Two-particle transverse momentum correlations in Pb–Pb collisions at ALICE

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Two-particle transverse momentum correlations

Enable measurements of collision dynamics features sensitive to momentum currents

- System life time increases with collision centrality
- The longer the system lives the wider the reach of the momentum transfer
- The changes in the shape of the rapidity dependence of the correlation function (1) with collision centrality provides information about the evolution of the system

It has been proposed

- Kinematic viscosity \( \nu/(Ts) \) contributes to the longitudinal diffusion of momentum currents
- \( \eta/\nu \) can be estimated [1] on based on the longitudinal broadening of the correlation function (2)
- Systematic changes in the shape of the longitudinal dependence of the correlation function with collision centrality make it possible to distinguish between diffusive propagation and wave propagation and to extract \( \tau_{\text{sys}} \), the system relaxation time [2]

Measured two-particle transverse momentum correlations

<table>
<thead>
<tr>
<th>Observables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>( G_2 (\Delta \eta, \Delta \varphi) )</td>
<td>( \langle n_{i,j} \rangle ) single particle multiplicity ( n_{i,j} ), two, multiplicity ( p_{T,i}, p_{T,j} ) particle one, two, transverse momentum</td>
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</tbody>
</table>

Measured as

- Charge independent (CI) driven by collective behavior
- Charge dependent (CD) influenced by charge conservation

\( G_2 \) near-side fitted to characterize its shape evolution
- Background (flow) + 2D Generalized Gaussian
- Width extracted as the variance of generalized Gaussian

Previous results: STAR at RHIC [3]

\( Au-Au \) at \( \sqrt{s_{NN}} = 200 \text{ GeV} \)

Widths evolution

- Longitudinal \( G_2 \) \( \sigma_{\Delta \eta} \) evolution
  - CI longitudinal broadening
  - CD almost flat with centrality

- Azimuthal \( G_2 \) \( \sigma_{\Delta \varphi} \) evolution
  - CI and CD azimuthal narrowing
  - CD azimuthally wider than CI

Comparison to models

- Longitudinal \( G_2 \) \( \sigma_{\Delta \eta} \) evolution
  - CI: None of the models describe the trend
  - CD: HIJING describes centrality evolution
  - All settings of AMPT have opposite trend

- Azimuthal \( G_2 \) \( \sigma_{\Delta \varphi} \) evolution
  - CI: AMPT with string melting (SM)
  - CD: None of the models describe the trend values, but all AMPT settings describe the trend

Comparison to RHIC results

- \( G_2 \) CI longitudinal broadening with collision centrality in agreement with results from STAR at RHIC
- Measured constant \( G_2 \) CD longitudinal width with collision centrality only described by HIJING

Conclusions and outlook

- Observed \( G_2 \) CI azimuthal narrowing with collision centrality described by AMPT with string melting
- Models do not explain richness of behaviors in both \( \Delta \eta \) and \( \Delta \varphi \) dimensions
- In the near future
  - Shear viscosity and relaxation time estimation
  - Extract results for other collision energies and collision systems at the LHC

Bibliography