Forward-backward multiplicity correlations in proton-proton and nucleus-nucleus collisions

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Outline

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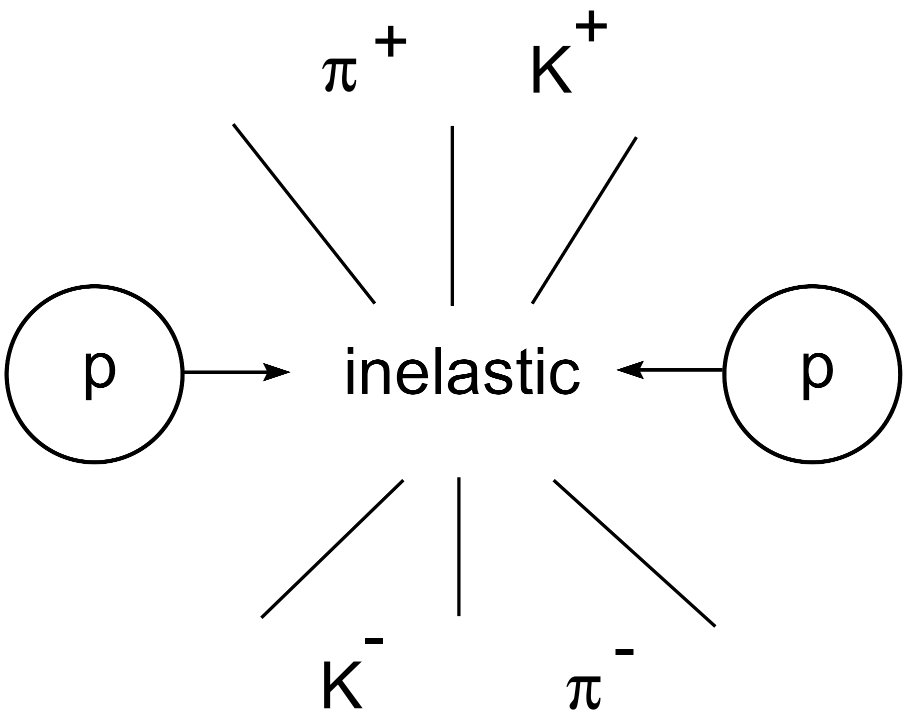
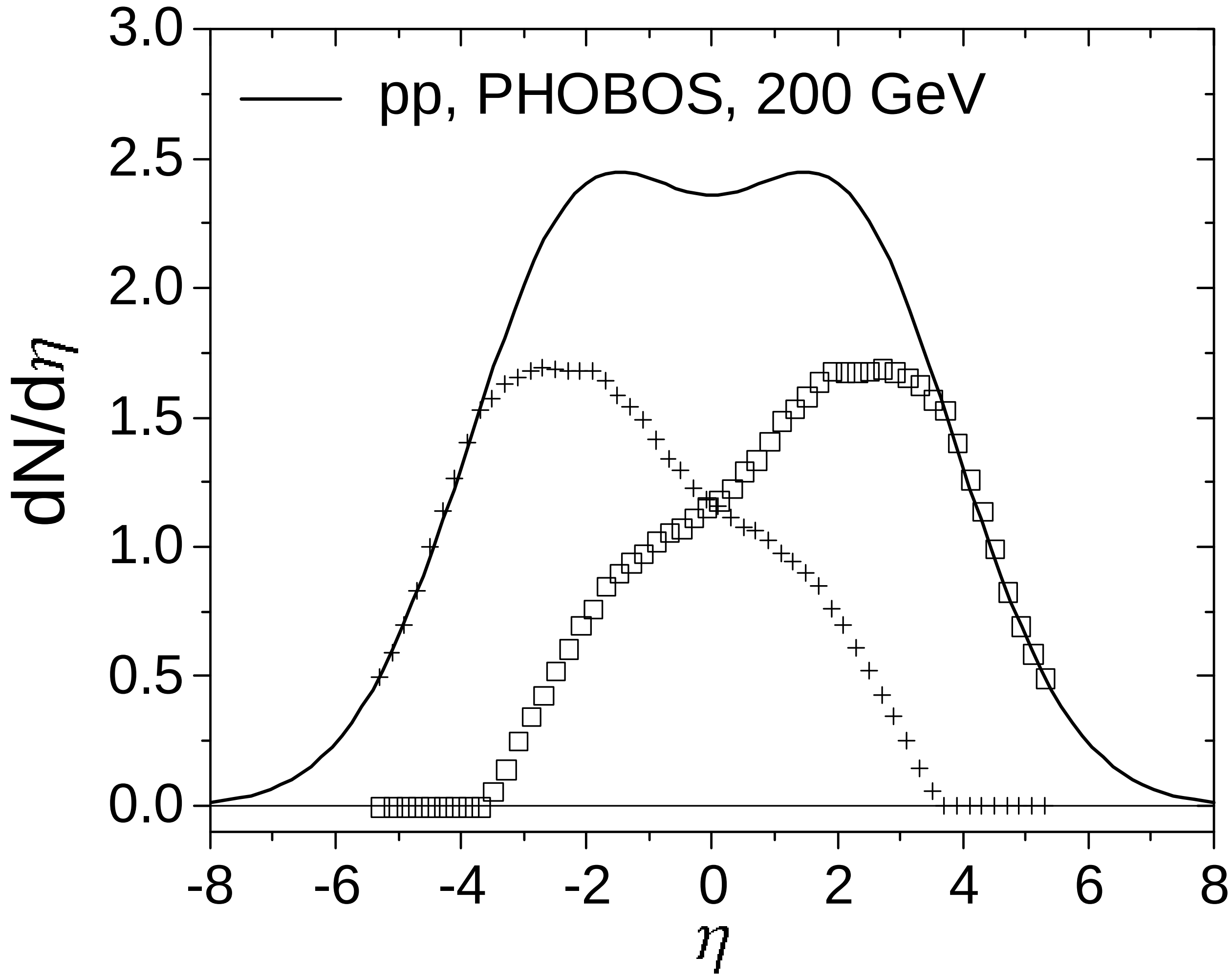
Introduction

Independent source model



$$\frac{dN(y)}{dy} = F_{\rm right}(y) + F_{\rm left}(y)$$

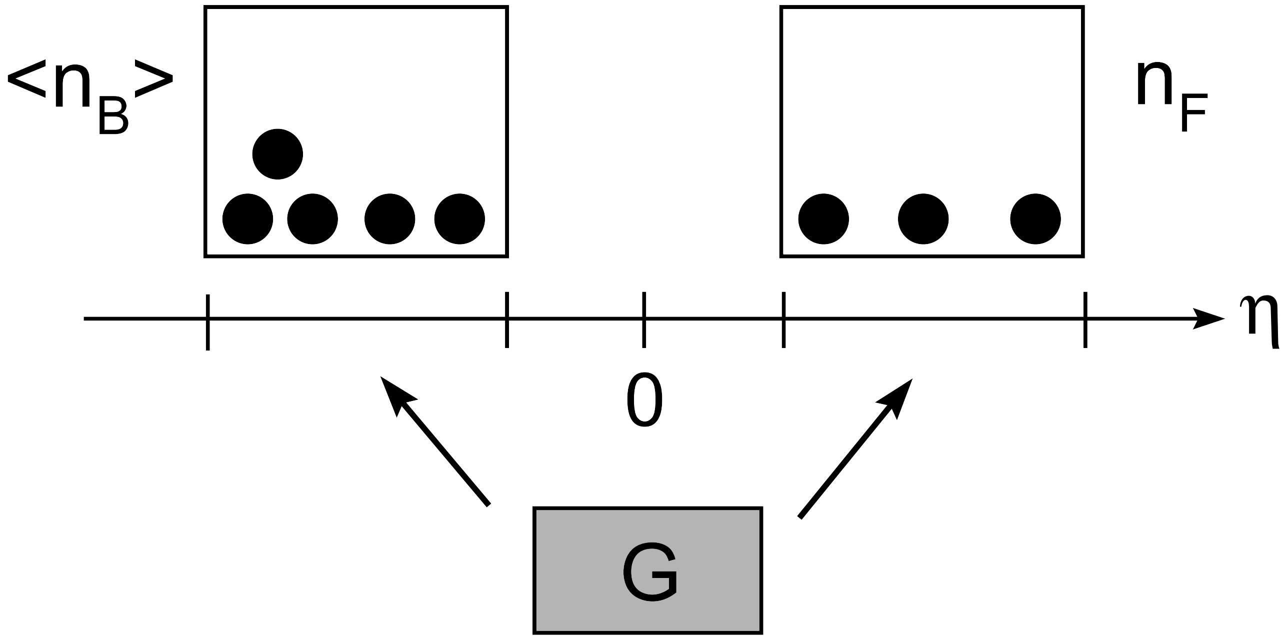
Contribution from one wounded nucleon



This picture suggests specific long-range correlations

Forward-backward multiplicity correlations

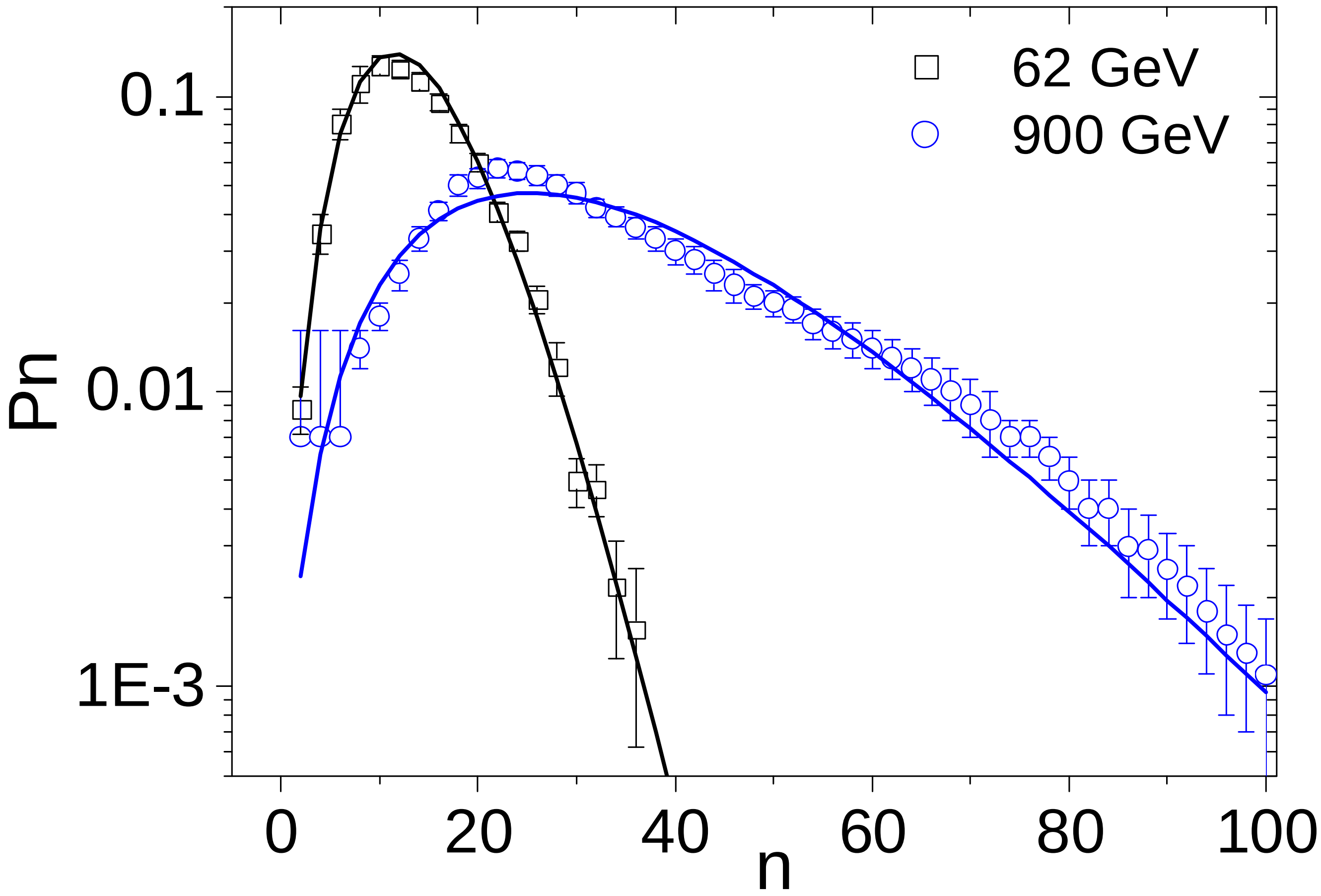
An average $\langle n_B \rangle$ on the left at a given n_F on the right



$$\langle n_B \rangle|_{n_F} = \frac{\sum_{n_B} n_B P(n_B, n_F)}{\sum_{n_B} P(n_B, n_F)} = |\ \mathrm{data}\ | = a + b n_F$$

Multiplicity distribution

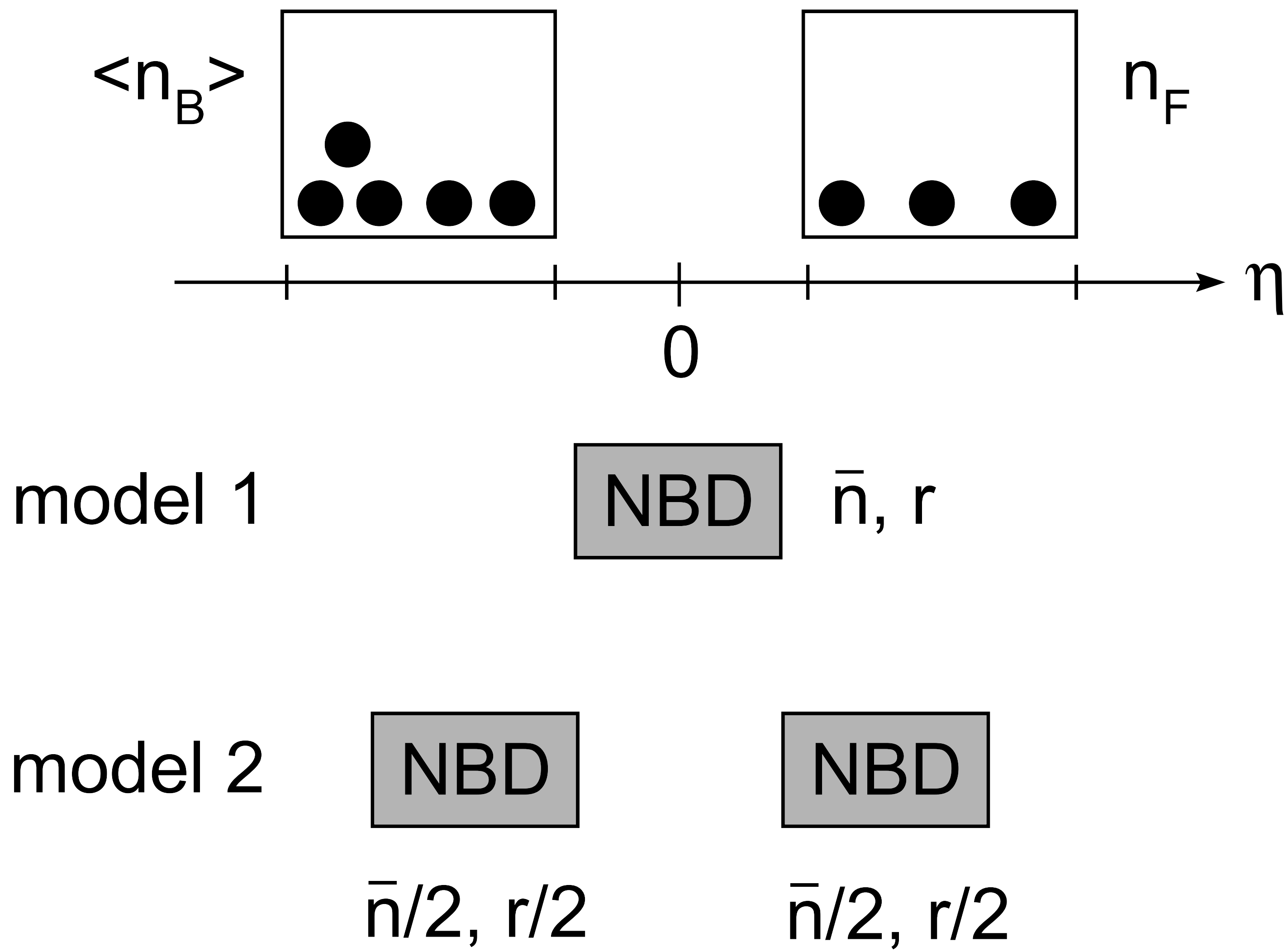
Negative Binomial Distribution (NBD)



$$P_n = \frac{\Gamma(n+r)}{\Gamma(n+1)\Gamma(r)} \left(\frac{\bar{n}}{r}\right)^n \left(1 + \frac{\bar{n}}{r}\right)^{-n-r}$$

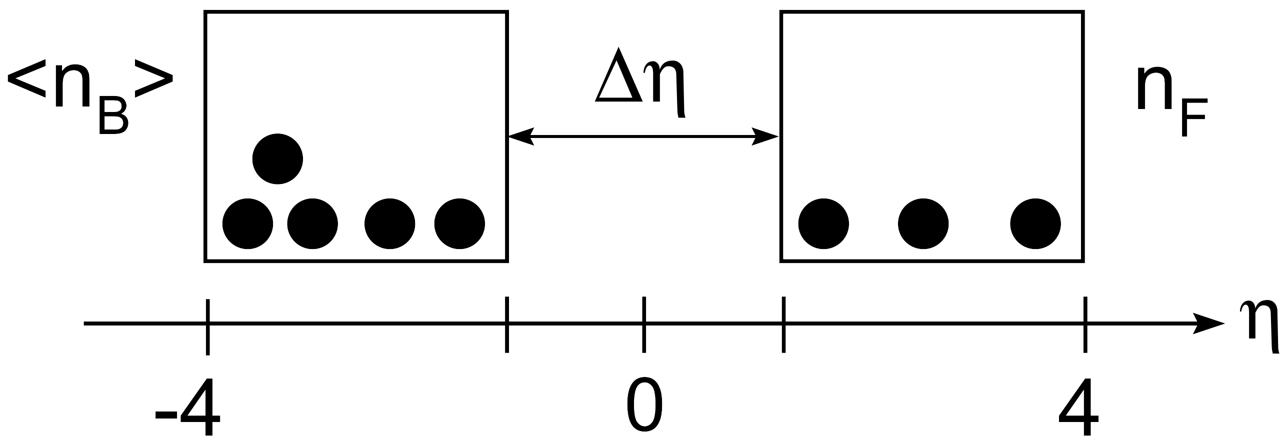
Two models

Single source (model 1), two sources (model 2)

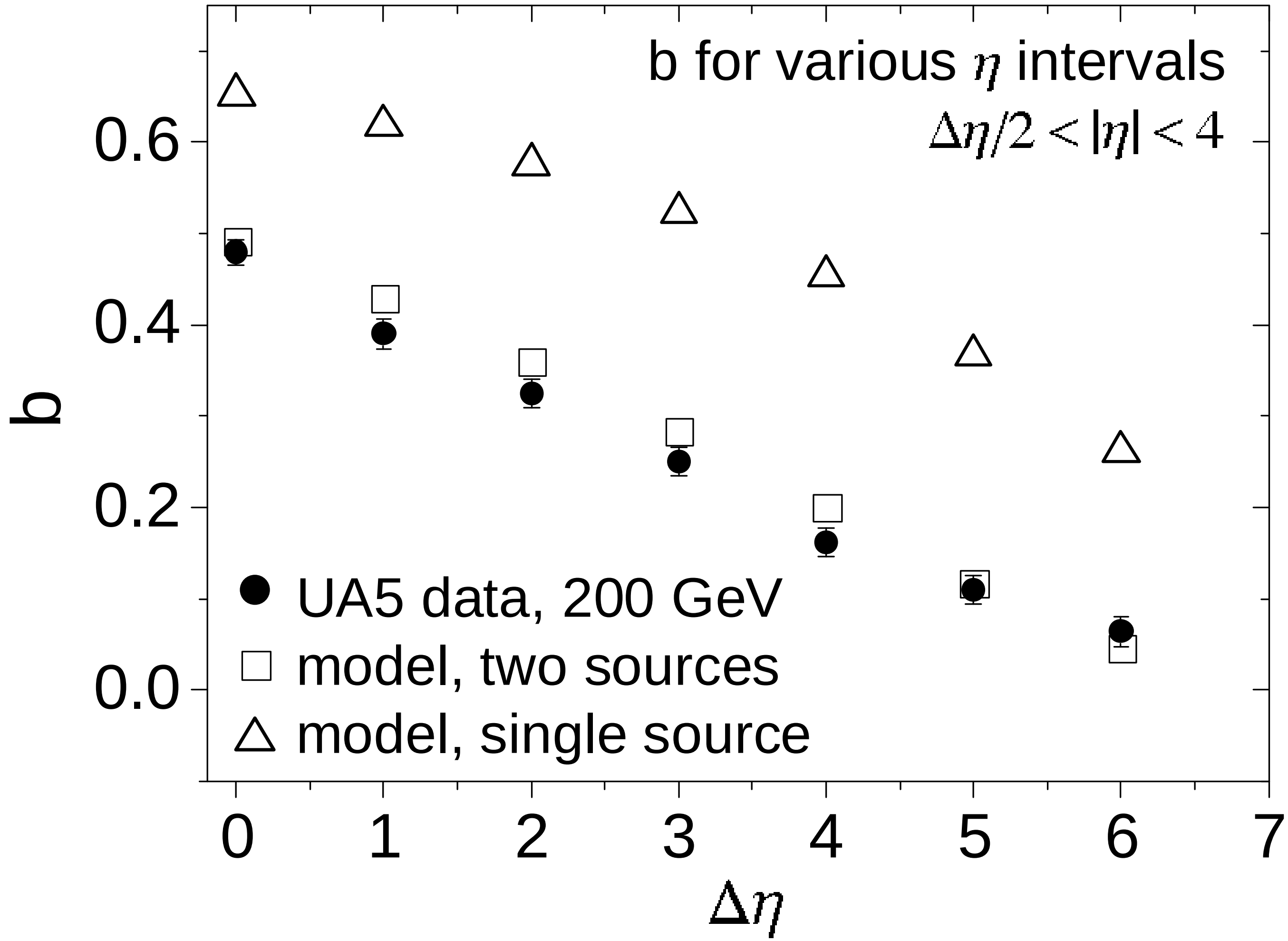


Correlation strength:

$$b = \frac{\langle n_B n_F \rangle - \langle n_B \rangle \langle n_F \rangle}{\langle n_F^2 \rangle - \langle n_F \rangle^2}$$

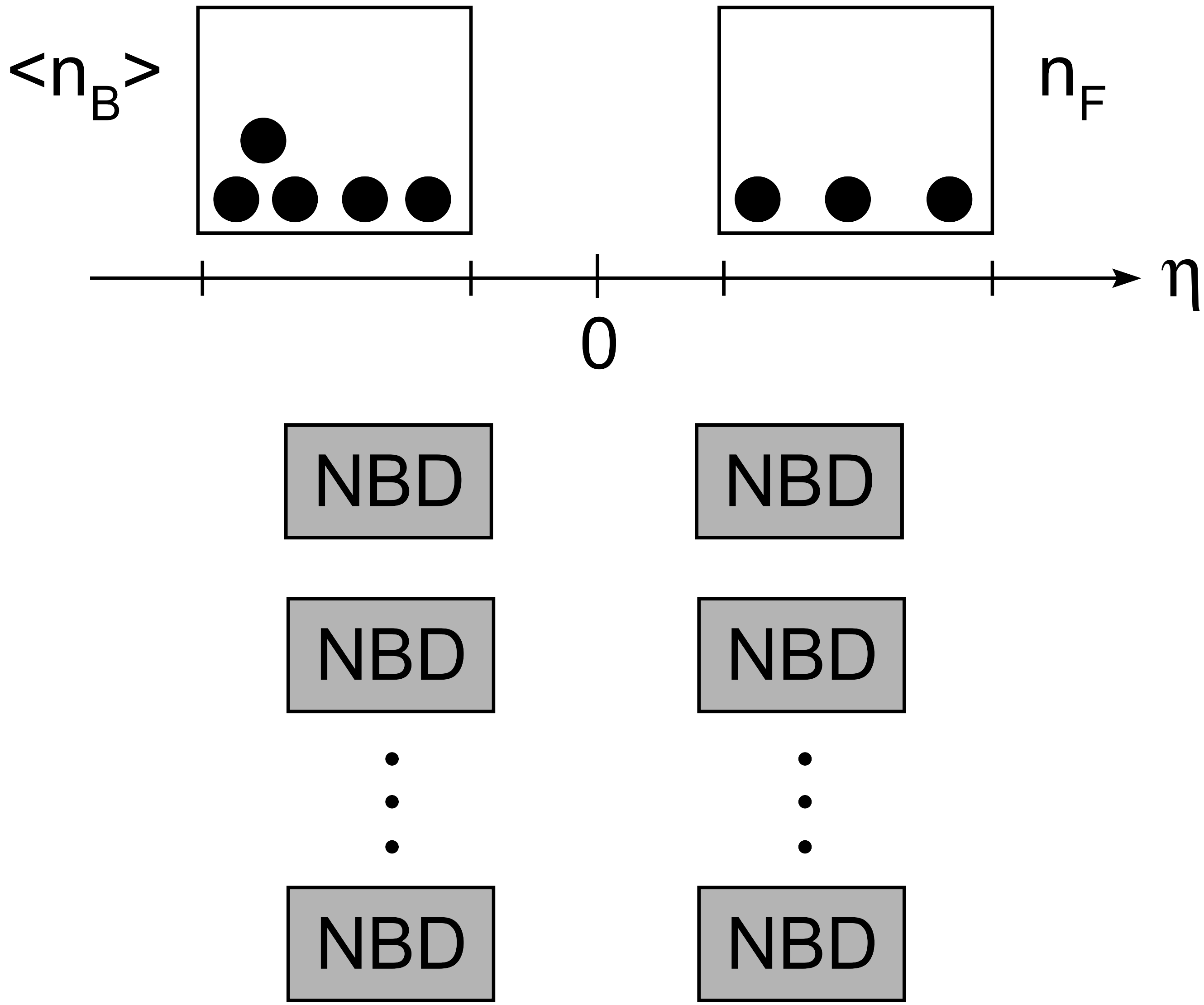


Correlation strength at different pseudorapidity intervals



Nucleus-nucleus collisions

$W = W_L + W_R$ sources of particles



Preliminary STAR data => for the most central collisions $b_{AA}/b_{pp} \approx 5$

Simple superposition model:

$$b_{AA} = 1 - \frac{1 - b_{pp}}{1 + \frac{r_{pp}}{2} b_{pp} \left[\frac{\langle W^2 \rangle - \langle W \rangle^2}{\langle W \rangle} \right]}$$

$\langle W^2 \rangle - \langle W \rangle^2 \neq 0$ fluctuations in the number of wounded nucleons

MC calculations => $\frac{\langle W^2 \rangle - \langle W \rangle^2}{\langle W \rangle} \approx 3$ for the most central collisions

Thus more than 60% (maybe more) can be easily explained

Conclusions

- pp collisons
  - single source model does not work
  - two (independent) sources model works remarkably well

- AuAu collisons
  - correlation strength enhancement
  - important fluctuations in the number of wounded nucleons
  - one should be careful when interpreting data