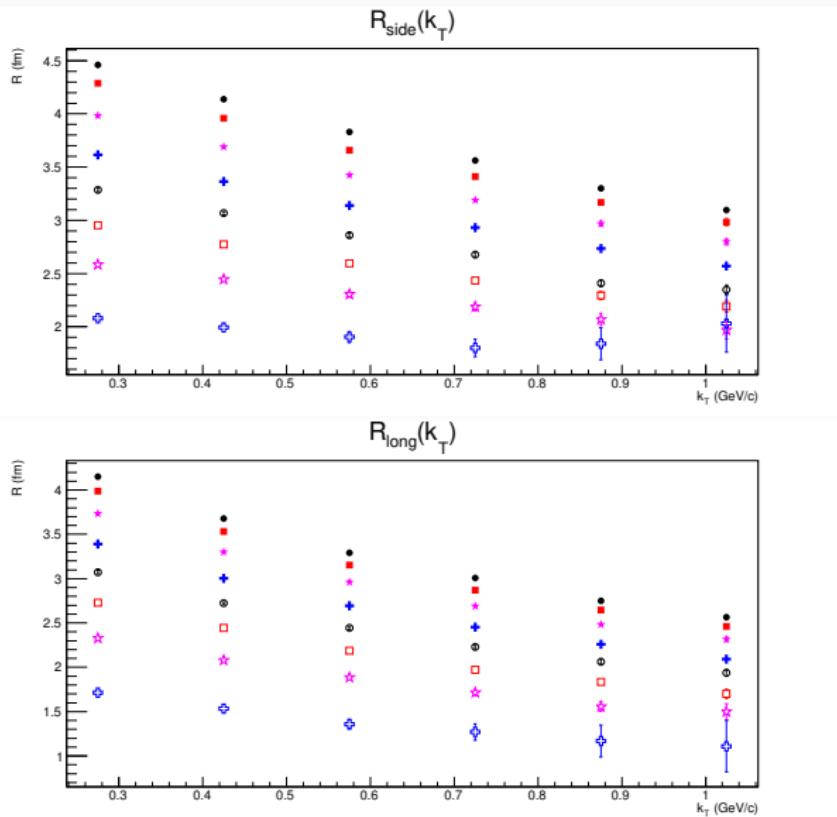
# $K^-K^-$ CF without Coulomb Interaction

## 3D correlation function



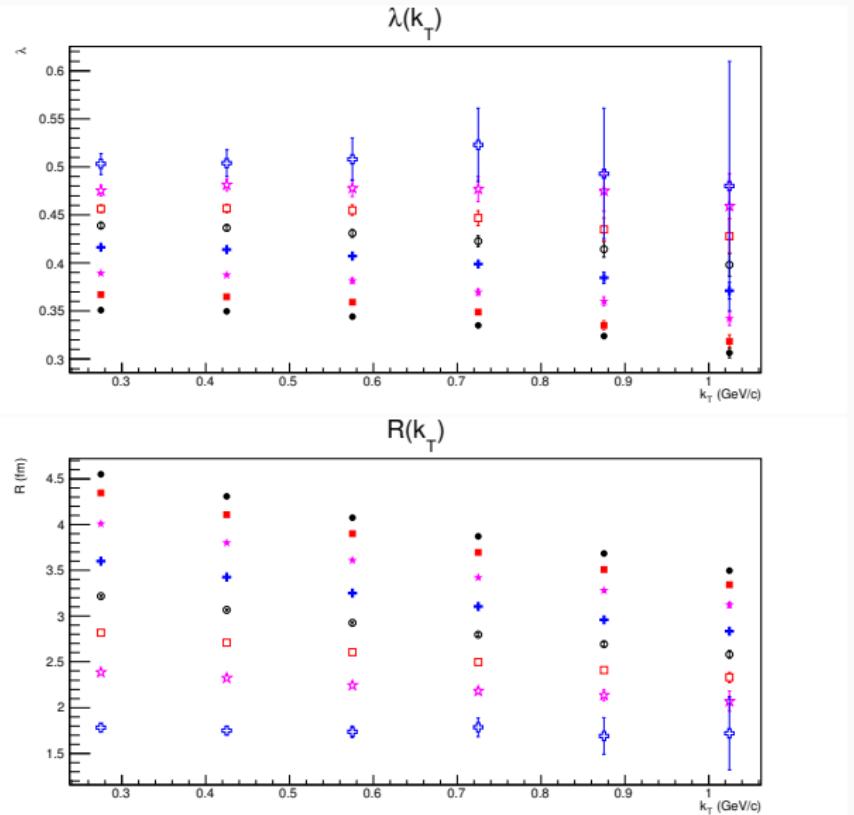
# $K^-K^-$ CF without Coulomb Interaction

## 3D correlation function



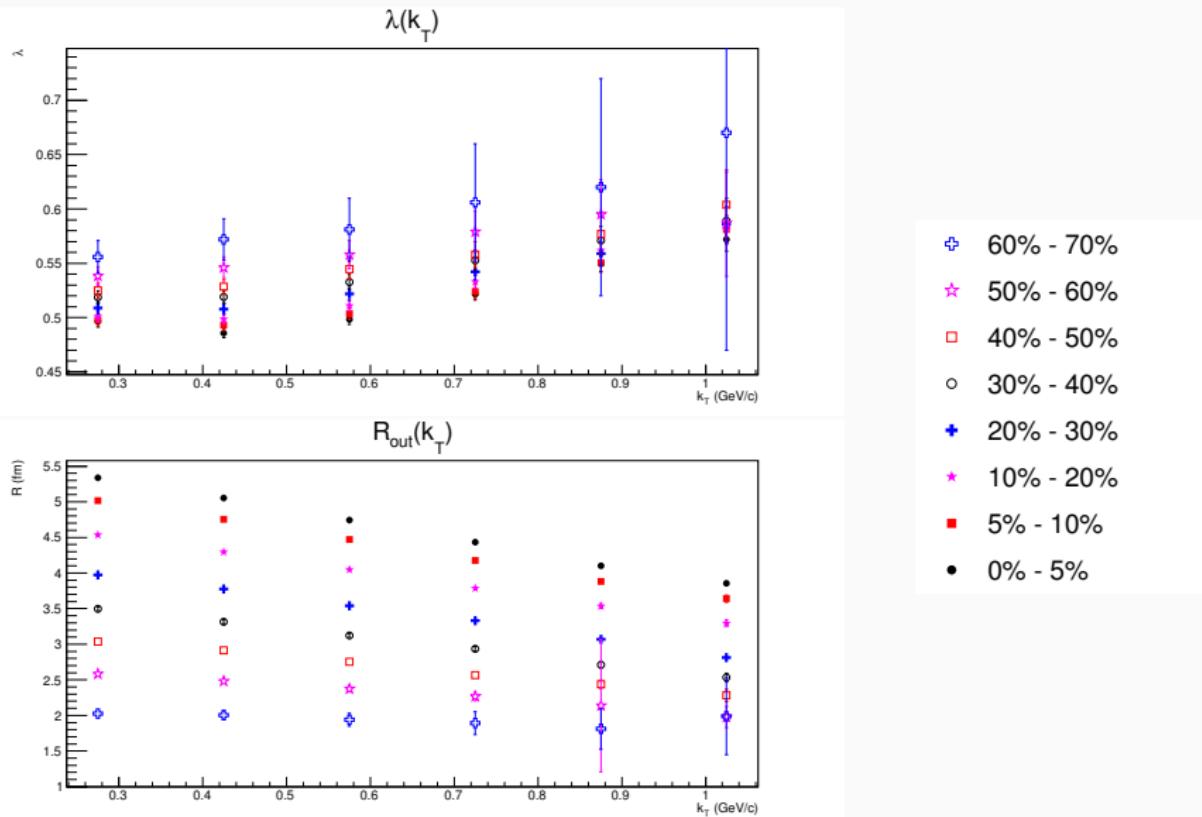
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- \* 10% - 20%
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## 1D correlation function

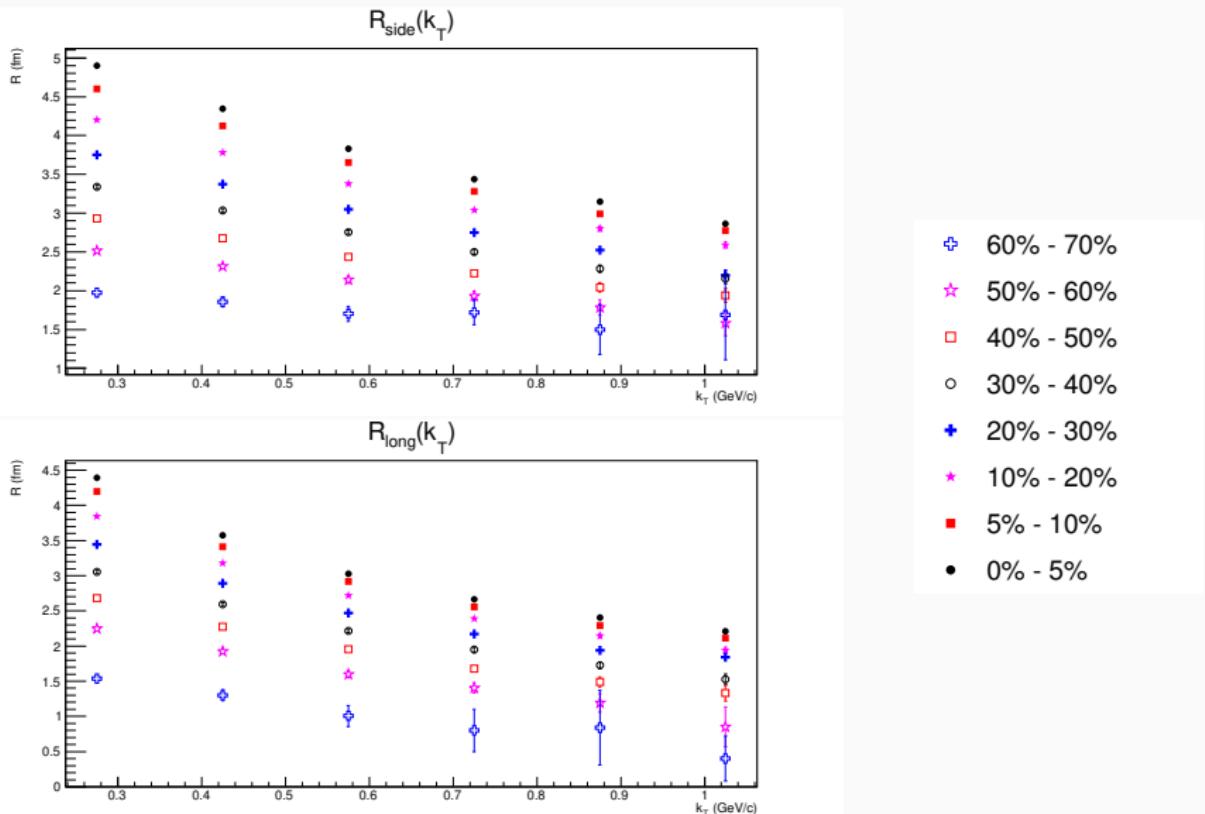


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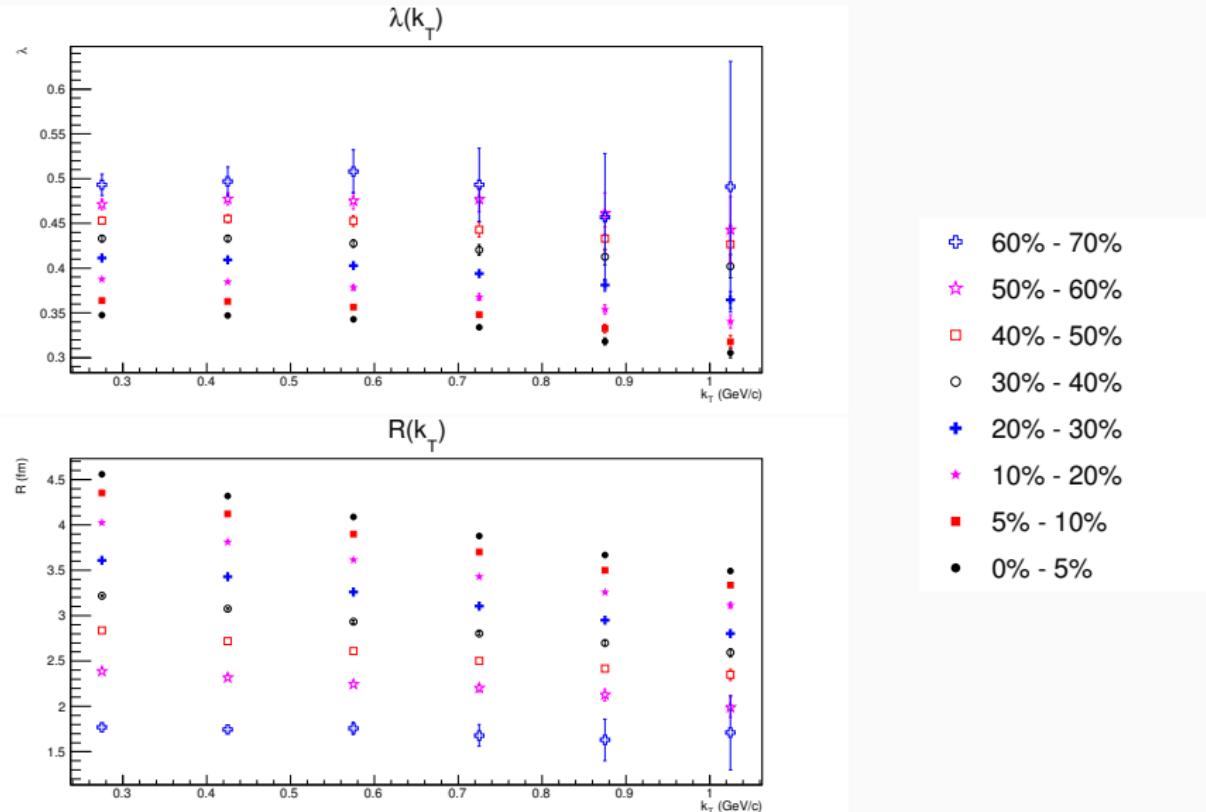
## 3D correlation function



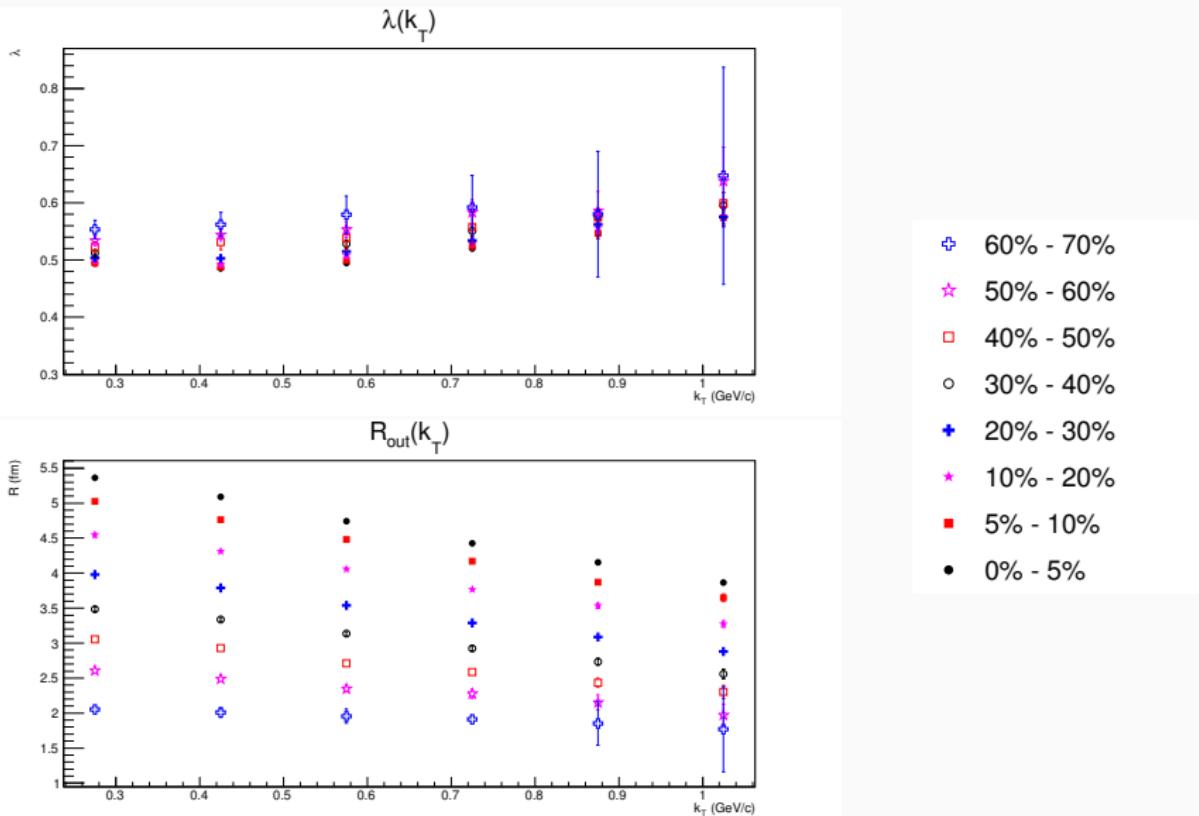
## 3D correlation function



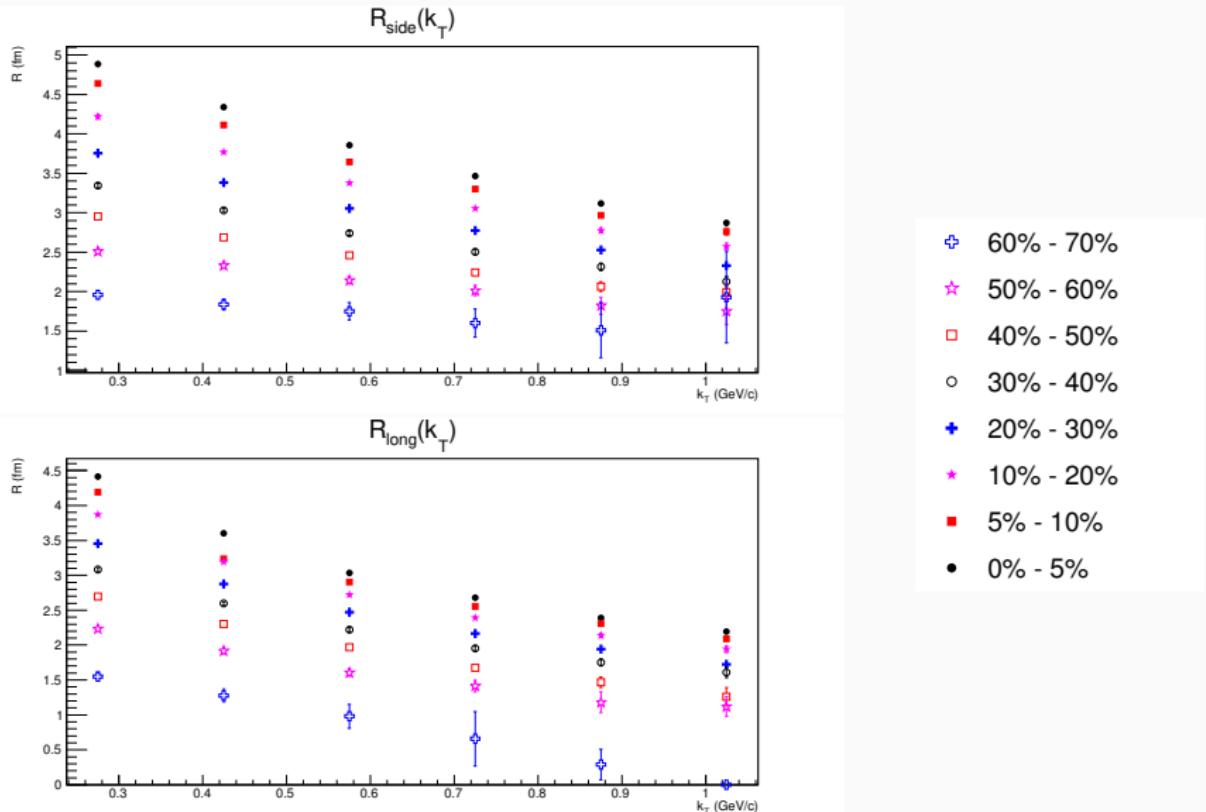
## 1D correlation function



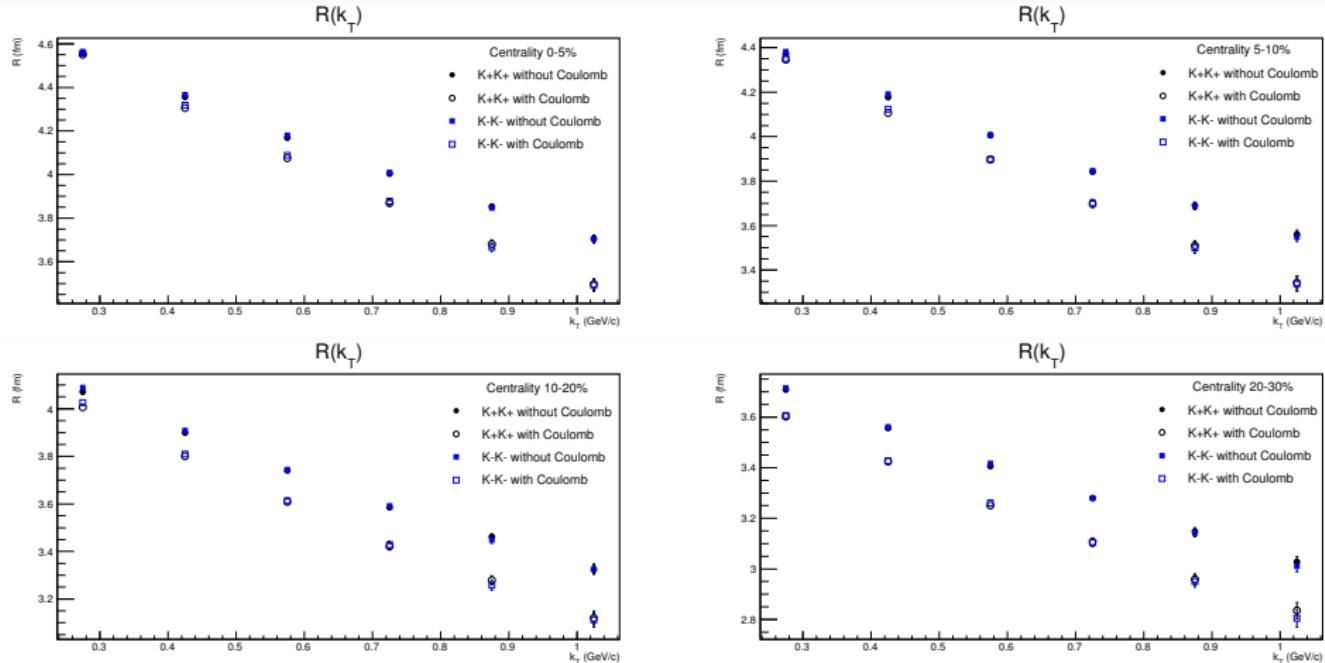
## 3D correlation function



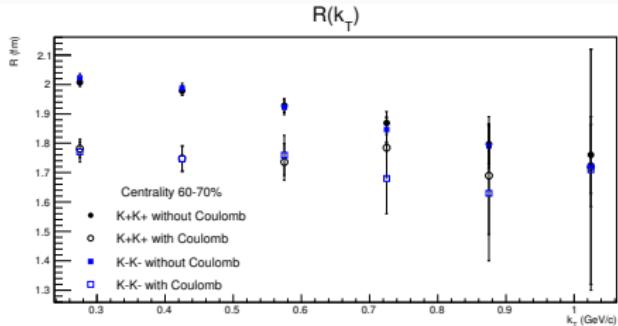
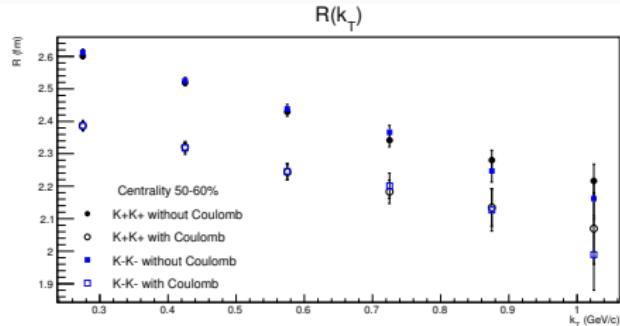
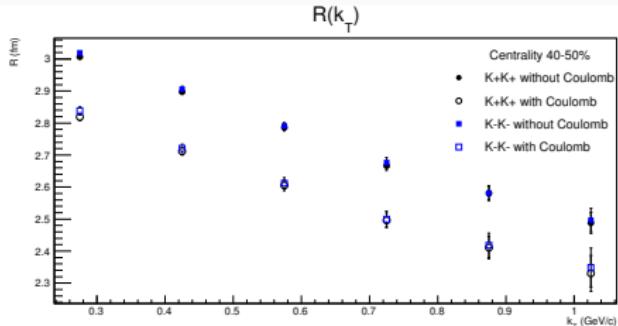
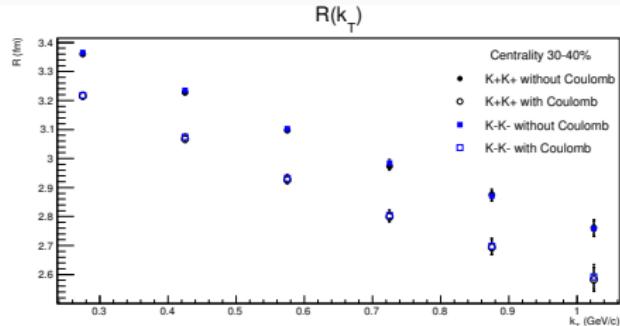
## 3D correlation function



# Comparision CF with and without Coulomb



# Comparision CF with and without Coulomb



## Conclusion

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# Conclusion

- 1D correlation function
  - $R_{inv}$  increases with centrality
  - $R_{inv}$  decreases with  $k_T$
- 3D correlation function - similar dependence like 1D CF
- similar source sizes for  $K^+K^+$  and  $K^-K^-$
- difference between CF with Coulomb and without is visible
  - decrease with centrality and increase with  $k_T$
- **Future plan:** all Beam Energy Scan energies and determination of lifetime from analysis radii in three dimensions

Thank you for your attention!

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