Nonidentical particle correlations

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Outline

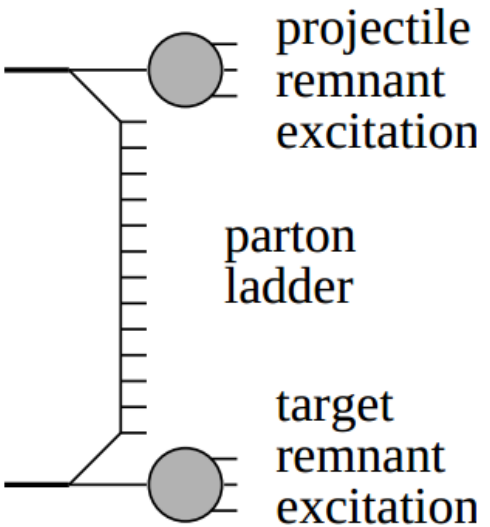
- EPOS model
  - Spectra p_T from EPOS and STAR[2]
  - Four-vector of space and momentum
- Correlation functions
  - Space-time asymmetry
  - STAR data
  - Results from EPOS
  - Centrality dependence
  - Fits
  - Sizes calculated from correlation functions
  - STAR and EPOS data for 39 GeV
- Summary
- Annotation

EPOS model[1]

EPOS is a parton model, with many binary parton-parton interactions, where each one creating a parton ladder.

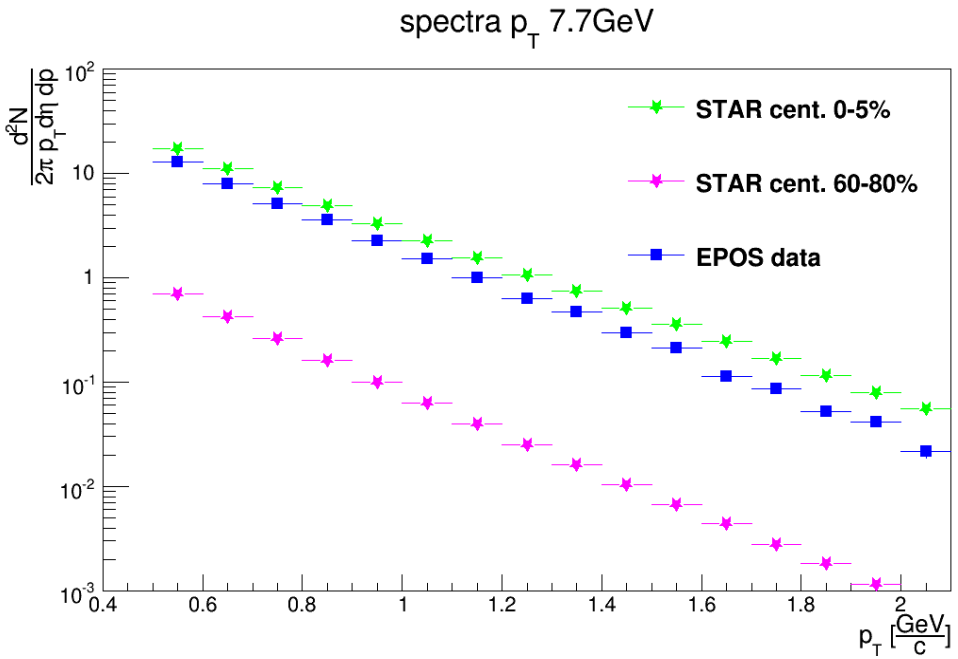
- **E**nergy-sharing : for cross section calculation and particle production
- **P**arton Multiple scattering
- **O**utshell remnants
- **S**creening and shadowing via unitarization and splitting
- Collective effects for dense systems (LHC energies)

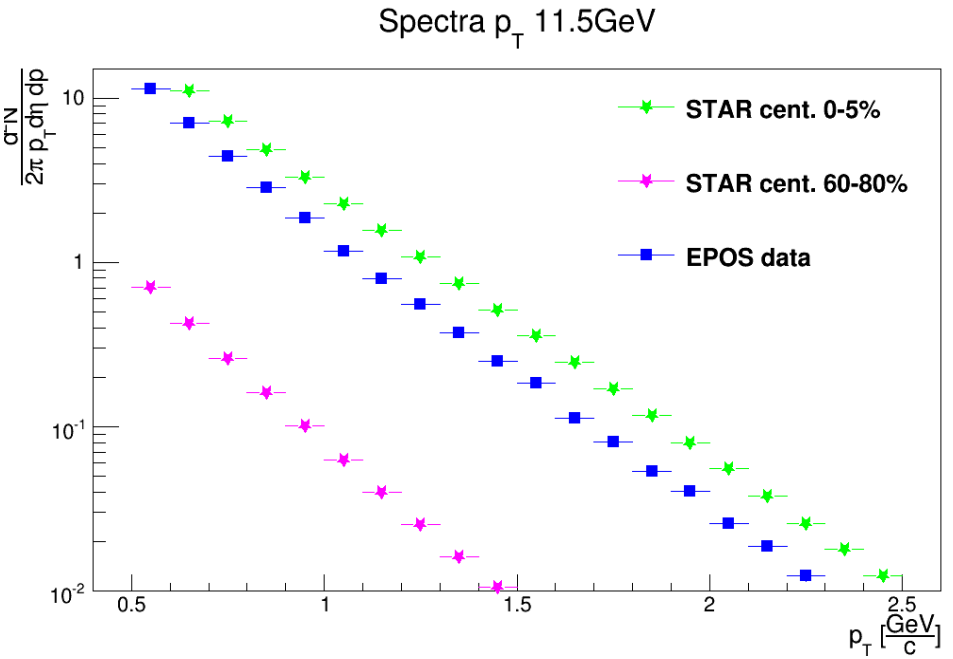
- We do not have the hydrodynamics for low RHIC energies.

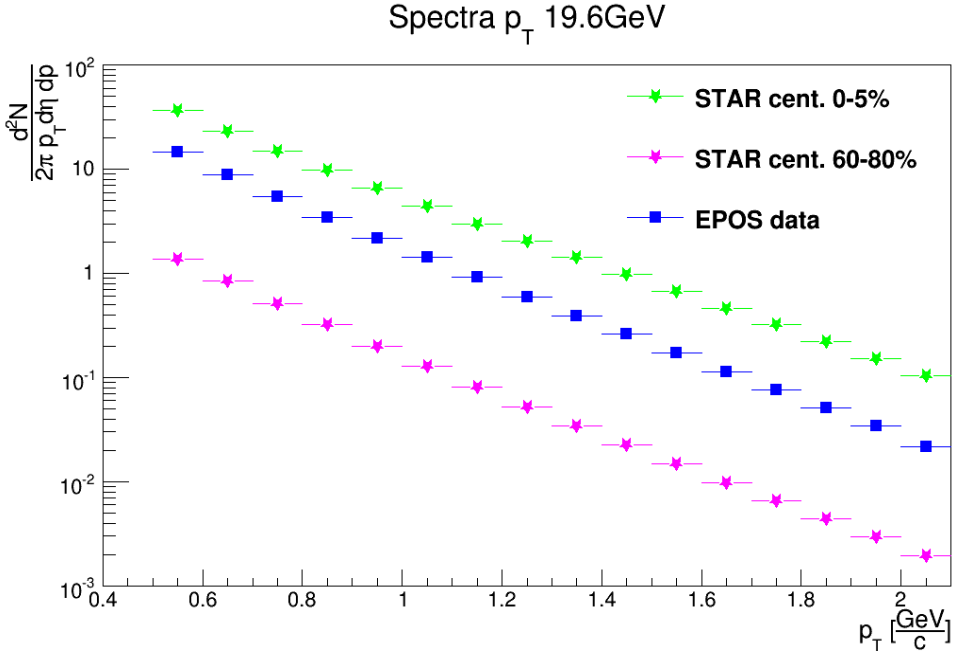


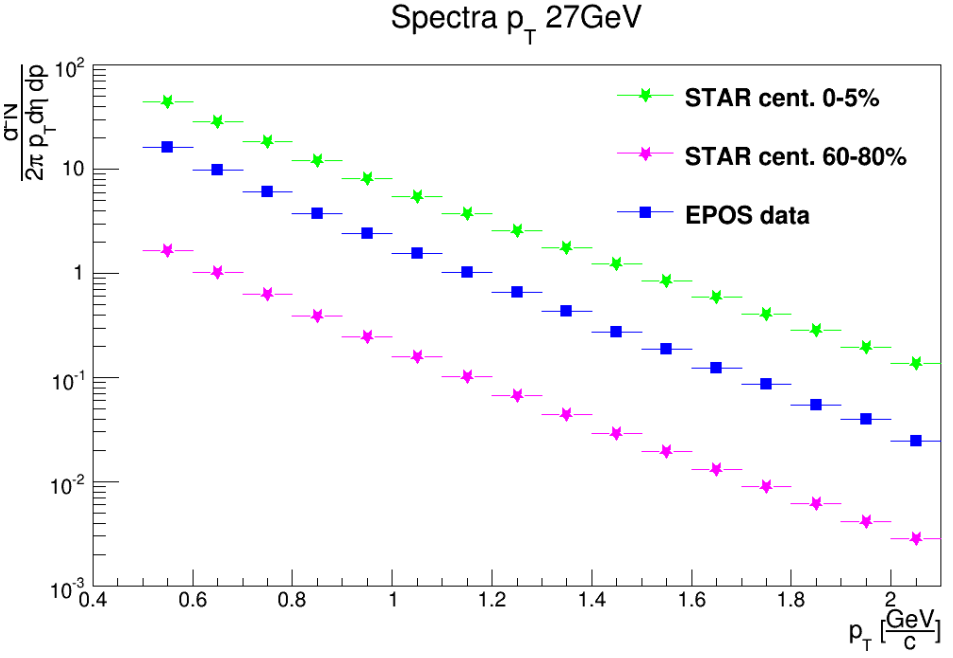
Author of the EPOS model is Klaus Werner from SUBATECH, University of Nantes – IN2P3/CNRS– EMN, Nantes, France.

Spectra p_T from EPOS and STAR[2]



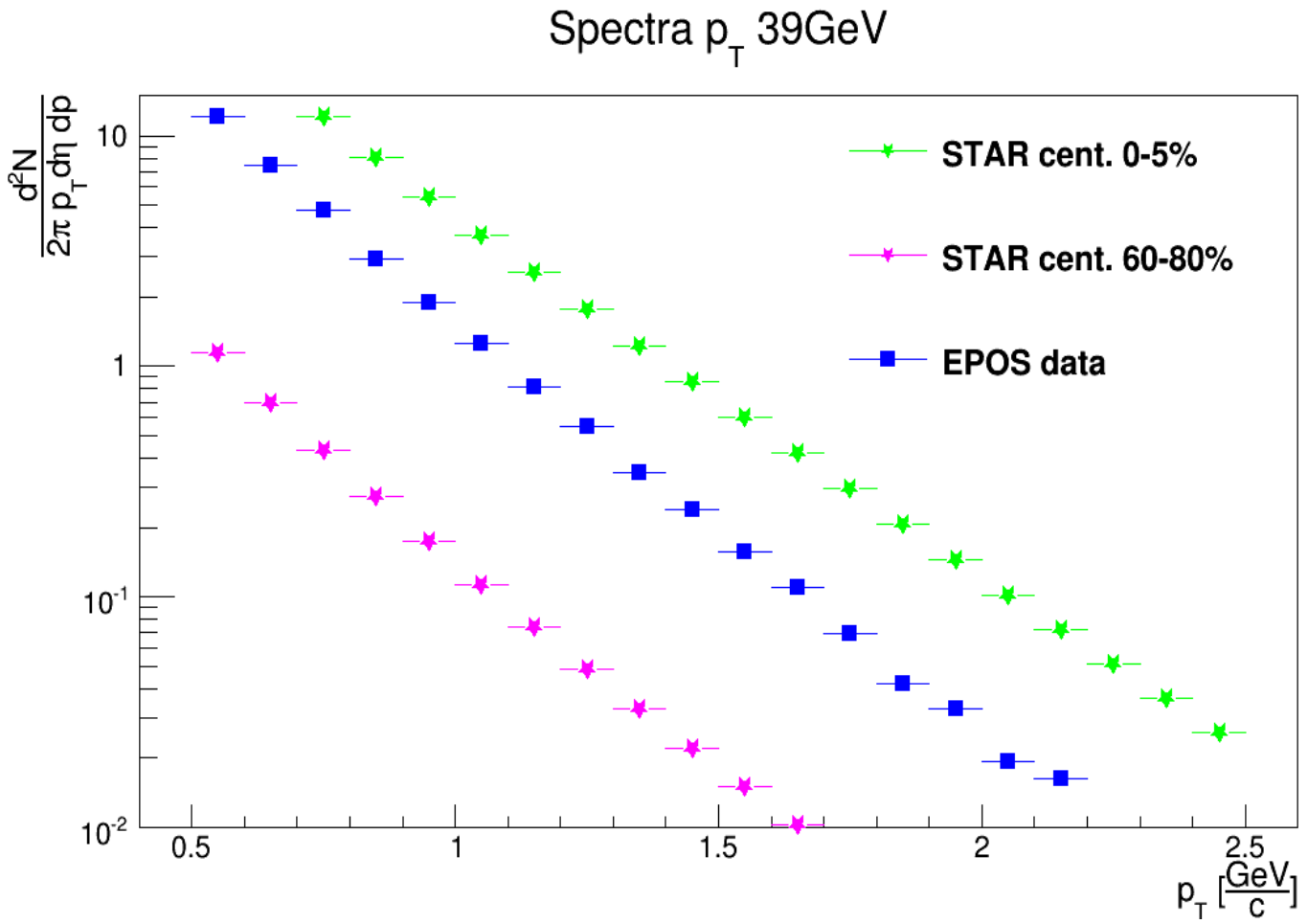






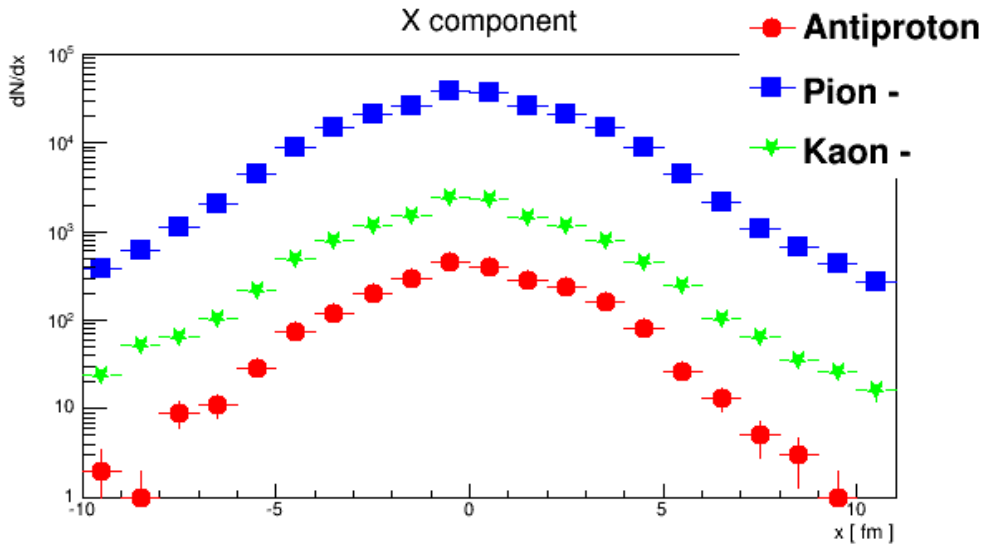
Spectra p_T from EPOS and STAR[2]

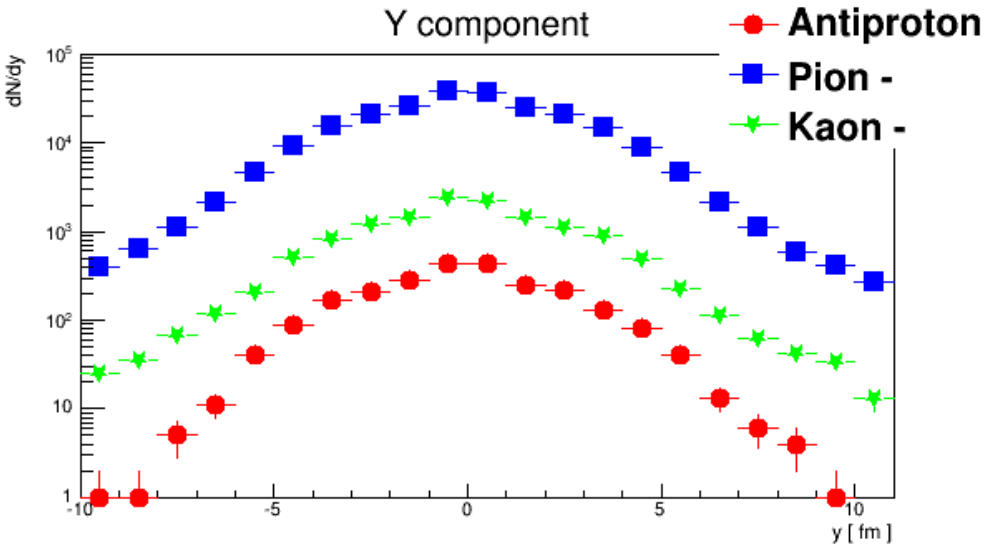
- Transverse momentum spectra results for charged particles from EPOS model are between STAR p_T spectra for the most central collisions (0-5%) and peripheral collisions (60-80%).

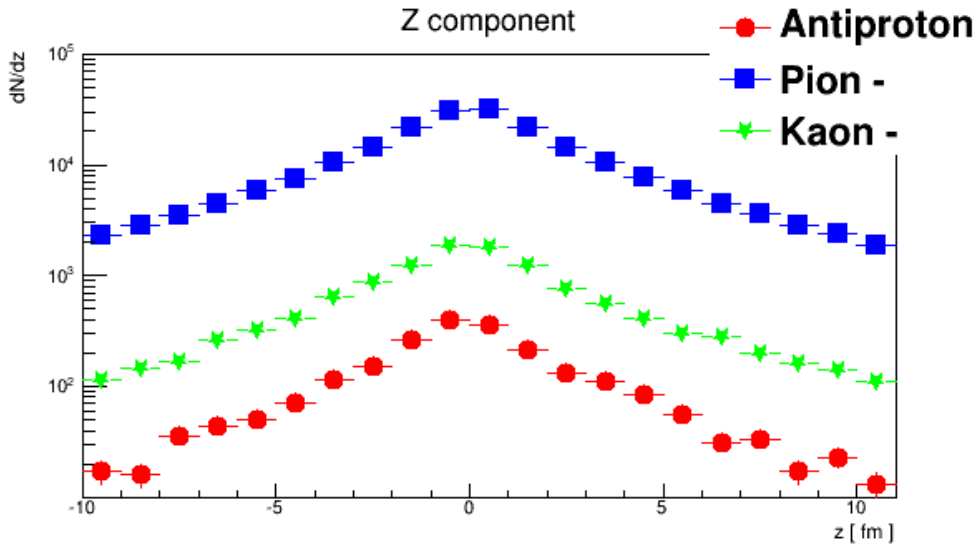


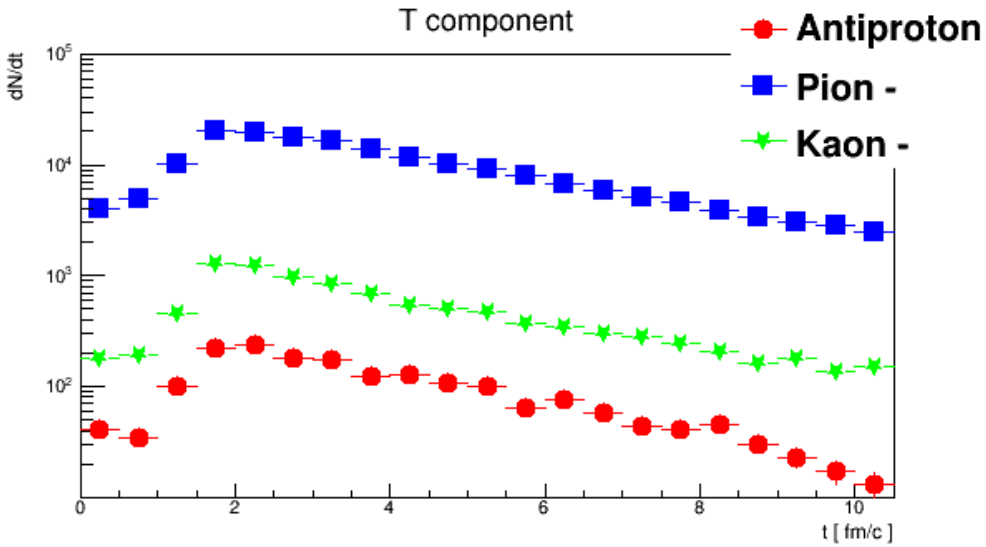
Space four-vector

Particles with negative charge @ 11.5GeV



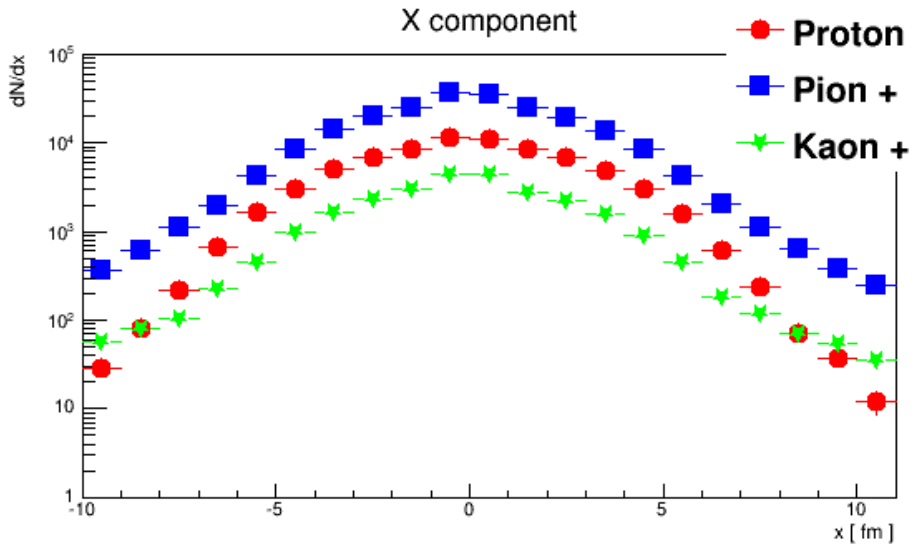


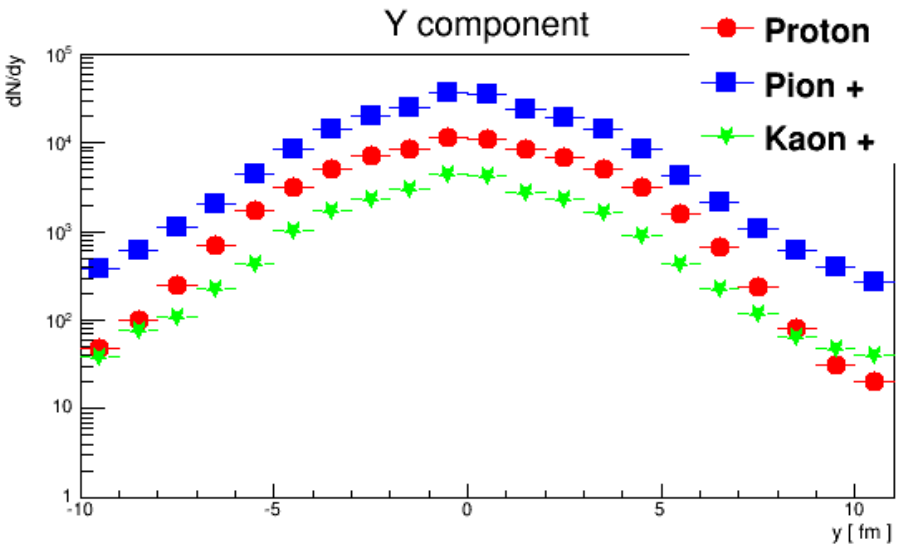


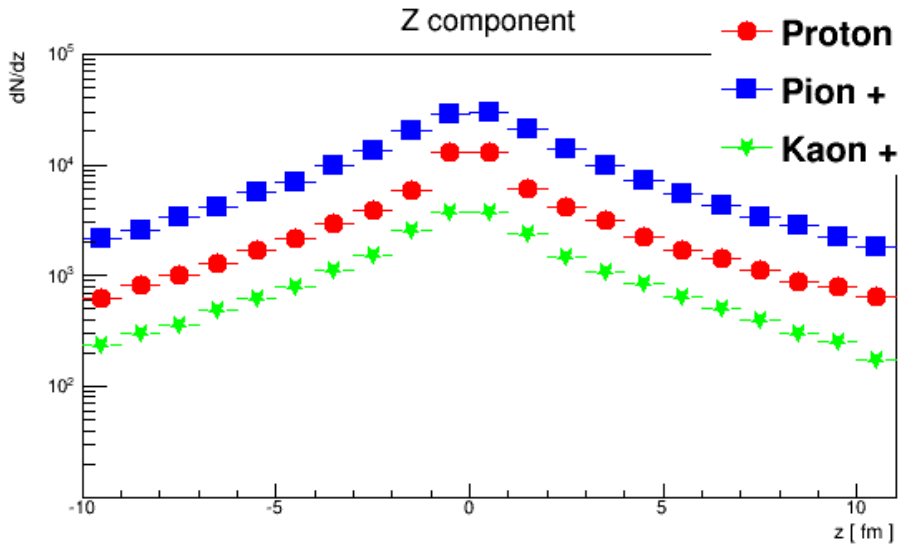


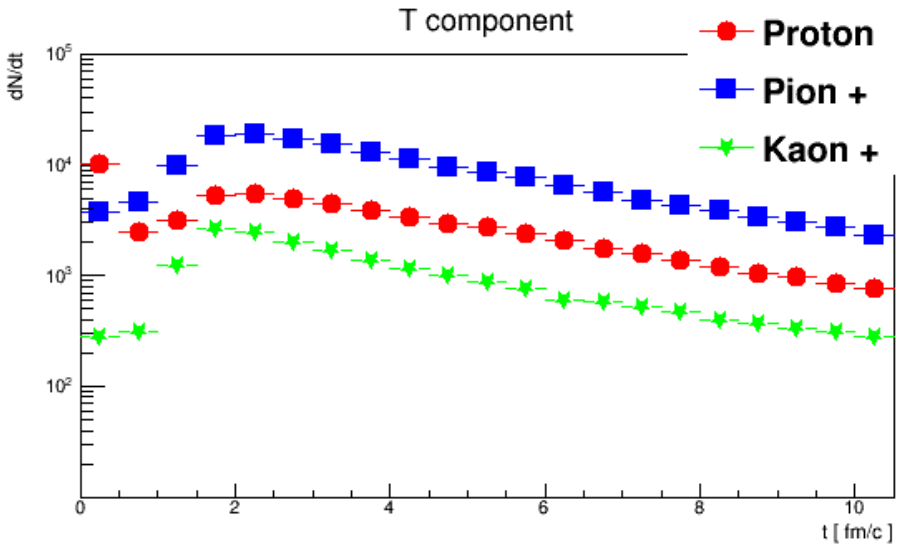
Space four-vector

Particles with positive charge @ 11.5GeV



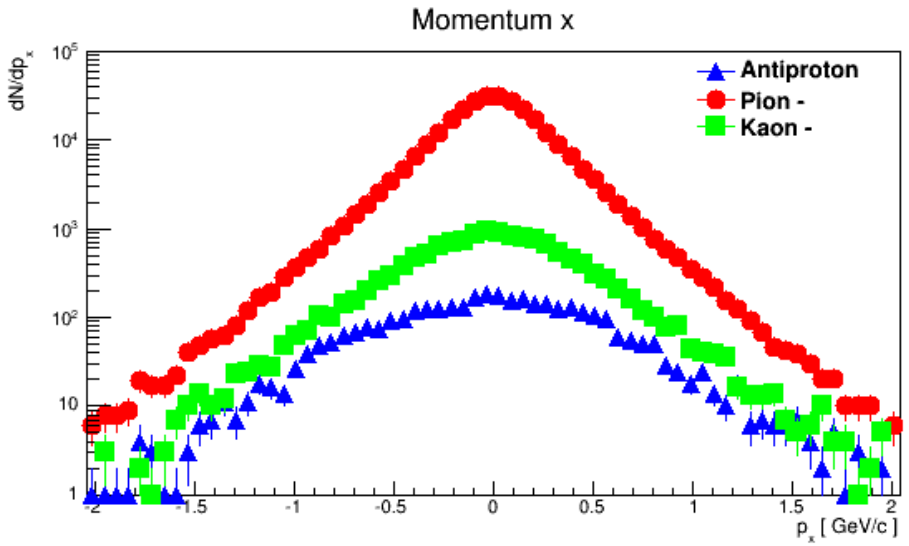


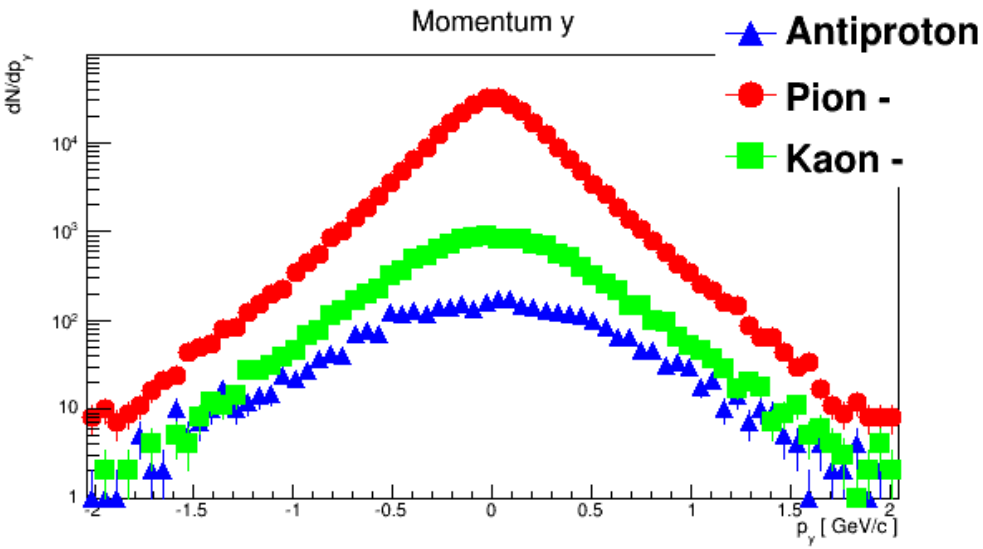


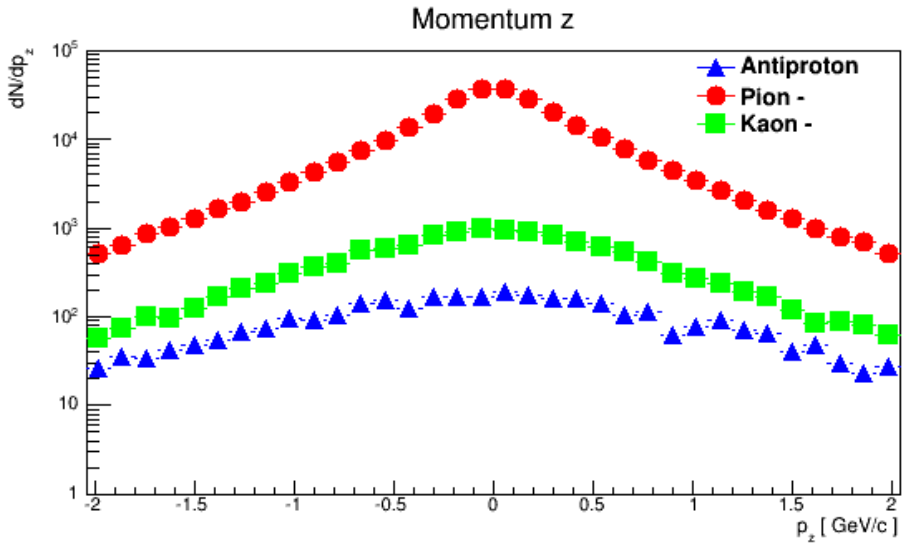


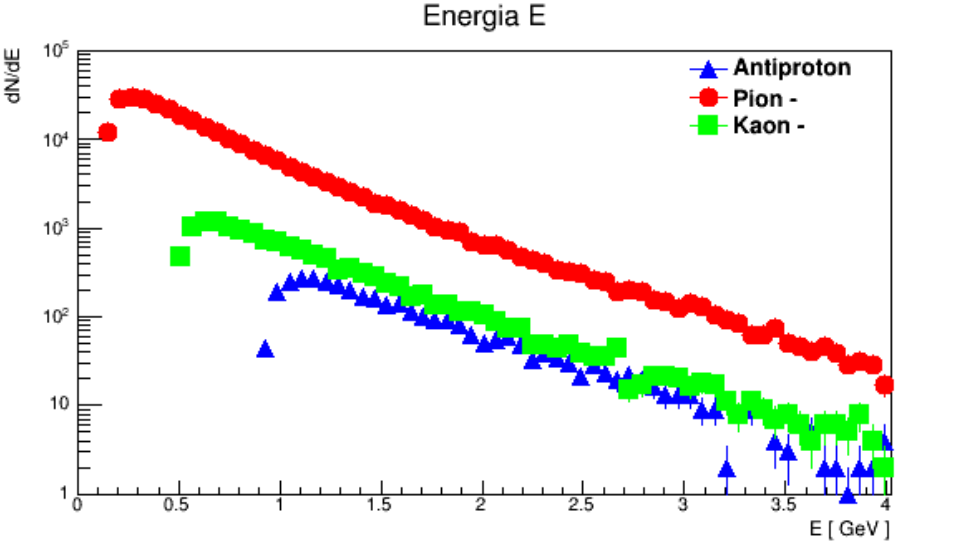
Momentum four-vector

Particles with negative charge @ 11.5GeV



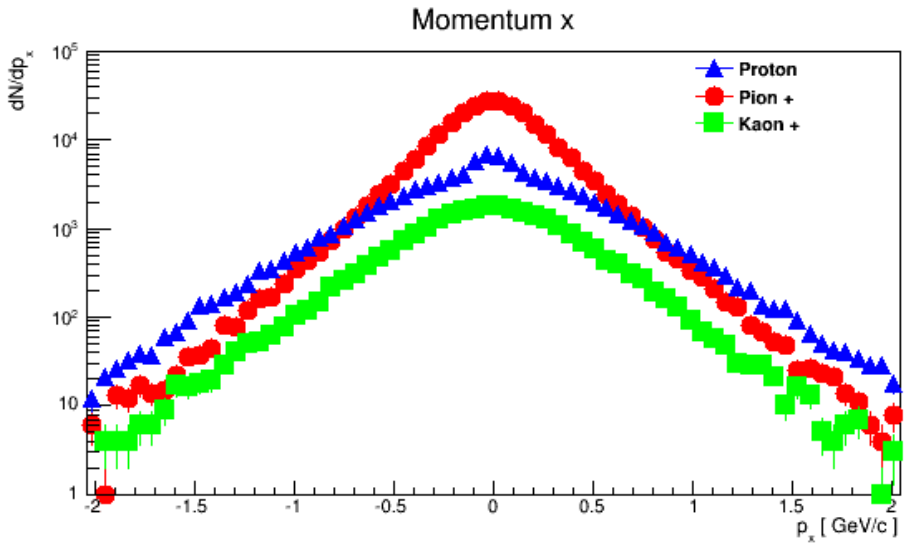


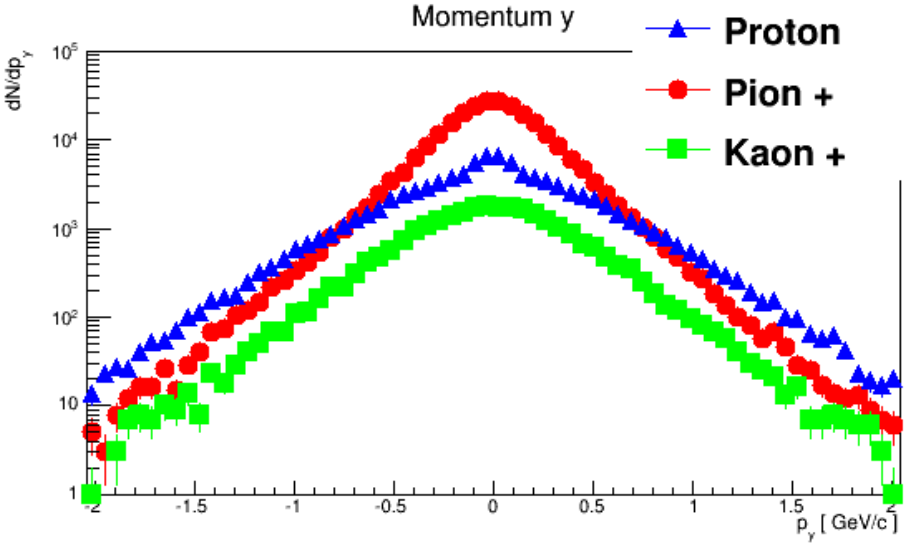


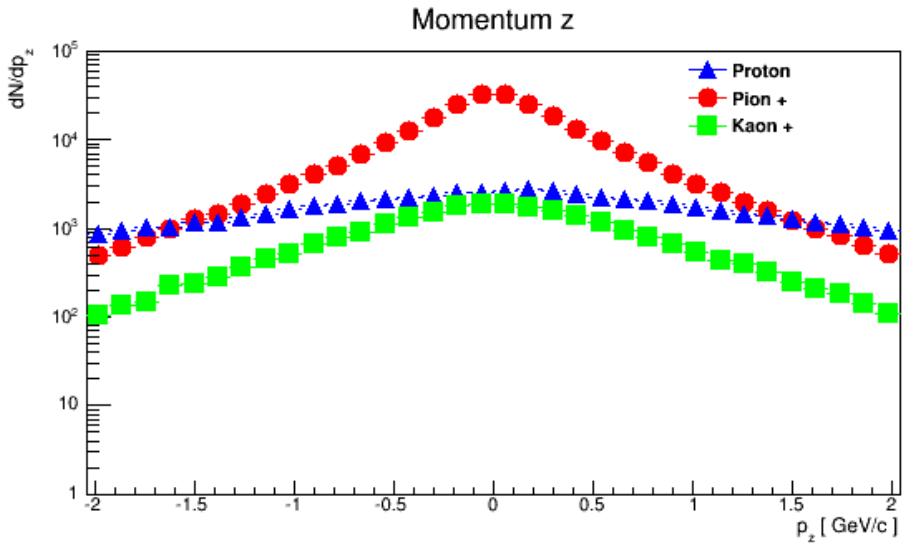


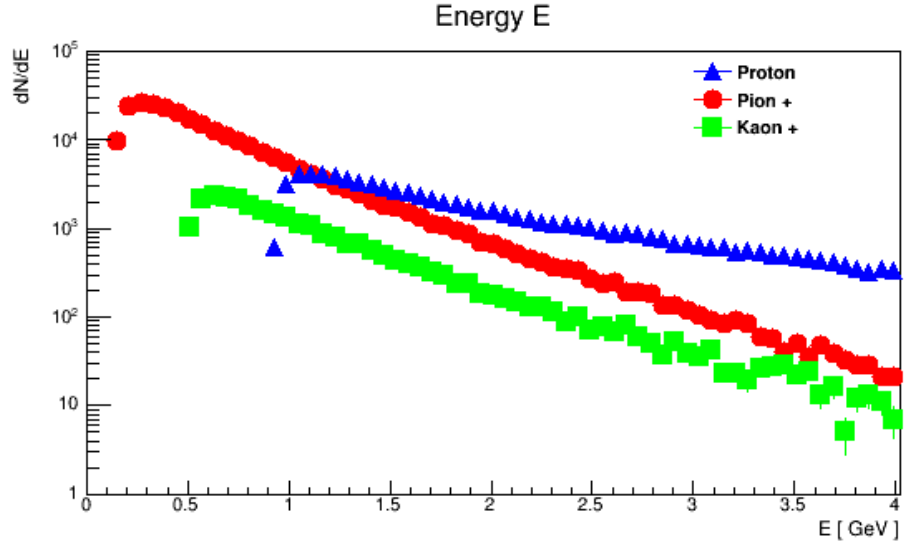
Momentum four-vector

Particles with positive charge @ 11.5GeV

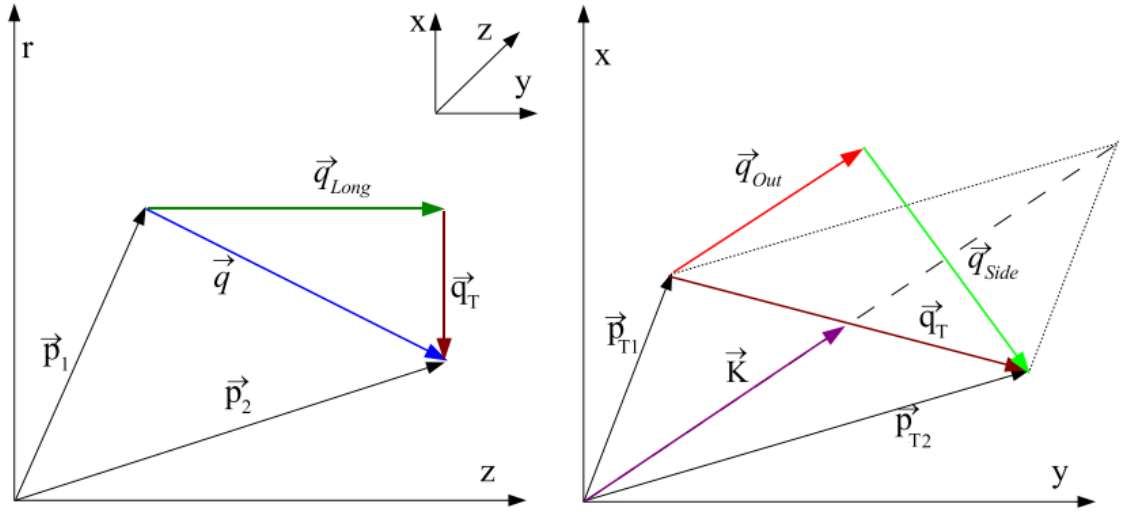








Correlation functions



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

$\mathbf{k^*} = \mathbf{p}_1 = -\mathbf{p}_2$ (relative pair momentum, calculated in the center of pair mass)

z – beam direction

r – radius

$\mathbf{p}_1$ and $\mathbf{p}_2$ – 1 and 2 particle momentum

Correlation function $C(\mathbf{p}_1, \mathbf{p}_2) = \dfrac{P_2(\mathbf{p}_1, \mathbf{p}_2)}{P_1(\mathbf{p}_1) P_1(\mathbf{p}_2)}$

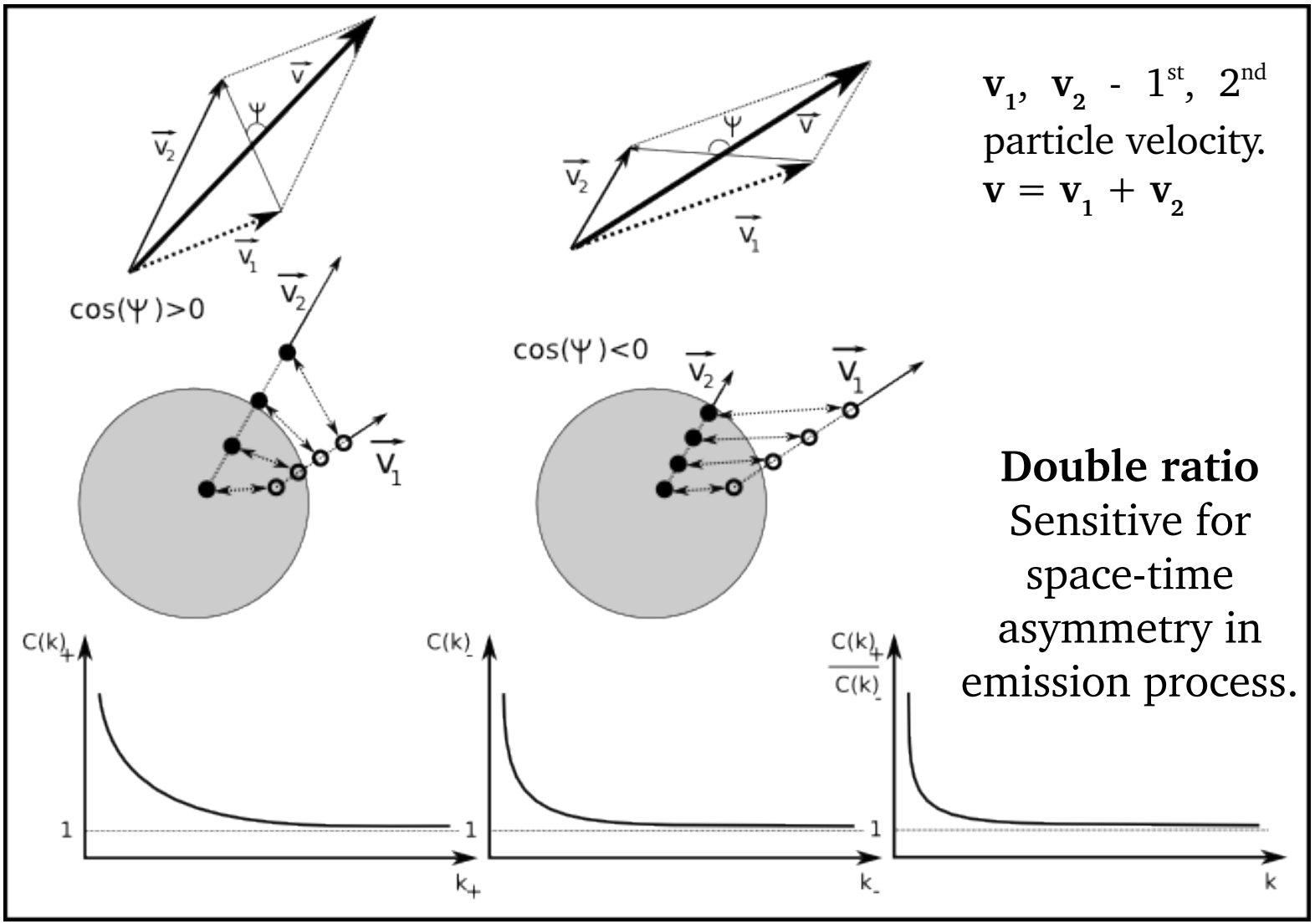
$P_2(\mathbf{p}_1, \mathbf{p}_2)$ – the probability of the simultaneous two particles emission with momentum p_1 and p_2

$P_1(\mathbf{p}_1)$, $P_1(\mathbf{p}_2)$ – the probability of the particle emission with momentum p_1 or p_2

Space-time asymmetry

cos(Ψ)>0
Catching up
Long time of effective interaction.
Strong correlation.

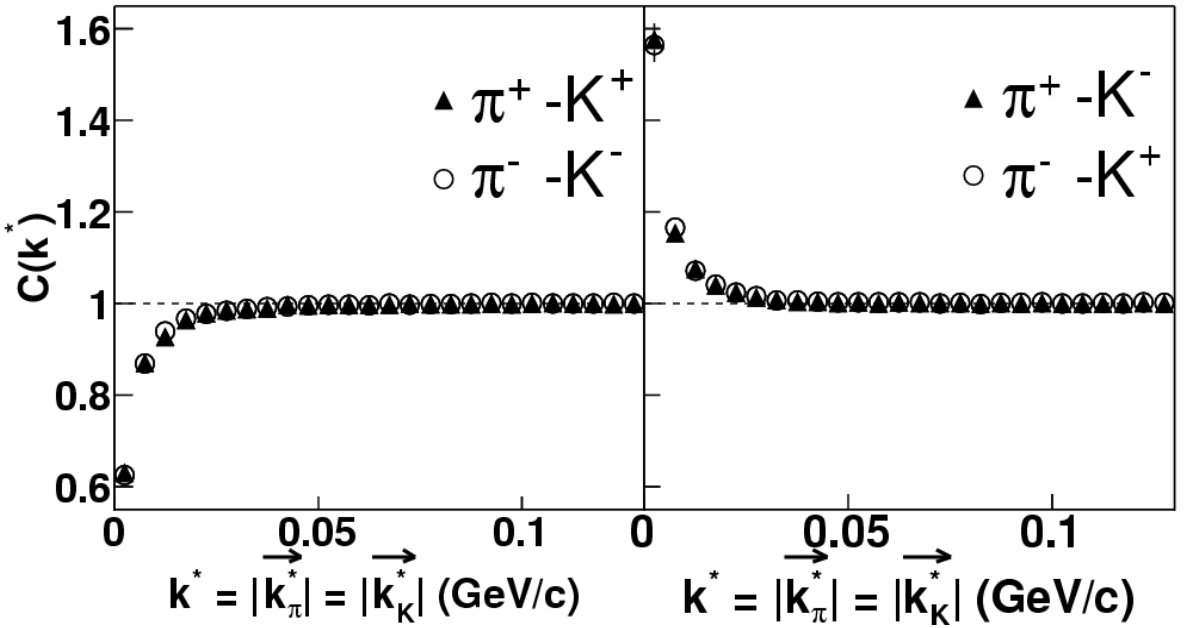
cos(Ψ)<0
Run away
Short time of effective interaction.
Weak correlation.



$\mathbf{v}_1$, $\mathbf{v}_2$ - 1st, 2nd particle velocity.
$\mathbf{v} = \mathbf{v}_1 + \mathbf{v}_2$

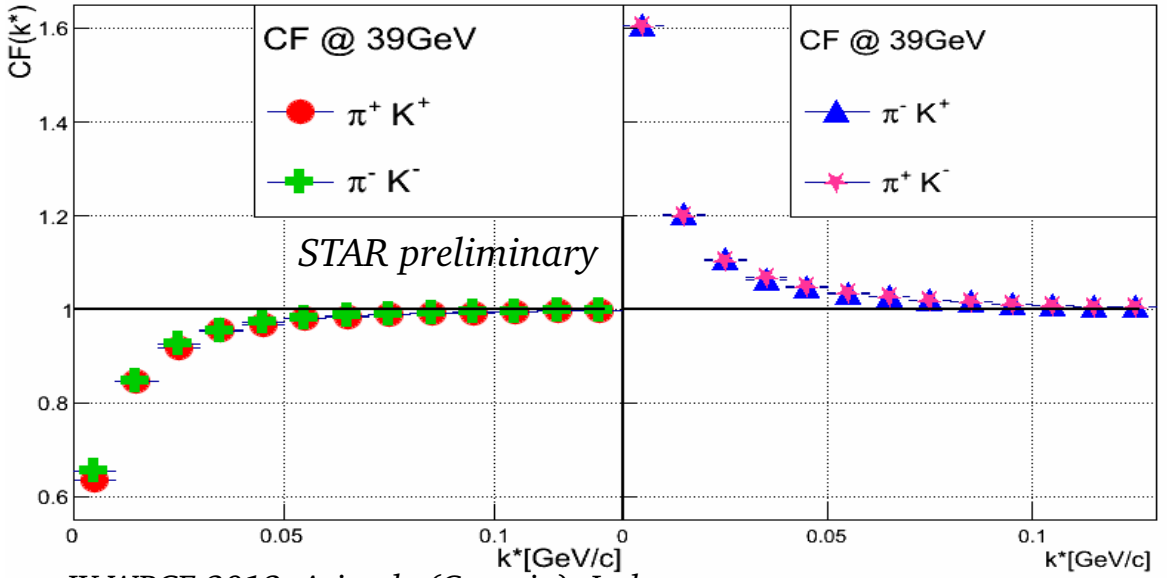
Double ratio
Sensitive for space-time asymmetry in emission process.

STAR data



AuAu collision at $\sqrt{s_{NN}} = 130\text{GeV}$

Phys. Rev. Lett. 91 (2003) 262302

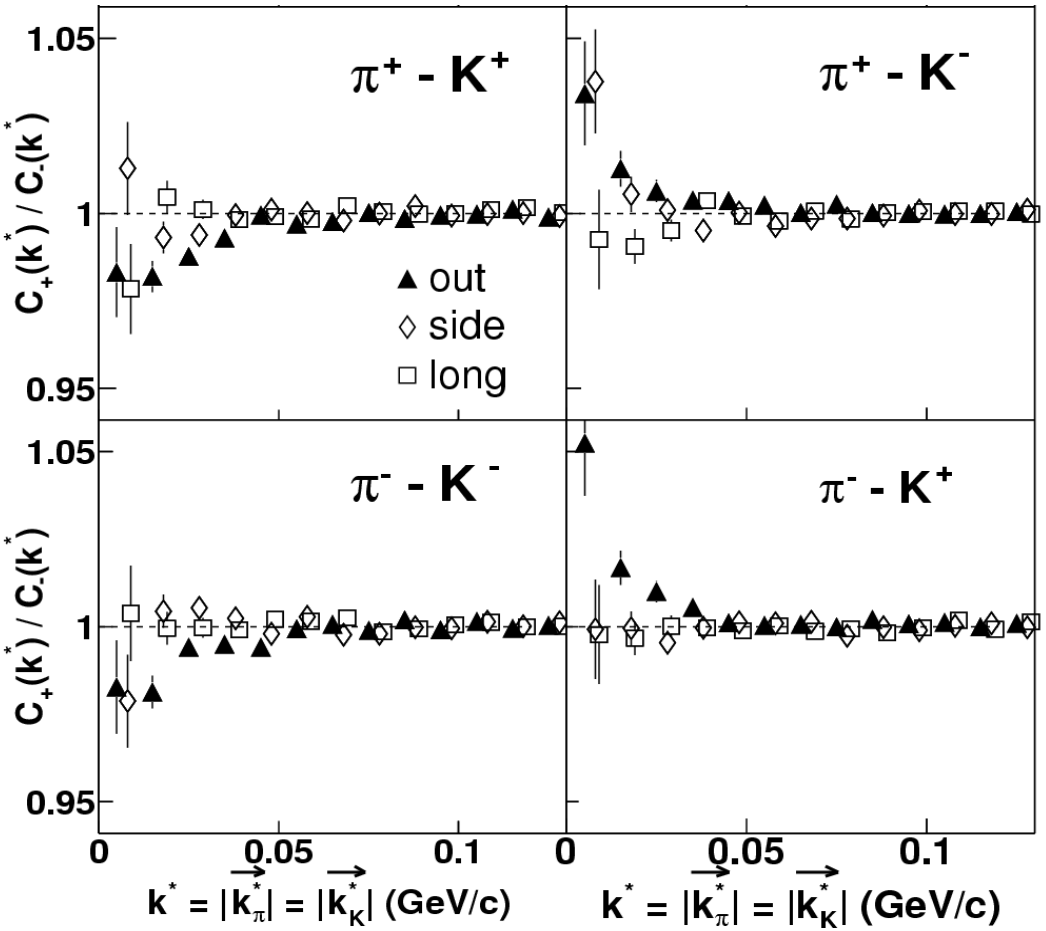


AuAu collision at $\sqrt{s_{NN}} = 39\text{GeV}$

STAR data

AuAu collision at $\sqrt{s_{NN}} = 130\text{GeV}$

Phys. Rev. Lett. 91 (2003) 262302



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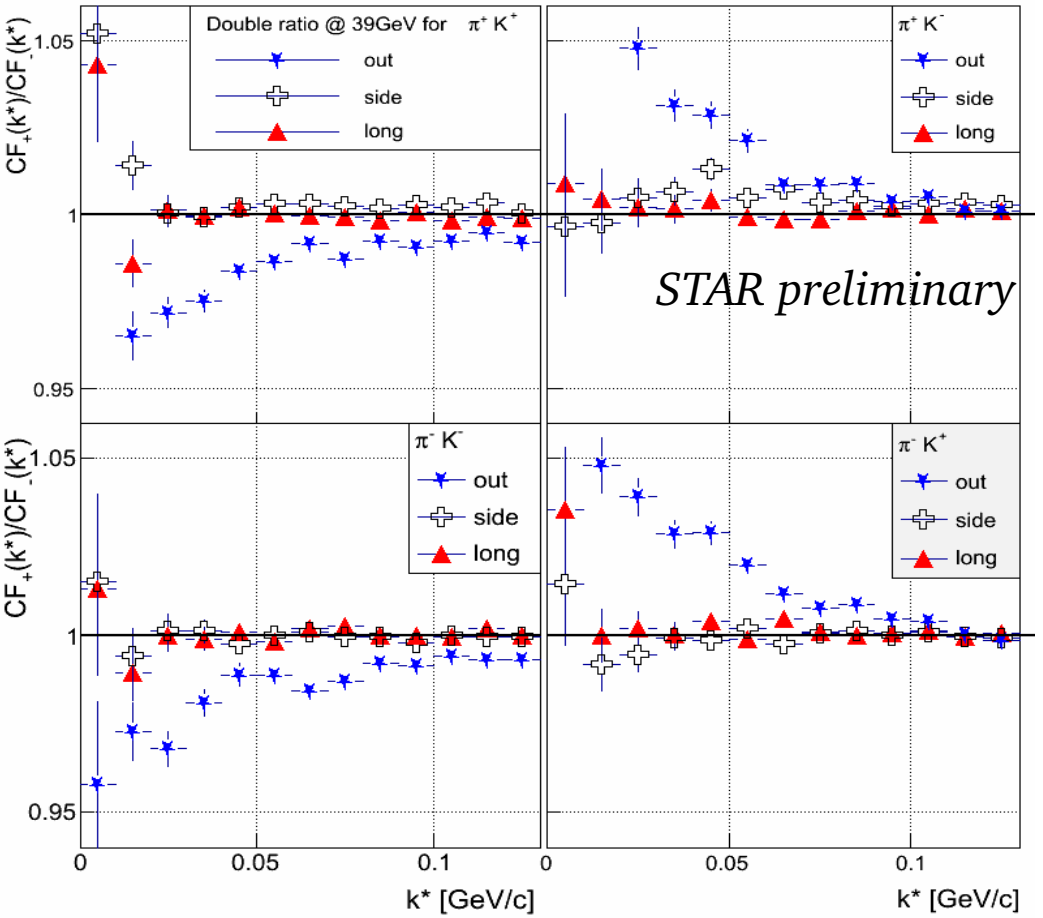
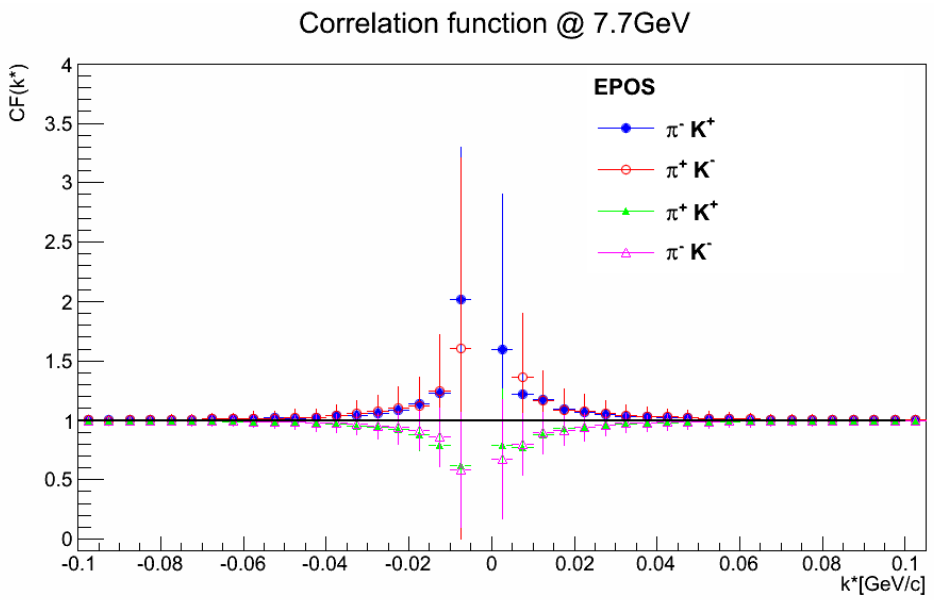
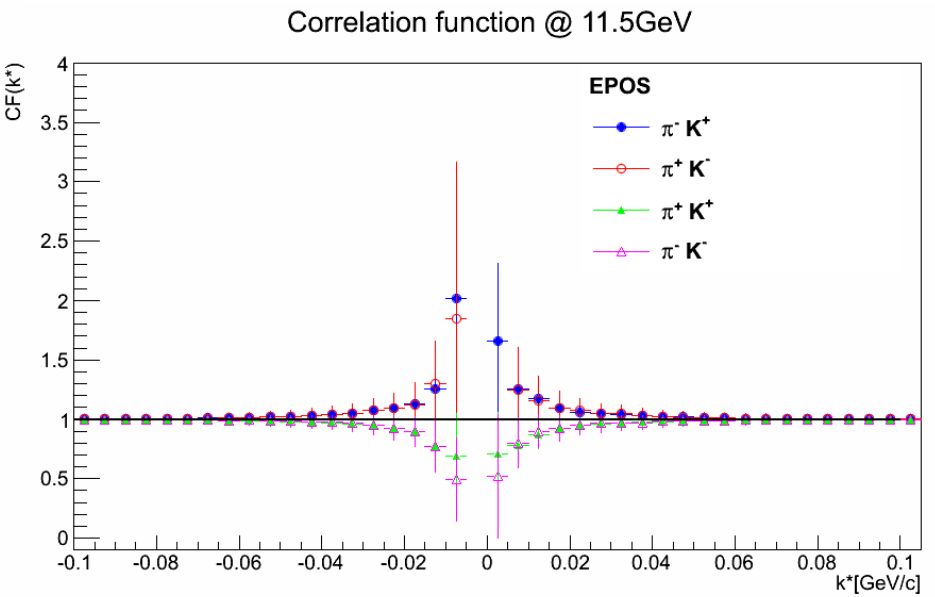
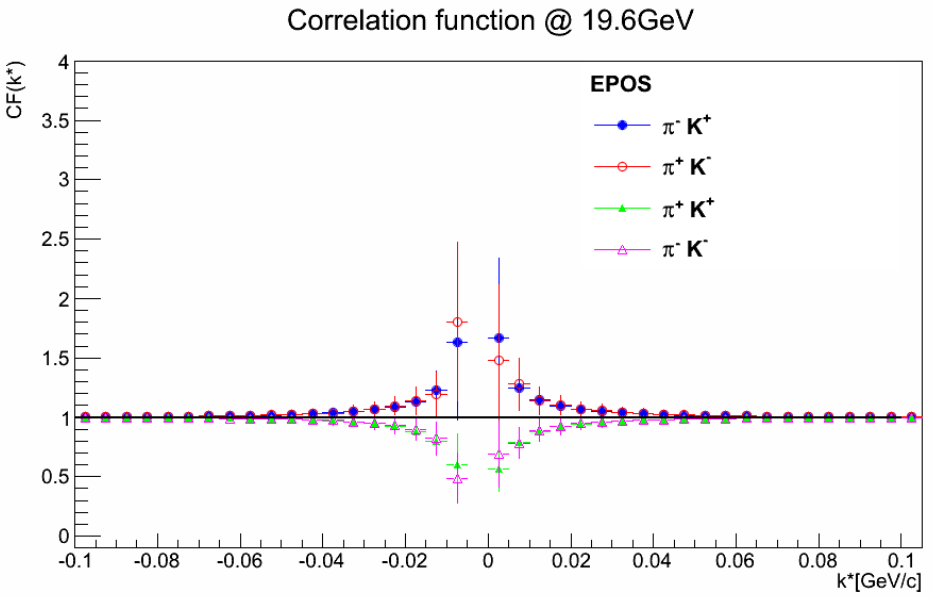
IX WPCF 2013, Acireale (Catania), Italy

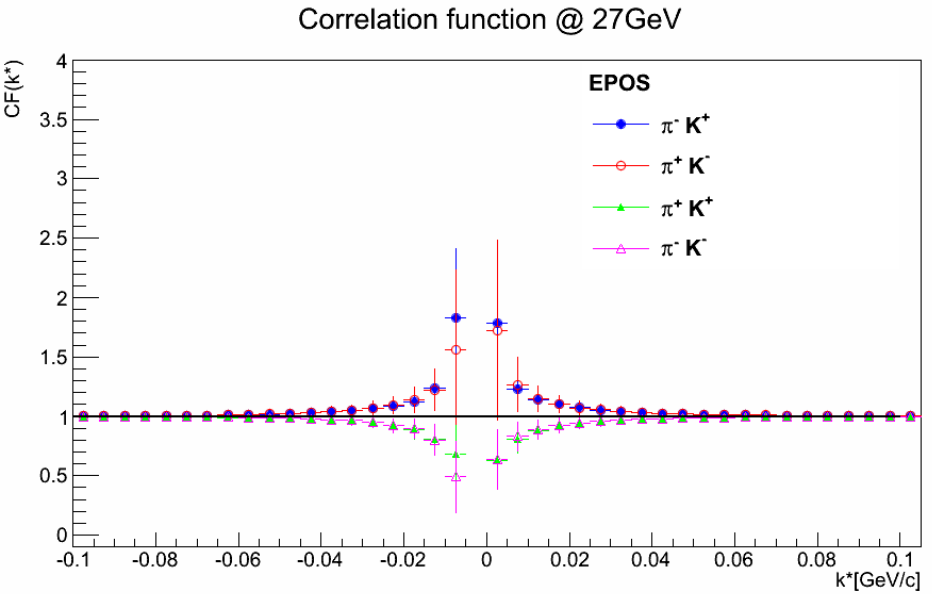


Results from EPOS



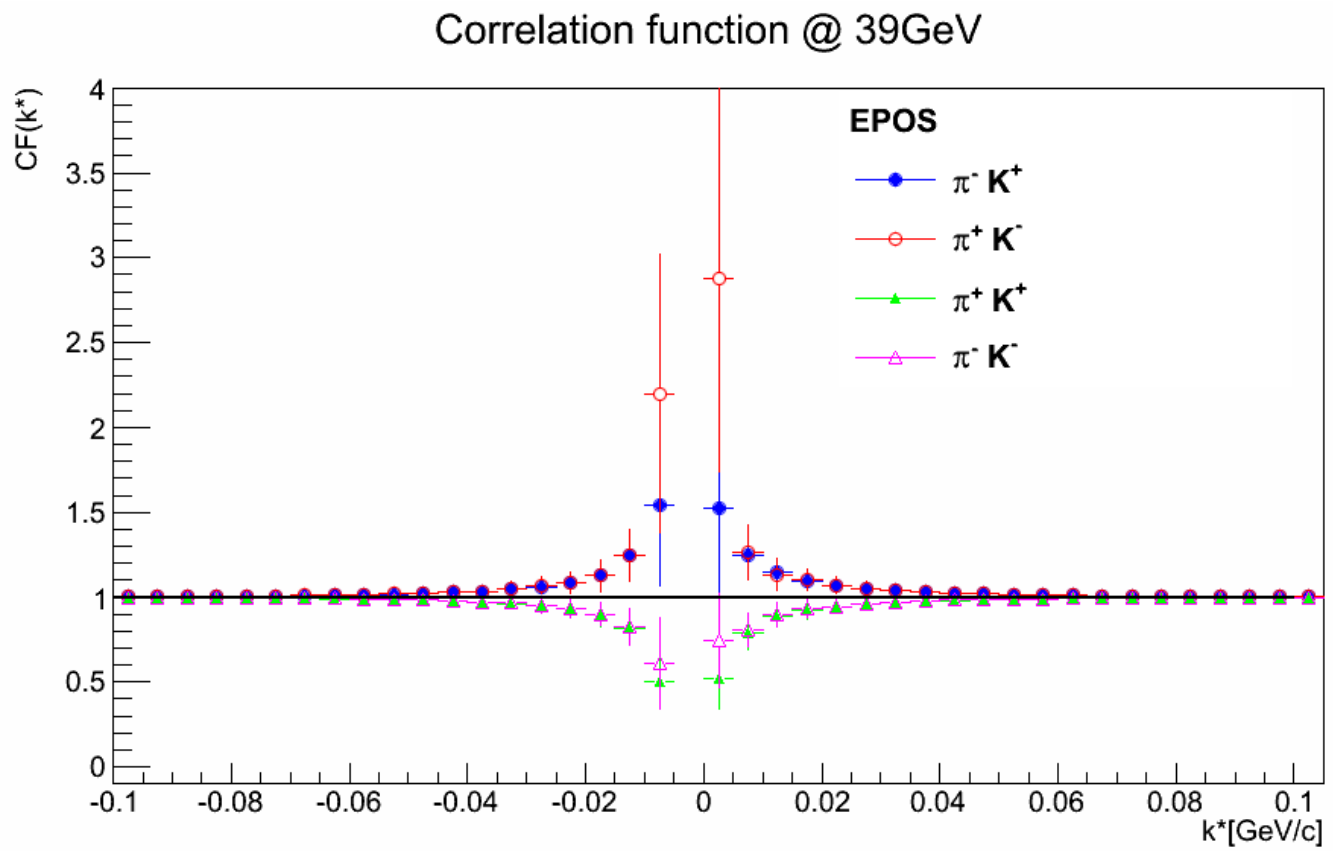




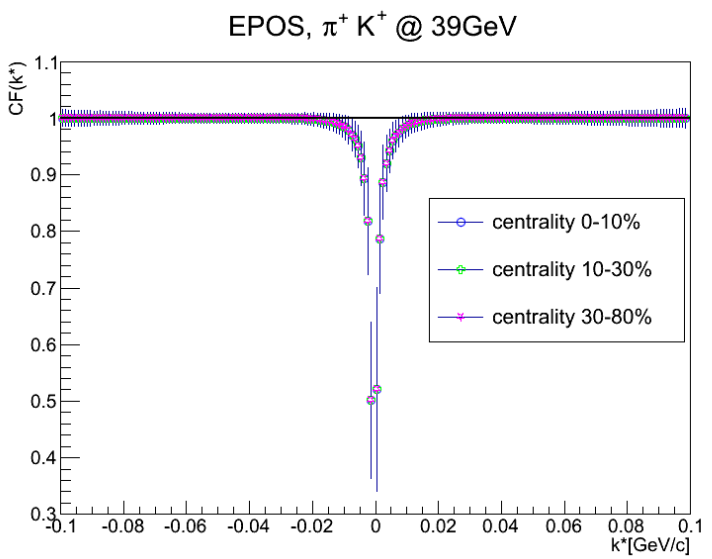


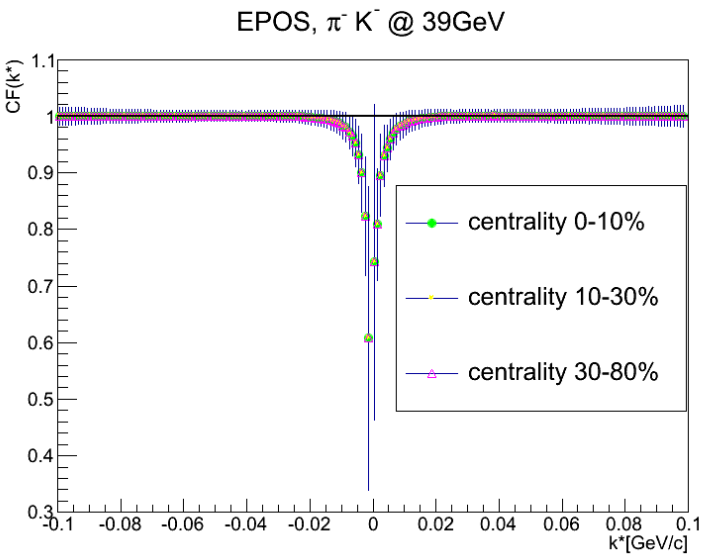
Results from EPOS

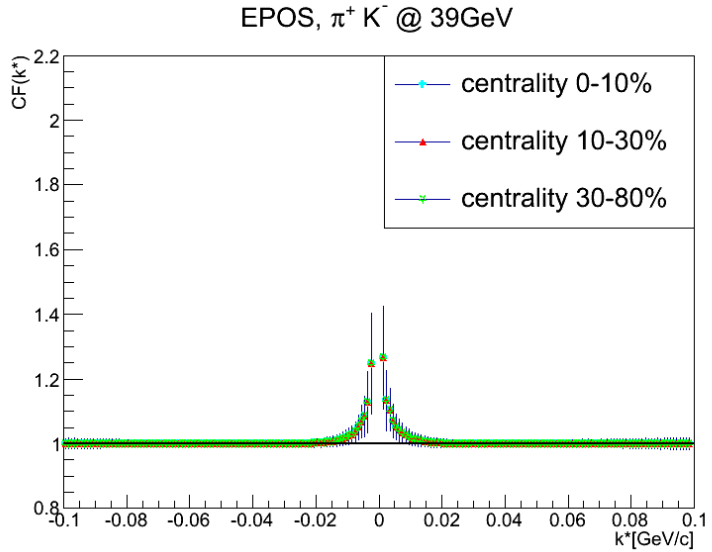
- The shape of the functions is determined by Coulomb force.
- In this model there is no big difference between correlation functions of the same sign systems (Pion - Kaon - and Pion + Kaon +) and for correlaion functions for different sign systems (Pion - Kaon + and Pion + Kaon -).

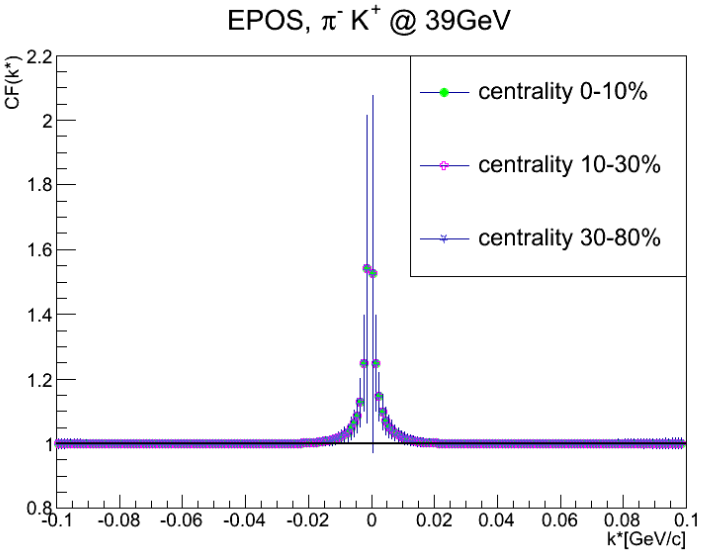


Centrality dependence









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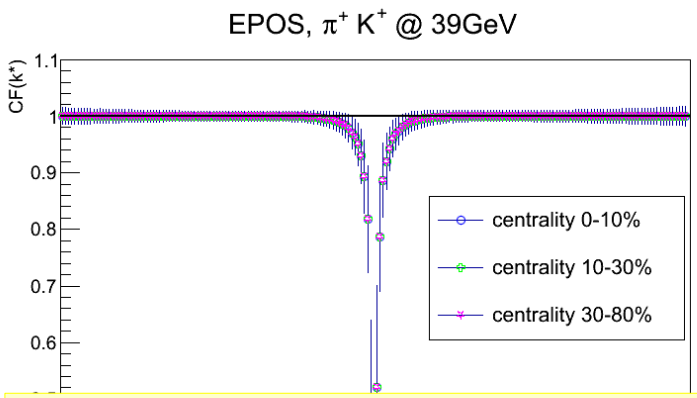
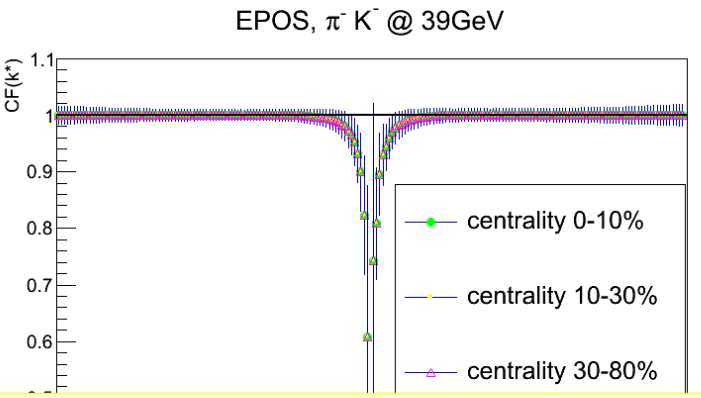
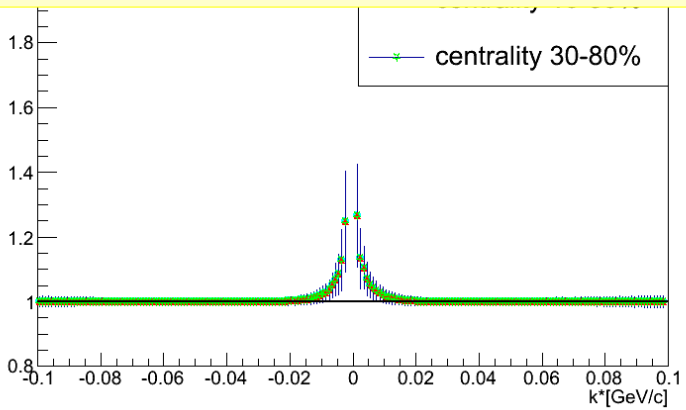
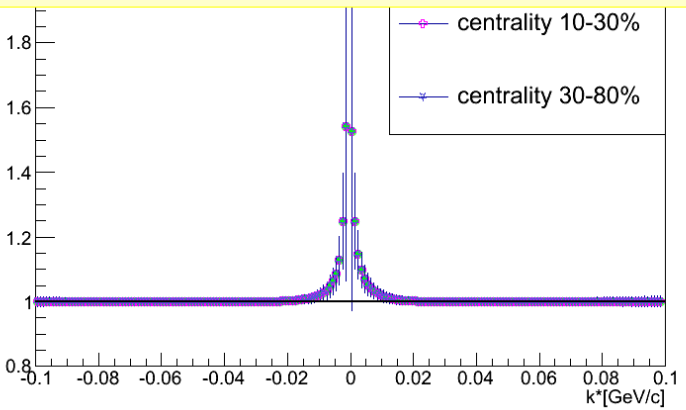


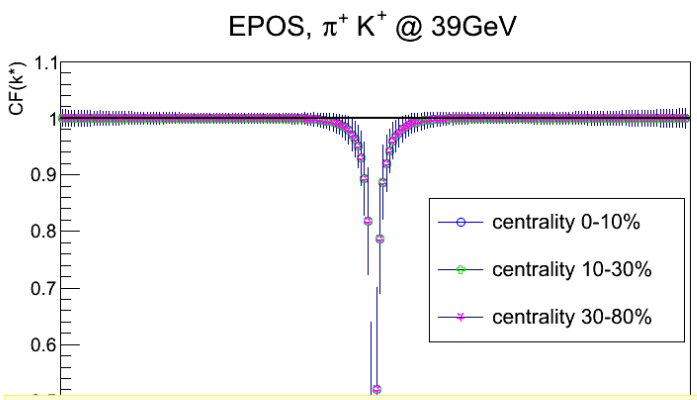


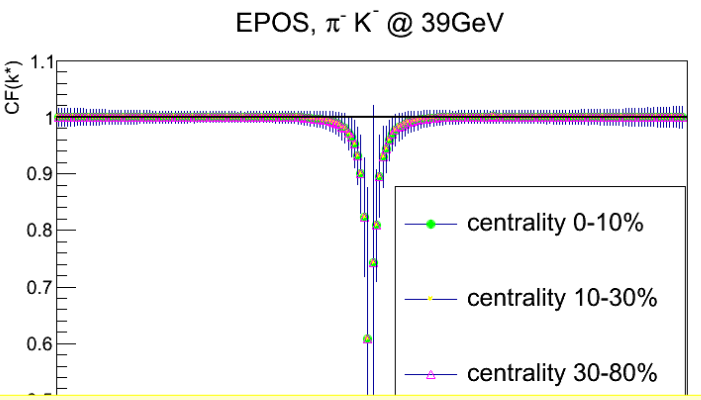
- No association between the strength of interaction and collision centrality for energy 7.7GeV, 11.5GeV, 19.6GeV, 27GeV and 39GeV.





Centrality dependence





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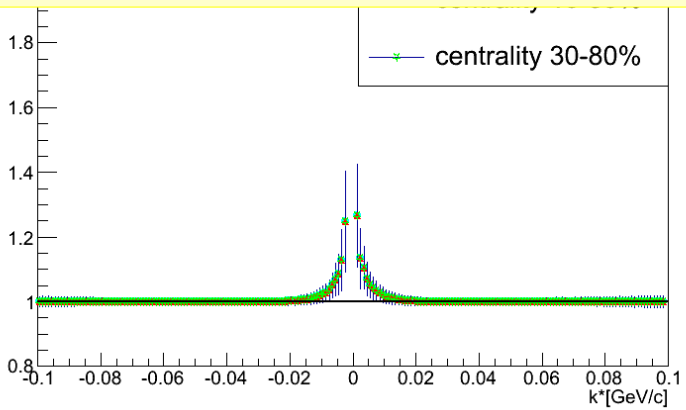
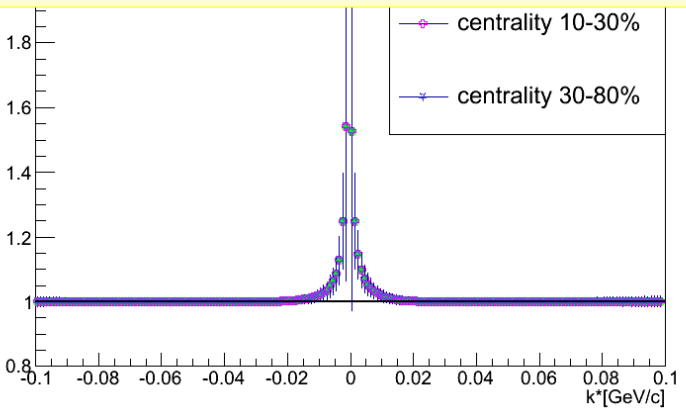
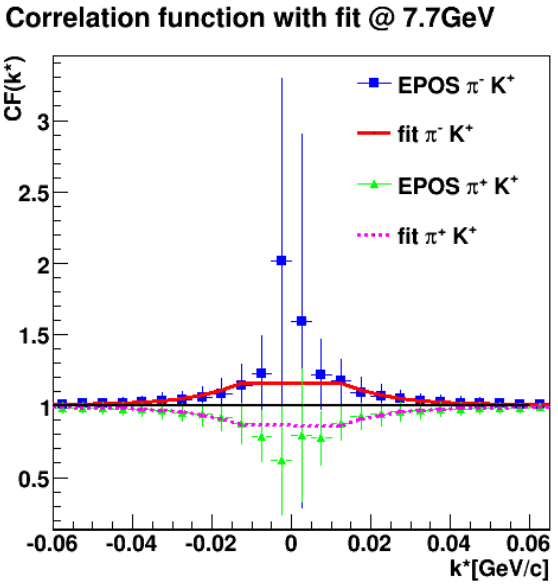
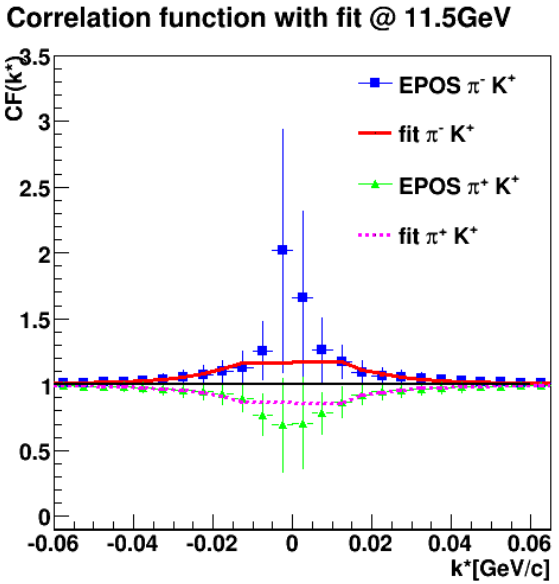
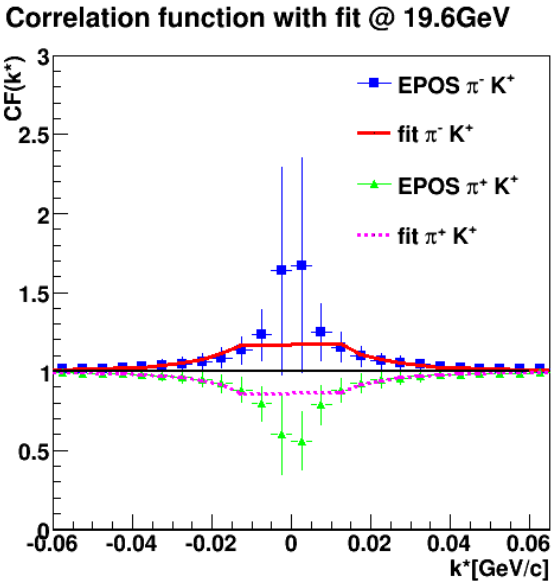


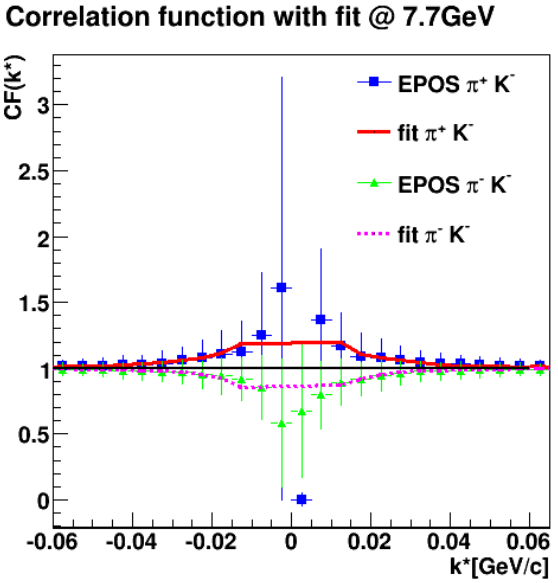


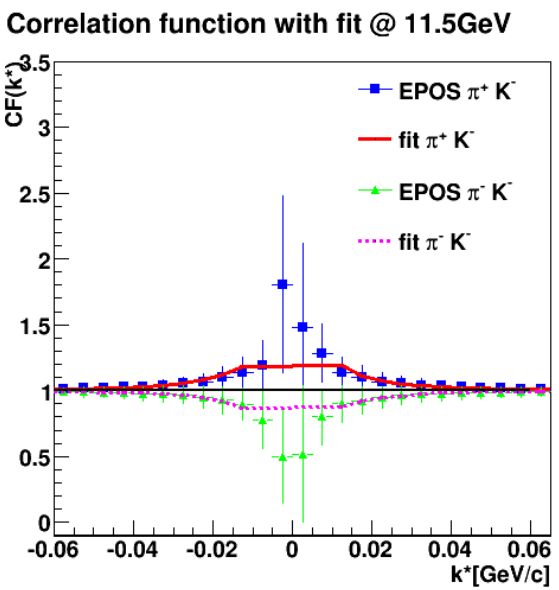
Fits

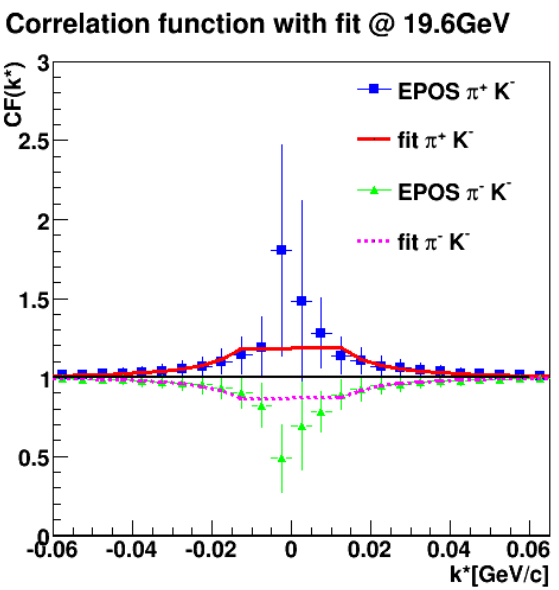

Correlation function with fit @ 7.7GeV
CF(k*)
EPOS π⁻ K⁺
fit π⁻ K⁺
EPOS π⁺ K⁺
fit π⁺ K⁺
k*[GeV/c]


Correlation function with fit @ 11.5GeV
CF(k*)
EPOS π⁻ K⁺
fit π⁻ K⁺
EPOS π⁺ K⁺
fit π⁺ K⁺
k*[GeV/c]

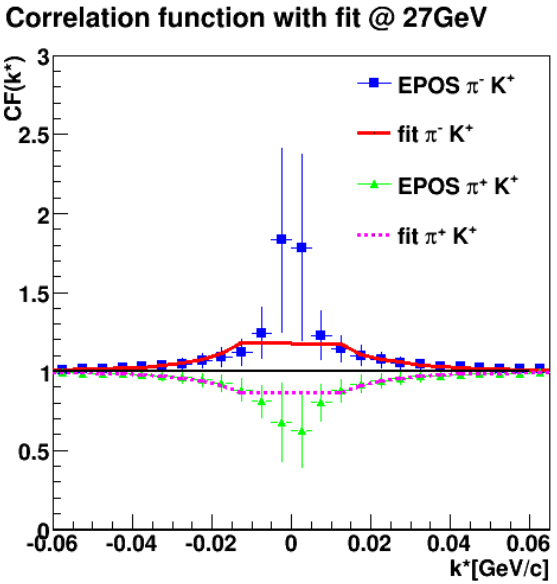

Correlation function with fit @ 19.6GeV
CF(k*)
EPOS π⁻ K⁺
fit π⁻ K⁺
EPOS π⁺ K⁺
fit π⁺ K⁺
k*[GeV/c]

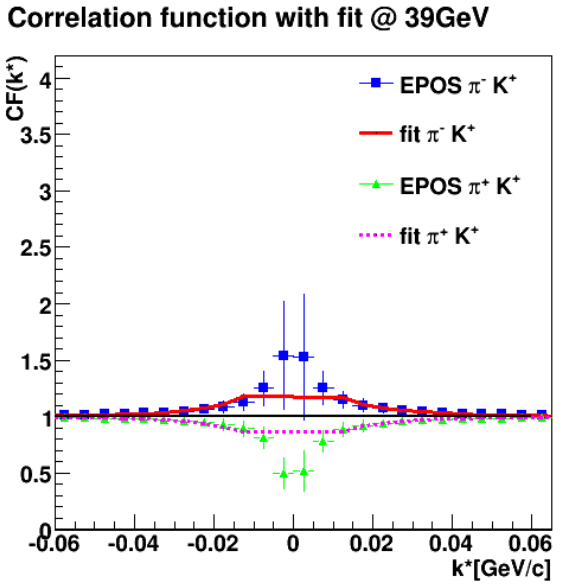

Correlation function with fit @ 7.7GeV
CF(k*)
EPOS π⁺ K⁻
fit π⁺ K⁻
EPOS π⁻ K⁻
fit π⁻ K⁻
k*[GeV/c]

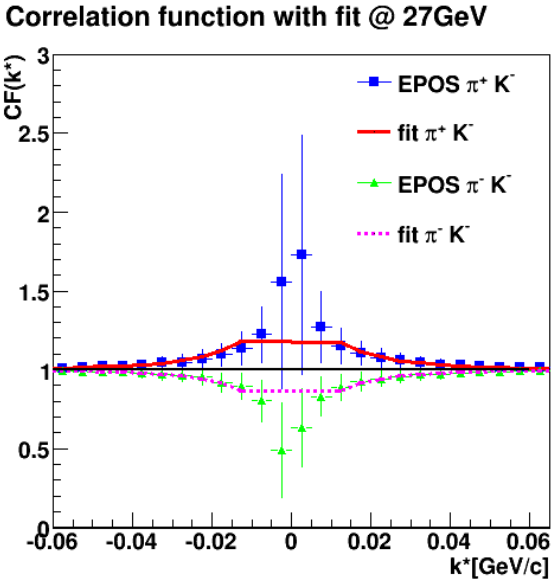

Correlation function with fit @ 11.5GeV
CF(k*)
EPOS π⁺ K⁻
fit π⁺ K⁻
EPOS π⁻ K⁻
fit π⁻ K⁻
k*[GeV/c]

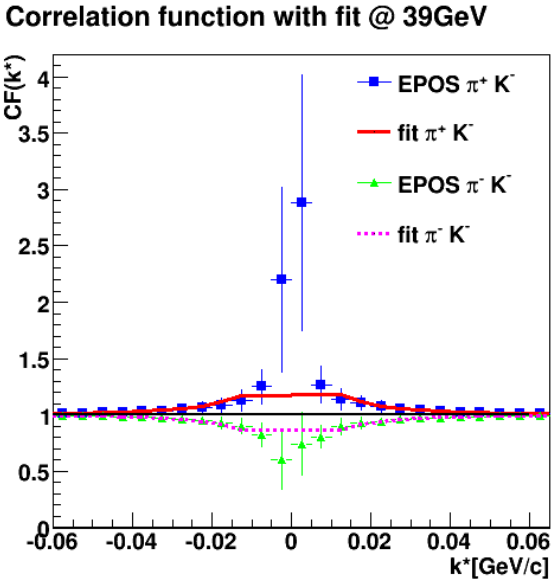

Correlation function with fit @ 19.6GeV
CF(k*)
EPOS π⁺ K⁻
fit π⁺ K⁻
EPOS π⁻ K⁻
fit π⁻ K⁻
k*[GeV/c]

Fits


Correlation function with fit @ 27GeV
CF(k*)
EPOS π⁻ K⁺
fit π⁻ K⁺
EPOS π⁺ K⁺
fit π⁺ K⁺
k*[GeV/c]

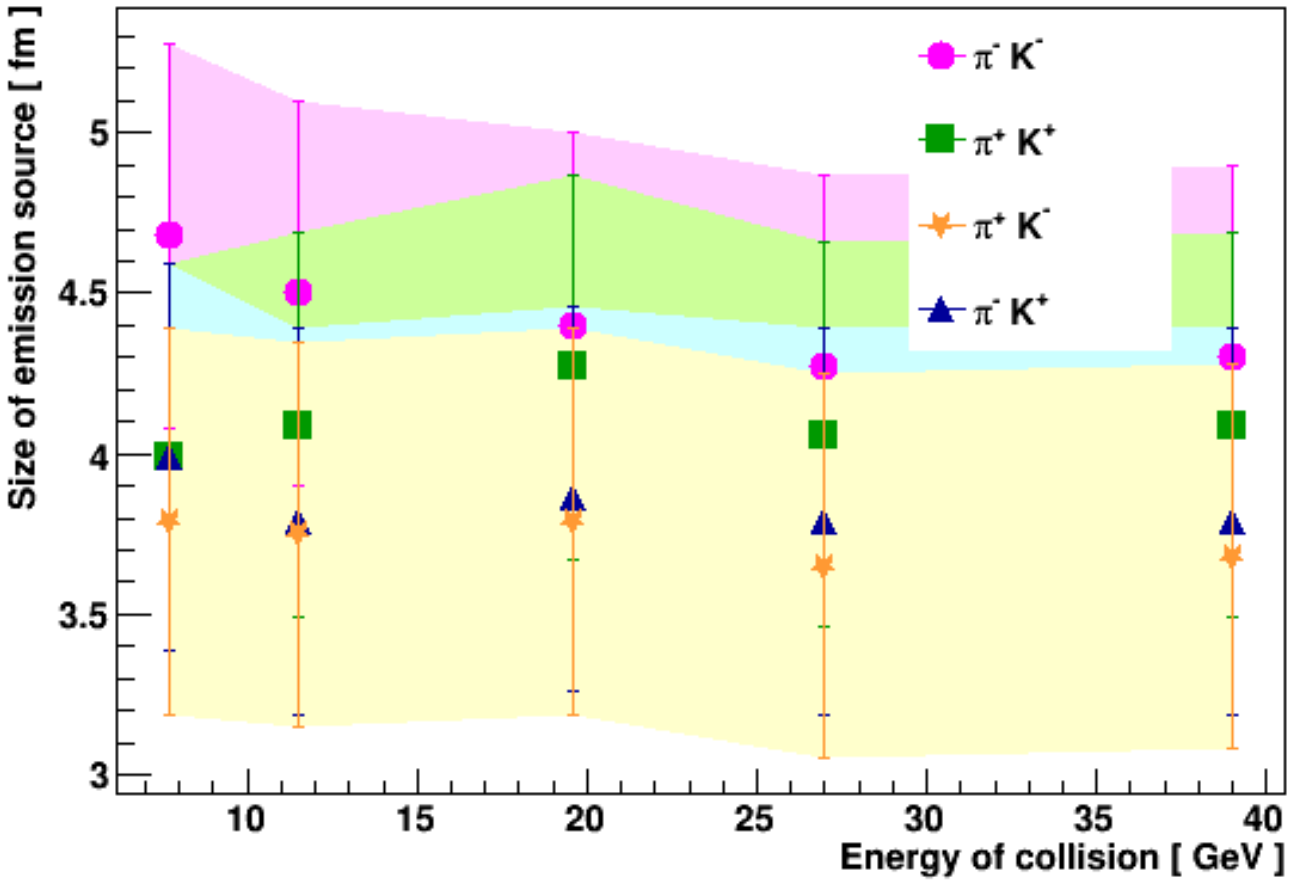

Correlation function with fit @ 39GeV
CF(k*)
EPOS π⁻ K⁺
fit π⁻ K⁺
EPOS π⁺ K⁺
fit π⁺ K⁺
k*[GeV/c]


Correlation function with fit @ 27GeV
CF(k*)
EPOS π⁺ K⁻
fit π⁺ K⁻
EPOS π⁻ K⁻
fit π⁻ K⁻
k*[GeV/c]

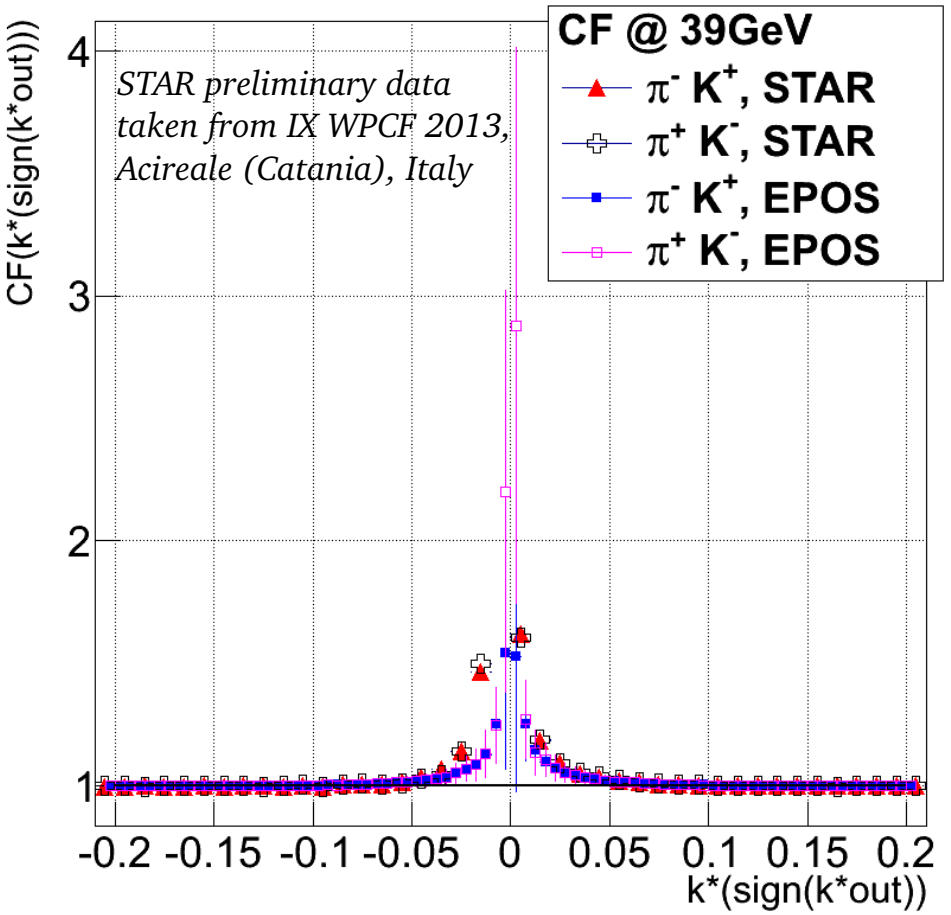

Correlation function with fit @ 39GeV
CF(k*)
EPOS π⁺ K⁻
fit π⁺ K⁻
EPOS π⁻ K⁻
fit π⁻ K⁻
k*[GeV/c]

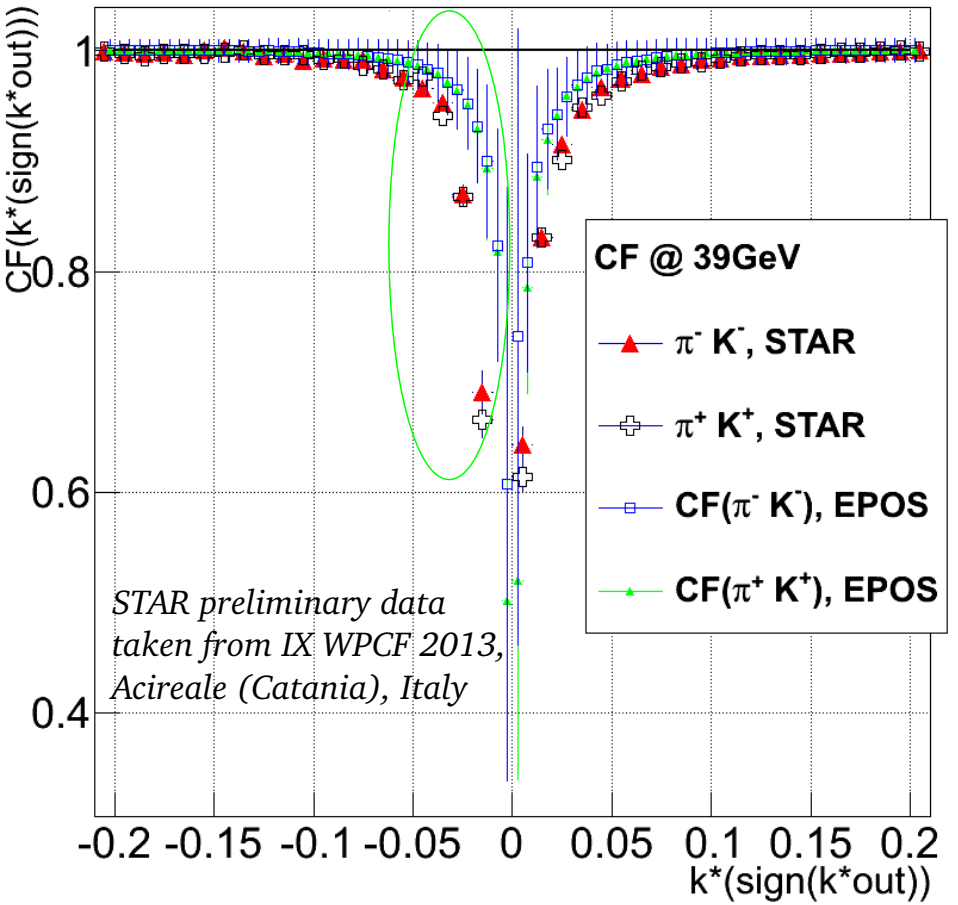
Sizes calculated from correlation functions

- We do not observe energy dependence in source sizes in EPOS model.



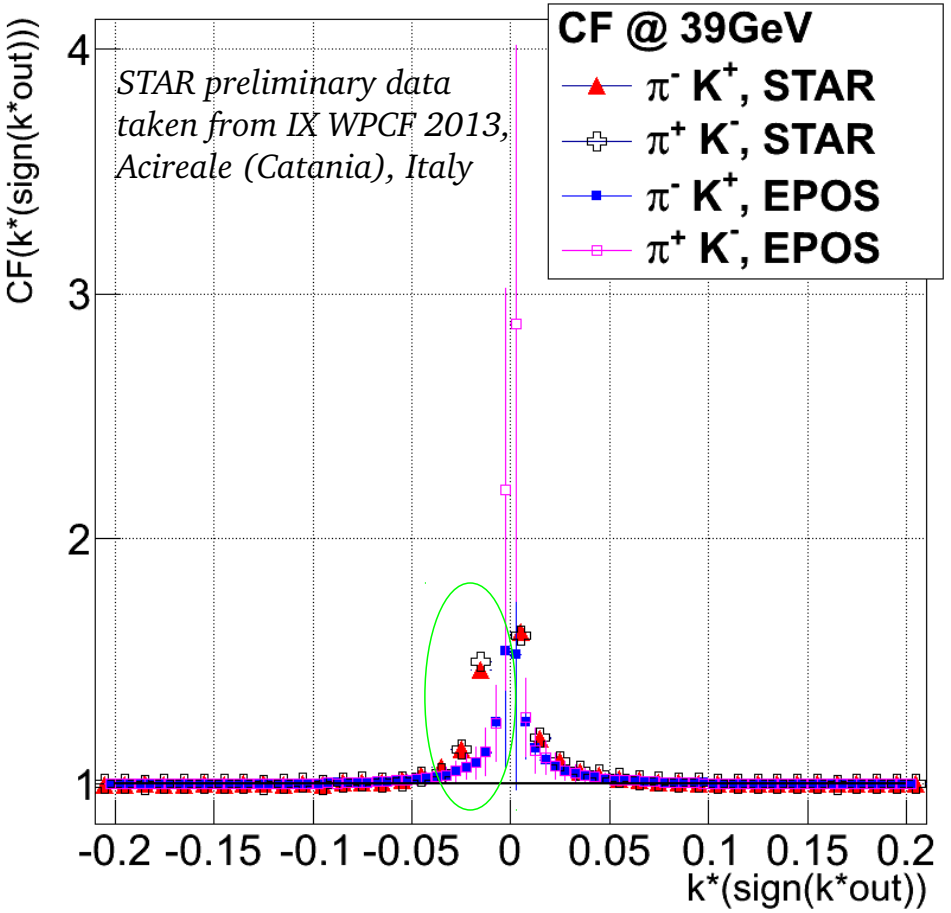
STAR and EPOS data for 39 GeV

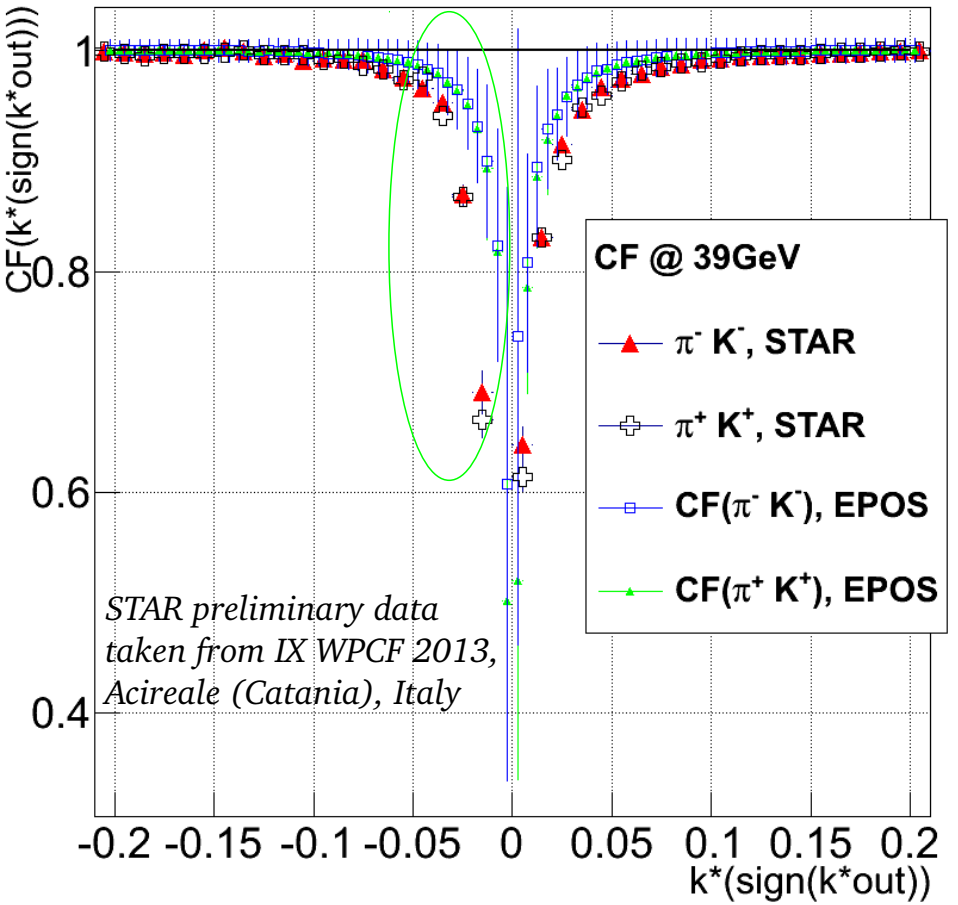




STAR and EPOS data for 39 GeV

- We observe difference between STAR and EPOS data





Summary

- Transverse momentum spectra results for charged particles from EPOS model are between STAR p_T spectra for the most central collisions (0-5%) and peripheral (60-80%).
- There is no big difference in EPOS model between correlation functions of the same sign particles systems (Pion - Kaon - and Pion + Kaon +) and for correlaion functions for different sign particles systems (Pion - Kaon + and Pion + Kaon -).
- No association between the strength of interaction and collision centrality for energy 7.7GeV, 11.5GeV, 19.6GeV, 27GeV and 39GeV.
- We do not observe energy dependence in source sizes in EPOS model.
- To compare the STAR resultes from BES with the model, we need the model with hydrodynamics.

Thank you!

Annotation

1. ***New Developments of EPOS 2***; T. Pierog from KIT, Institut fur Kernphysik, Karlsruhe, Germany; Iu. Karpenko from Bogolyubov Institute for Theoretical Physics, Kiev, Ukraine; S. Porteboeuf from University of Clermont-Ferrand, Clermont-Ferrand, France; K. Werner from SUBATECH, University of Nantes – IN2P3/CNRS– EMN, Nantes, France

2. *Quark Matter 12-18 August 2012, Proceedings*; ***R_CP and R_AA Measurements of Identified and Unidentified Charged Particles at High p_T in Au+Au Collisions at 7.7, 11.5, 19.6, 27, 39, and 62.4 GeV in STAR***, Evan Sangaline for the STAR Collaboration