Multibin multiplicity correlations in a superposition approach
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Introduction
- Multibin correlation coefficients quantify how multiplicity in various rapidity windows influence one another.
- The primary goal of these analyses is to get insight into the space-time dynamics of the earliest stages of the reaction, probed via the multibin correlations


The concept of the sources
- Sources in the transverse plane: wounded nucleons or binary collisions
- Concept of longitudinal strings (fluxtubes). Their number decreases with centrality
- We assume well separated F, B, and C rapidity bins, such that the particles produced in one bin do not fall into another one

Time evolution of the system
- Initial tubes extend along the forward and backward rapidity range
- Quarks and gluons (more generally partons) form from breaking fluxtubes
- Partons produced from a source have the same distribution in bins F, B, C
- The density of partons yields the initial condition for hydrodynamics
- Hydrodynamic evolution
- Statistical hadronization is carried out at freeze-out

Superposition model and the three stage approach
- In the initial phase we assume that the parton production occurs from each source in the same manner,
  \[ p_s = \sum_{i=1}^{s_i} \mu_i, \quad A = B, F, C \]
- The evolution of the cell with initially \( p \) partons yields the density of fluid \( h \) at freeze-out. It may be thought of as entropy contained in the cell.
- When fluctuations are not too large
  \[ h = t_s(p) + t_t(p - p) + \sigma \]
- At freeze-out 1 cell emits \( n \) hadrons into a corresponding region of phase space, with a statistical distribution superimposed over \( h \),
  \[ n_A = \sum_i n_i \]

The moments of sources
- We introduce the moments and scaled moments of sources
  \[ S_{ijk} = \langle \Delta s_i \Delta s_j \Delta s_k \rangle, \quad \tilde{S}_{ijk} = \frac{\langle \Delta s_i \Delta s_j \Delta s_k \rangle}{\sqrt{\langle \Delta s_i^2 \rangle \langle \Delta s_j^2 \rangle \langle \Delta s_k^2 \rangle}} \]
- In the three-stage approach we obtain relations between the moments of the initial sources (\( s \)) and observed hadrons (\( n \)),
  \[ \langle n_{s(i)} \rangle = \alpha(s_i), \quad \langle \Delta n_{s(i)} \rangle = \beta(s_i) + \gamma(\Delta s_i), \quad \langle \Delta n_{s(i)} \Delta s_{j(k)} \rangle = \gamma(\langle \Delta s_i \Delta s_j \Delta s_k \rangle) \]
  \[ \langle \Delta n_{s(i)} \Delta s_{j(k)} \rangle = \gamma^2(\langle \Delta s_i \Delta s_j \Delta s_k \rangle) + \gamma(\Delta s_i \Delta s_j \Delta s_k) \]
  \[ \langle \Delta n_{s(i)} \rangle = \zeta(s_i) + \gamma (\Delta s_i) + \gamma^2 (\Delta s_i) \]
  where the \( c \)- and \( \eta \)-independent parameters are
  \[ \alpha = t_s(p)(p), \quad \beta = t_t(p)(p) + t_t^2(p)(p) \]
  \[ \gamma = t_t(p)(p) + t_t^2(p)(p) \]
  \[ \zeta = t_s(p)(p) + 3t_t(p)(p) + t_t^2(p)(p) + t_t^3(p)(p) \]

Rapidity distribution of sources
- Centrality determined from the central bin \( C \)
- \( \Delta n \) is the separation of \( F \) and \( B \) bins, bin width = 0.2
- Results depend on \( \Delta c \), but same choice as in the experiment can be made

Results and predictions from GLISSANDO
- Natural fall-off with centrality from \( \langle s_{s(i)} \rangle / \langle \Delta s_{s(i)} \rangle \)

Conclusions
- Within a three-stage superposition model we have derived simple formulas which link statistical properties of the distribution of initial sources (wounded nucleons, gluons) with the number of the observed hadrons
- May fit multiplicities, variances, and higher-order multi-bin correlations.
  This will provide information of the properties of the overlaid distributions and the parameters of hydrodynamics