Forward-Backward Multiplicity Correlations in Au+Au

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Chemistry Department

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Quark Matter 2005, Budapest, Hungary

PHOBOS Collaboration

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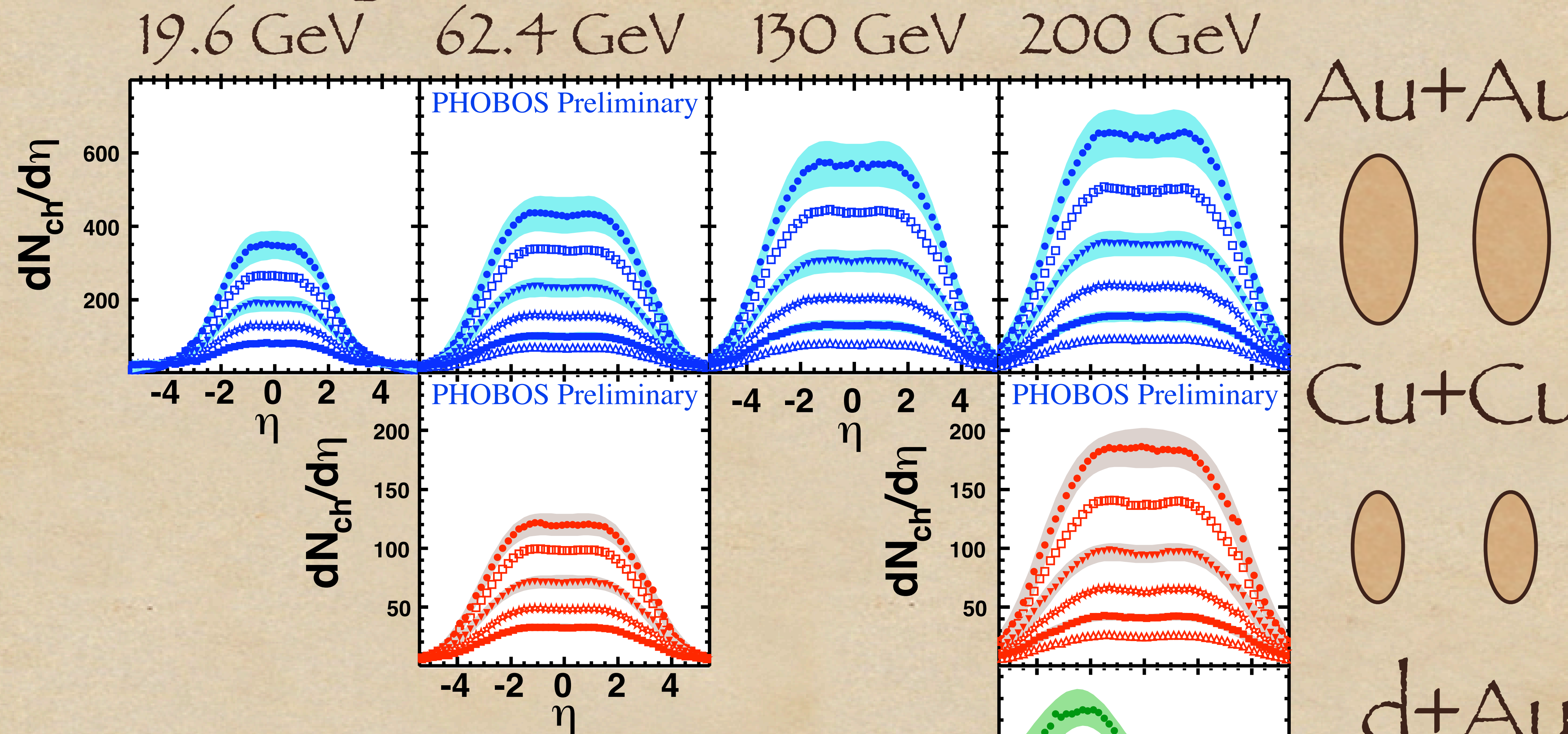
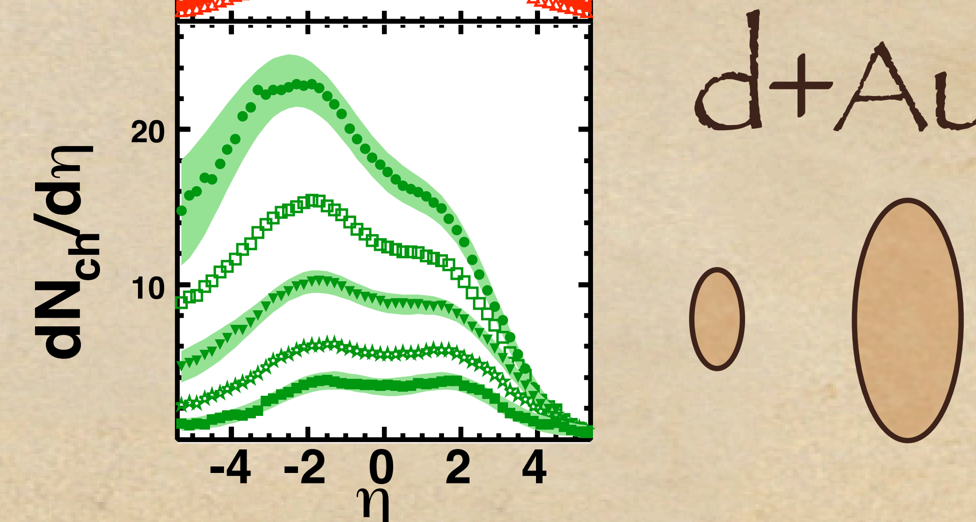
Single-Particle dN/dη





Talks by G. Roland, Thursday

G.Stephans, Monday

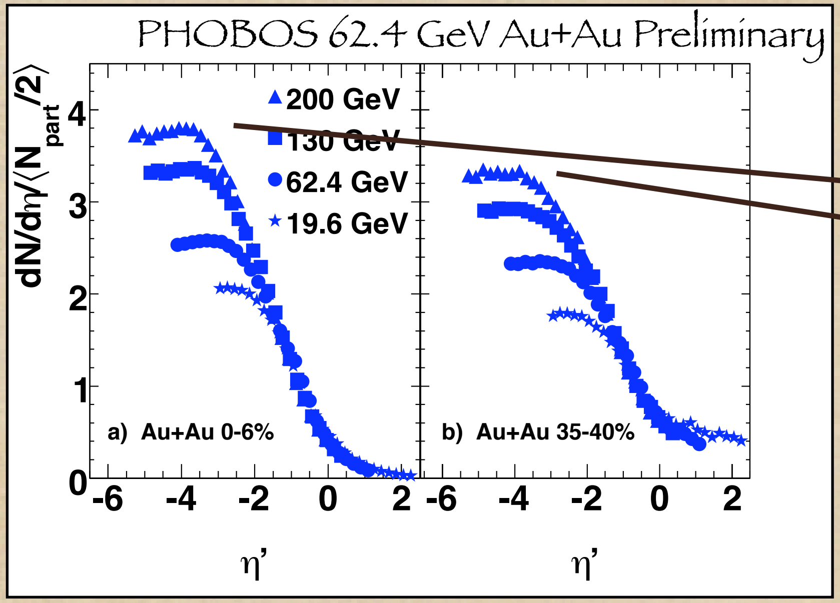
Poster by R. Hollis

Phys. Rev. Lett. 91, 052303 (2003)

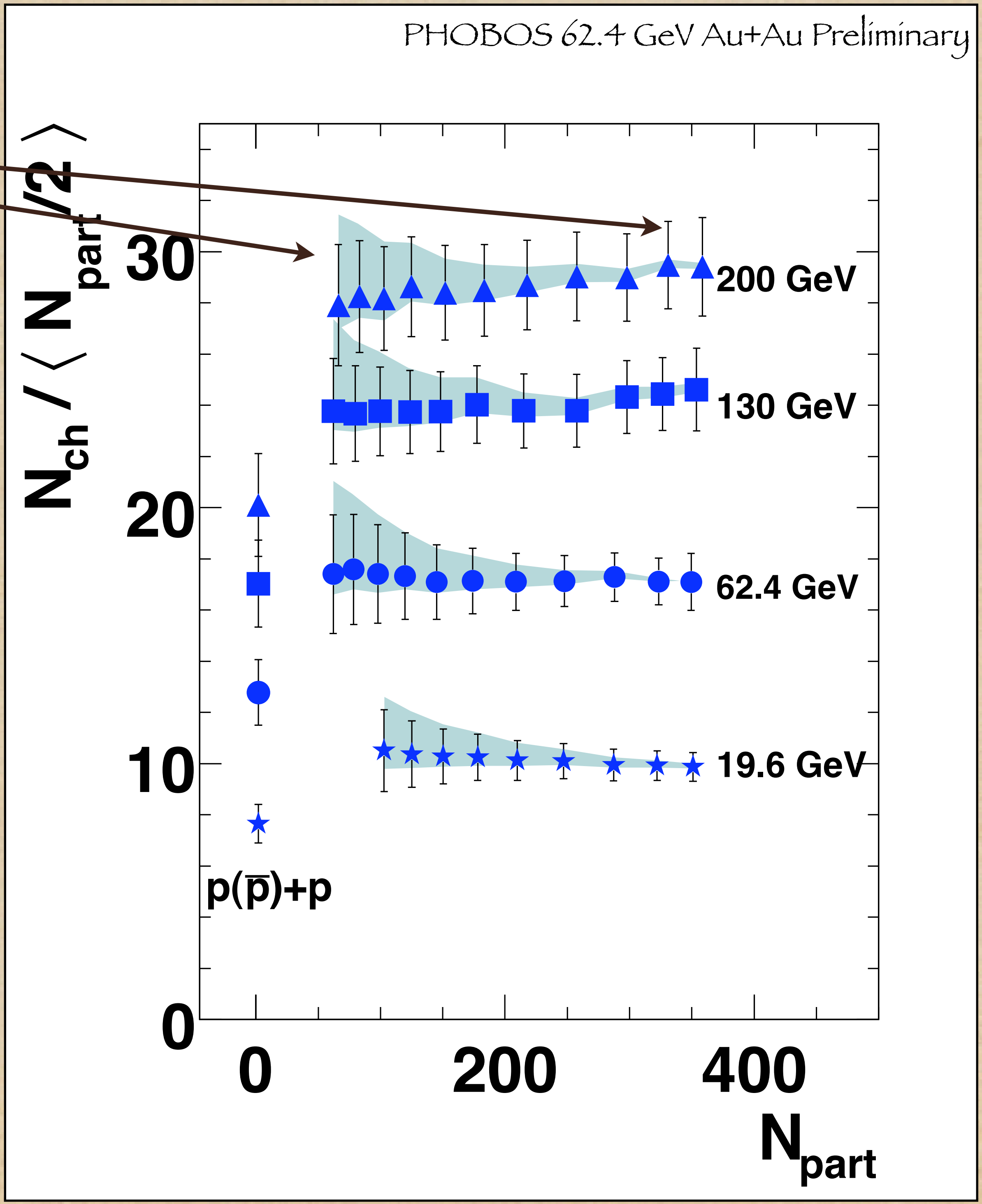
Phys. Rev. Lett. 93, 082301 (2004)

nucl-ex/0409021

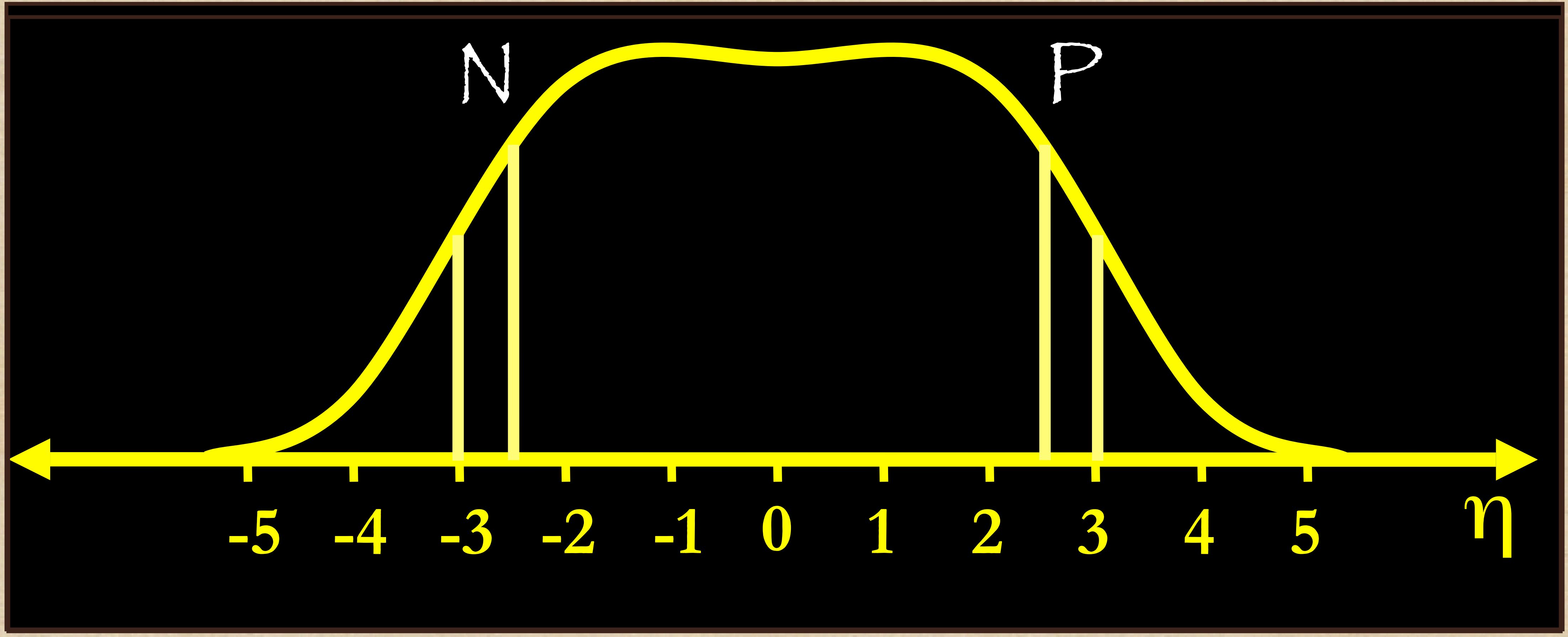
N_{part} Scaling ≈ Long Range



Integrating over 4π gives simple scaling with N_{part}: Emphasizes non-trivial correlation between mean values of forward and mid-rapidities



“Correlation Structure”

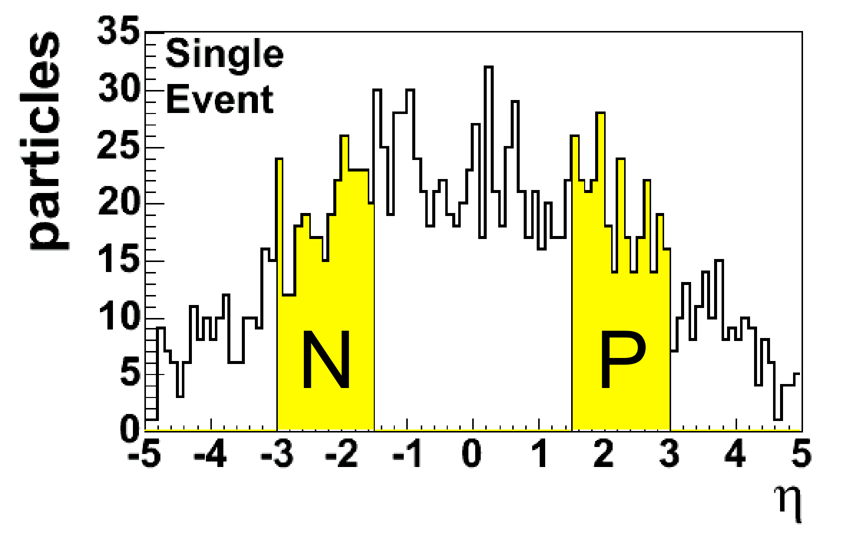


What underlies the single-particle distributions?

Are correlation short or long range?

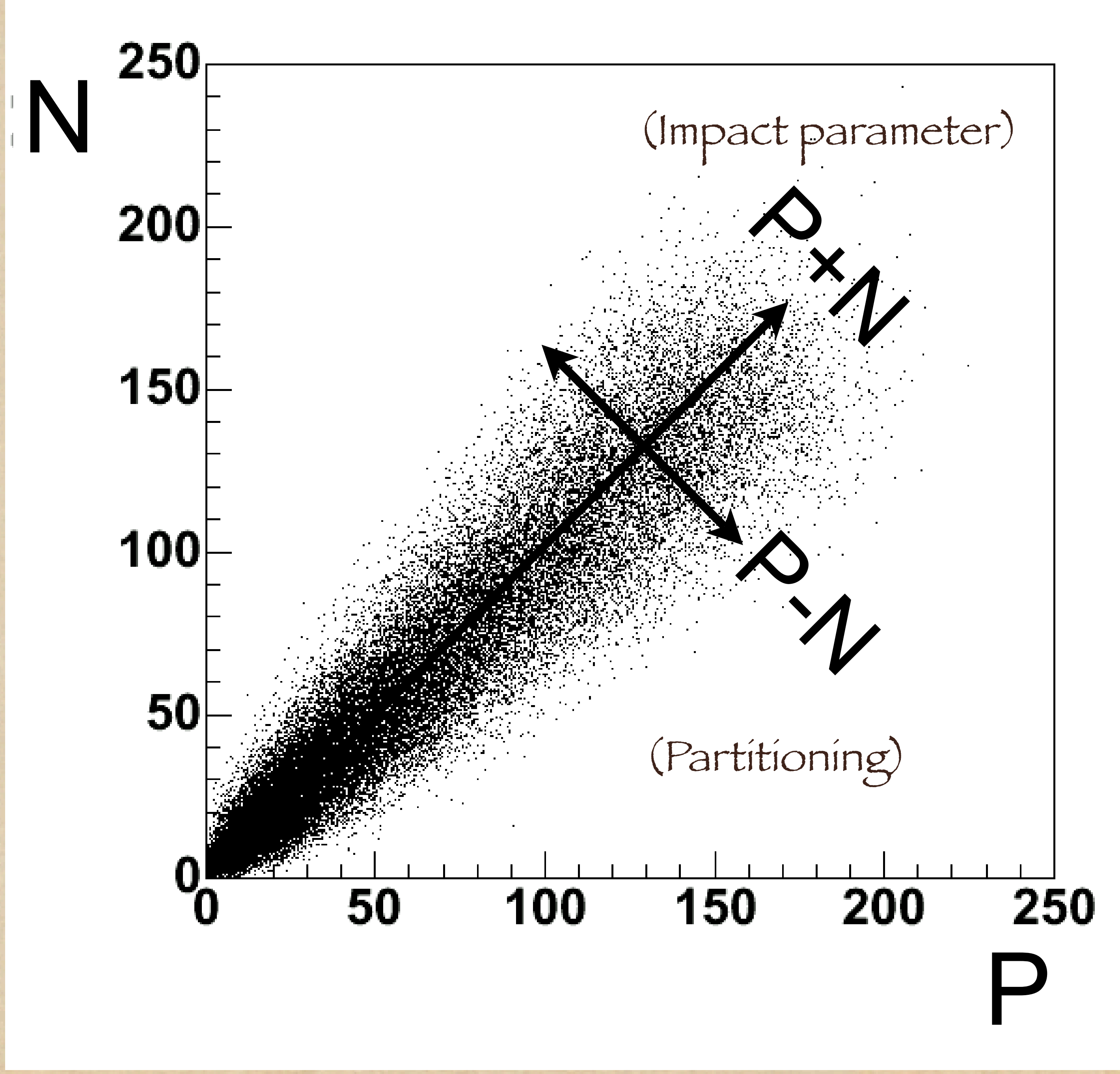
<u>Forward-Backward Multiplicity Correlations</u>

Analysis Concept



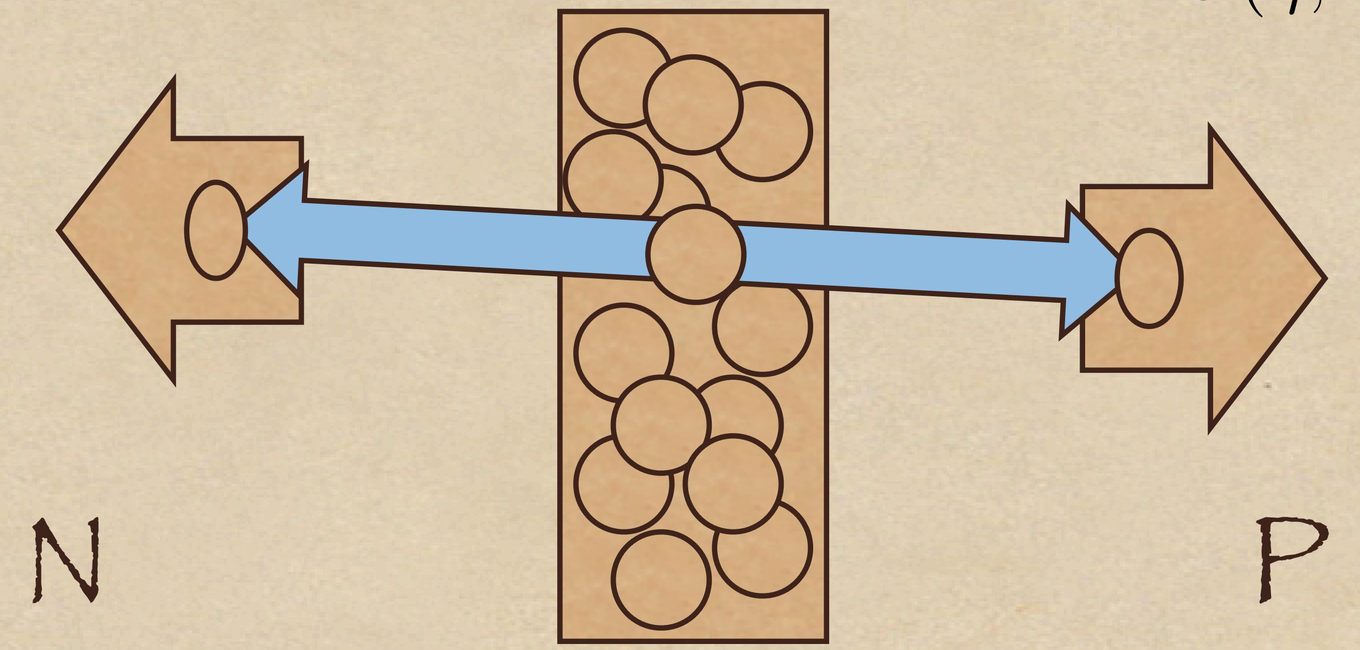
$$C = \frac{P - N}{\sqrt{P + N}}$$

RMS used to determine σ_C



Long Range Correlations

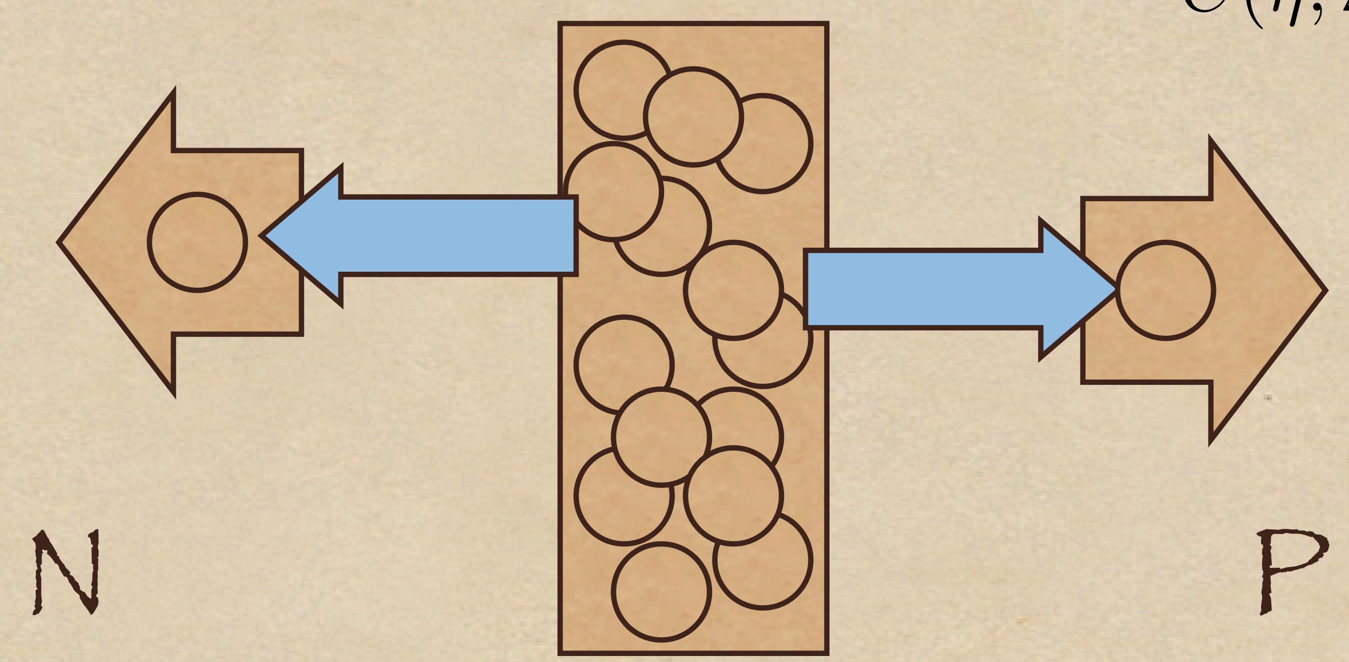
$$C(\eta, \Delta\eta) = \frac{P - N}{\sqrt{P + N}}$$



Correlated partitioning of X objects
(e.g. one object splits into two)
is an "intrinsic long range correlation"
(reduces $\sigma^2_C \rightarrow 0$)

"Long Range" Correlations

$$C(\eta, \Delta\eta) = \frac{P - N}{\sqrt{P + N}}$$

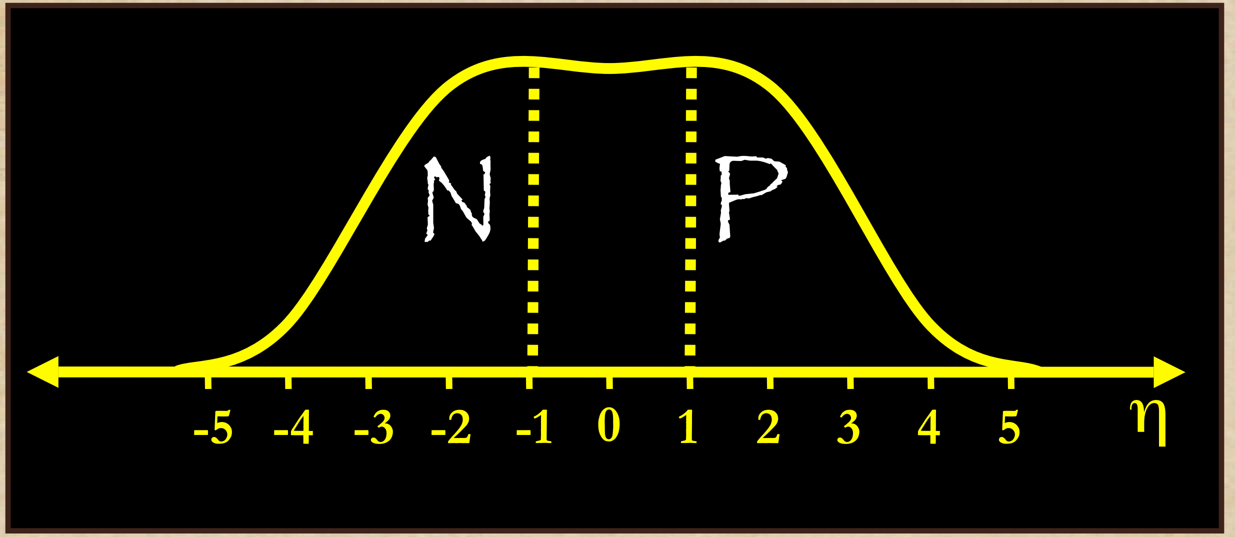


Binomial partitioning of X objects into P and N sides induces another type of "long range correlation"

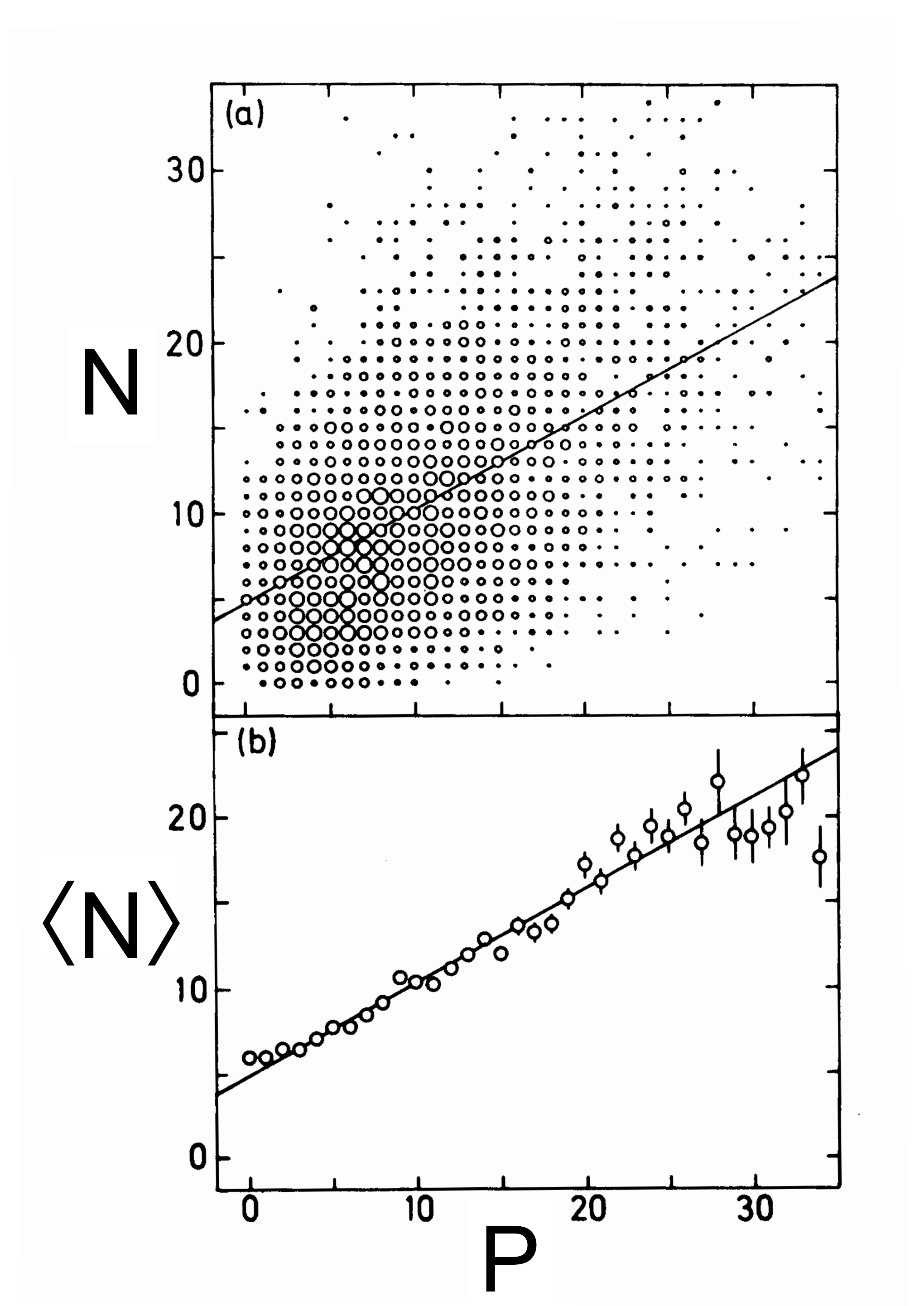
$$\sigma^2(P-N) \approx P+N \rightarrow \sigma^2_C \approx 1$$

“Long Range” Correlations in p+p

p+p collisions have always had a “long range” component, in the binomial, i.e. non-intrinsic, sense



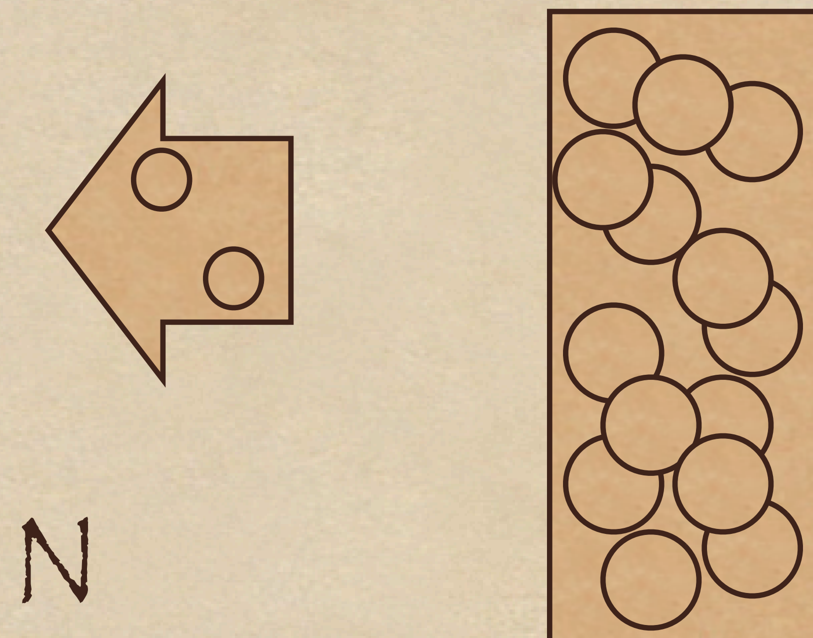
Persists when removing the central 2 units of rapidity

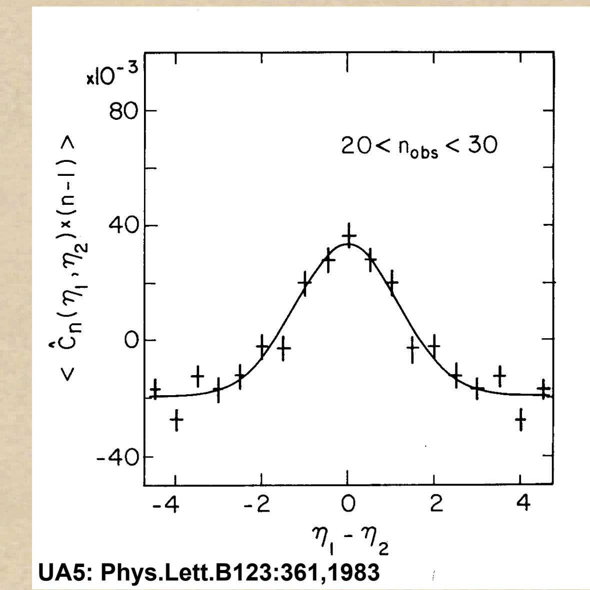


UA5: Phys.Lett.B123:361,1983

Short Range Correlations

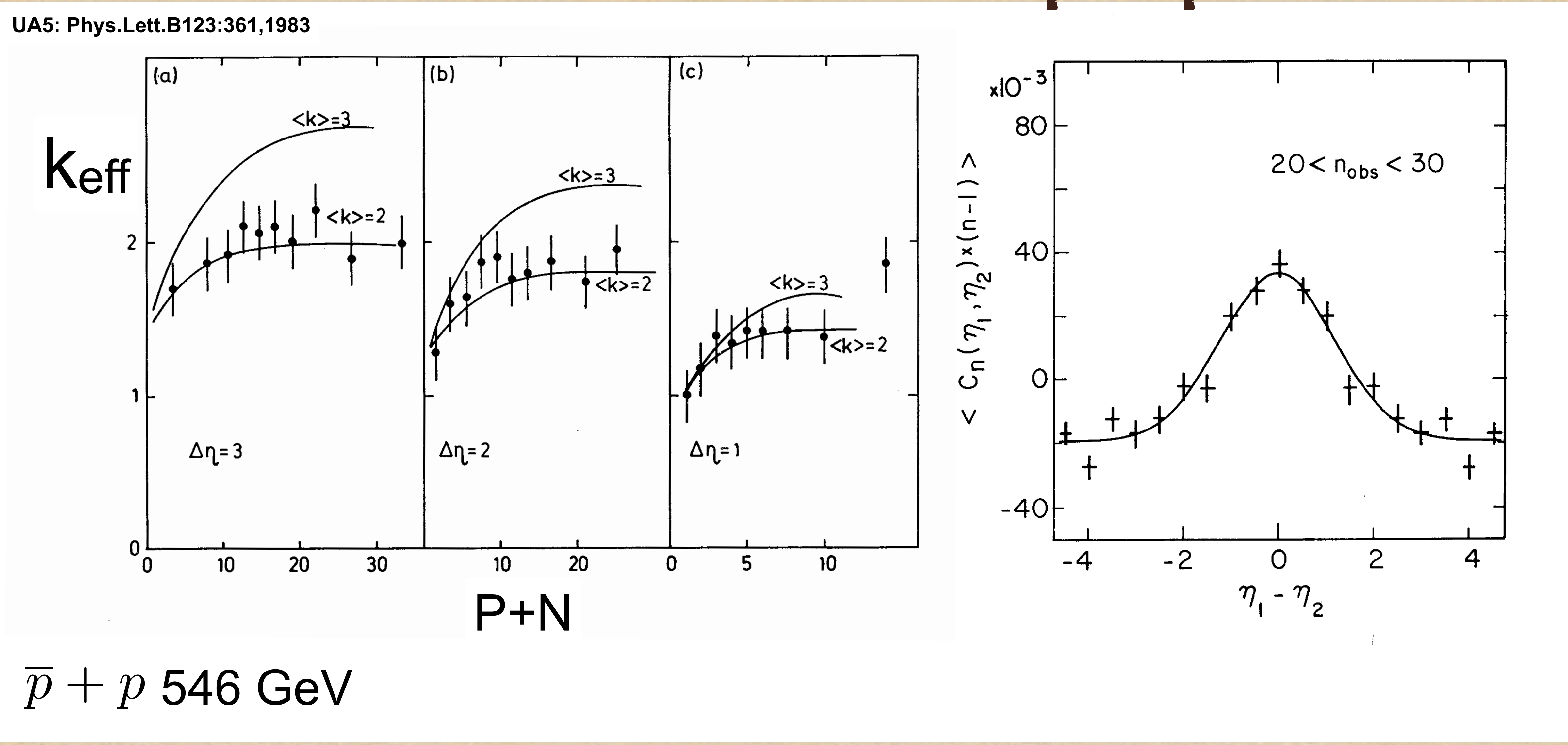
$$C(\eta, \Delta\eta) = \frac{P - N}{\sqrt{P + N}}$$





If each object breaks into K "pieces" that stay close in rapidity, induces correlations over a short range (e.g. resonances [thermal models?], gluon splitting)

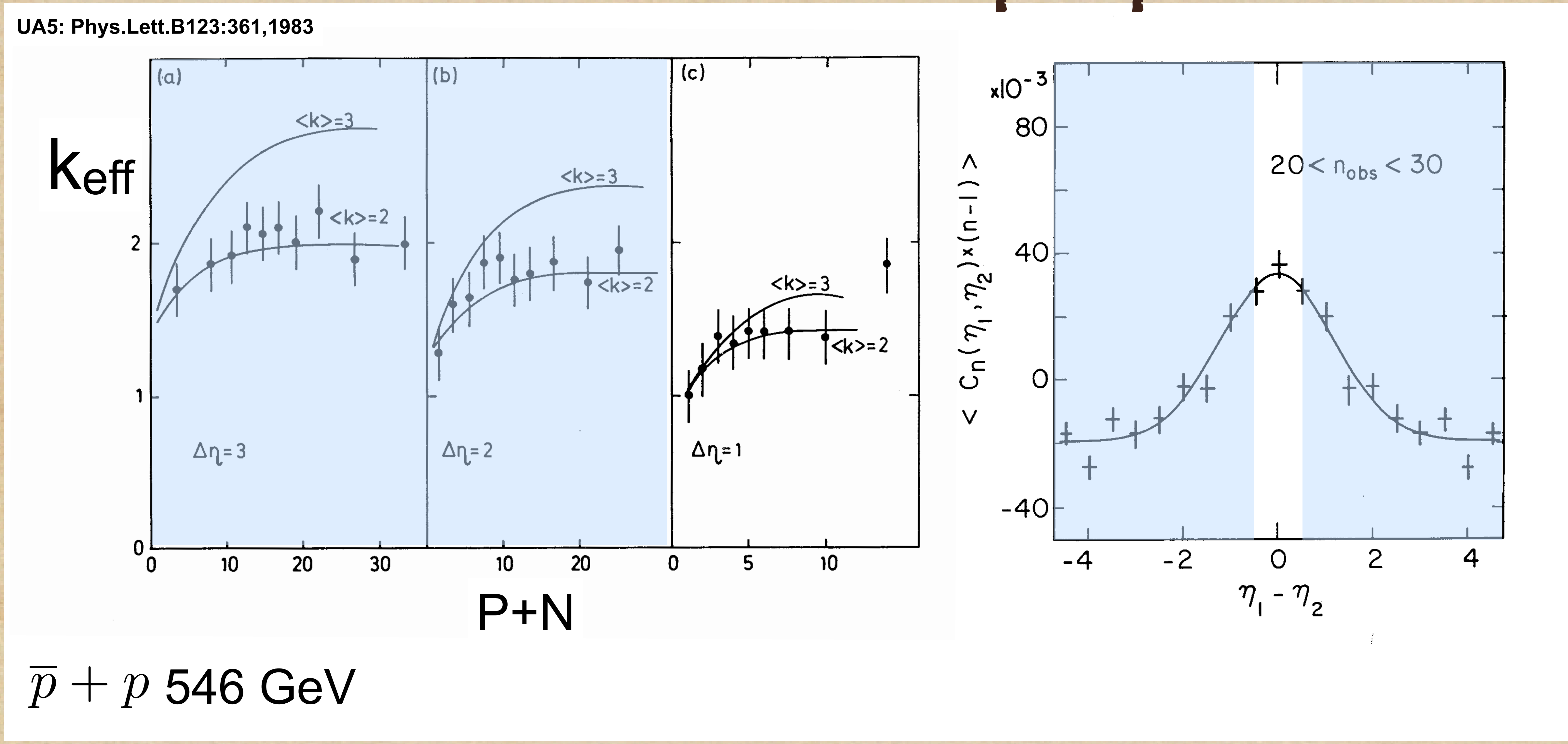
“Clusters” in $\overline{p}$+p



FB correlations interpreted in terms of production of “clusters”

Limited rapidity windows prevent seeing all K particles in a cluster → “effective cluster multiplicity”: $k_{eff} = \langle k \rangle + d_k^2 / \langle k \rangle$

Clusters in $\bar{p}$+p



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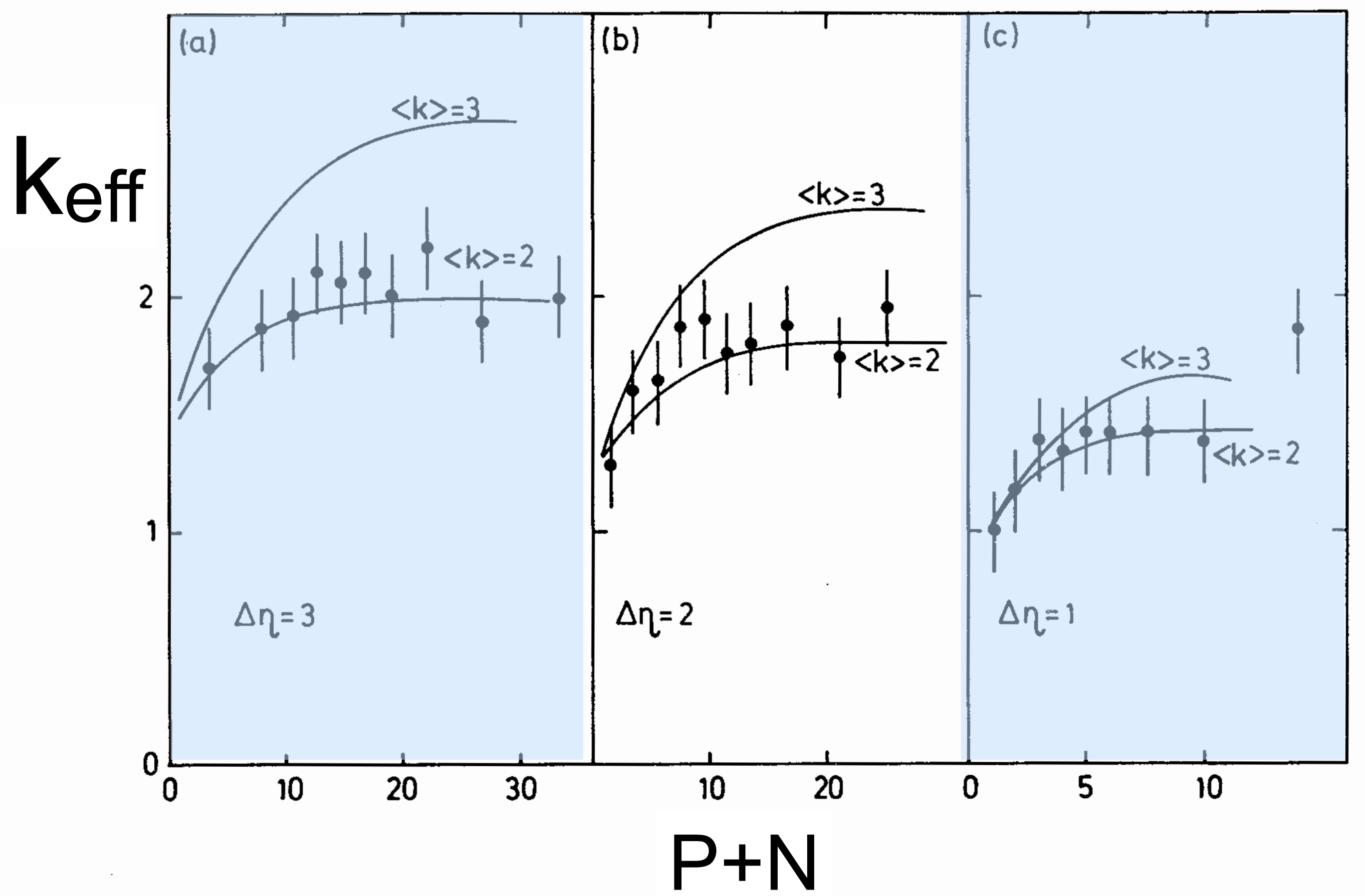

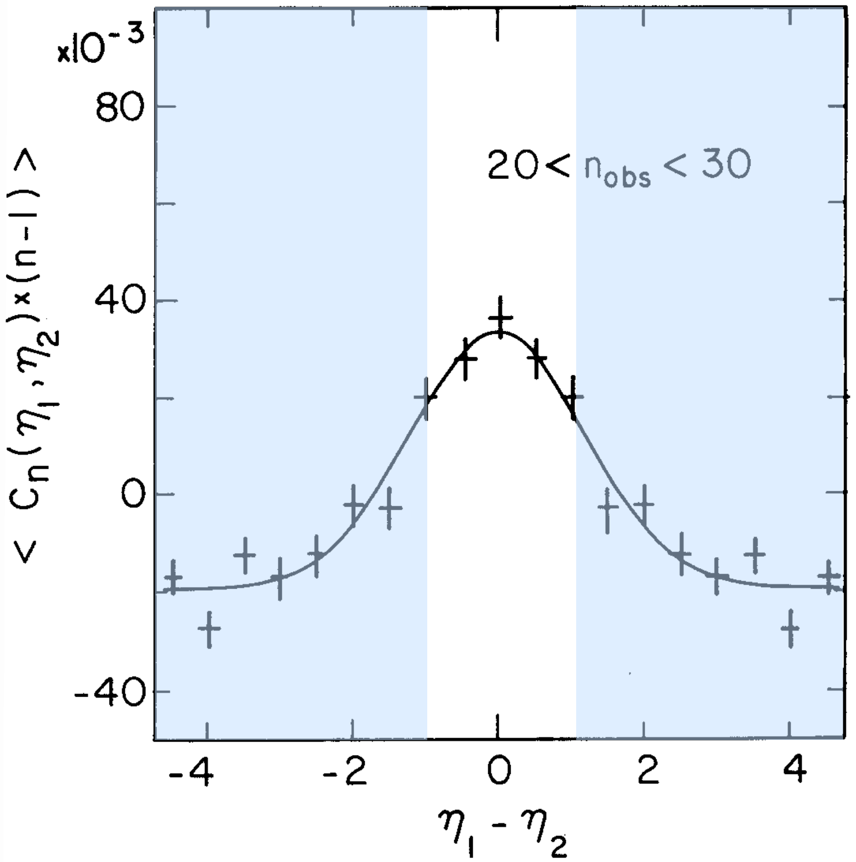

$\overline{p}+p$ 546 GeV

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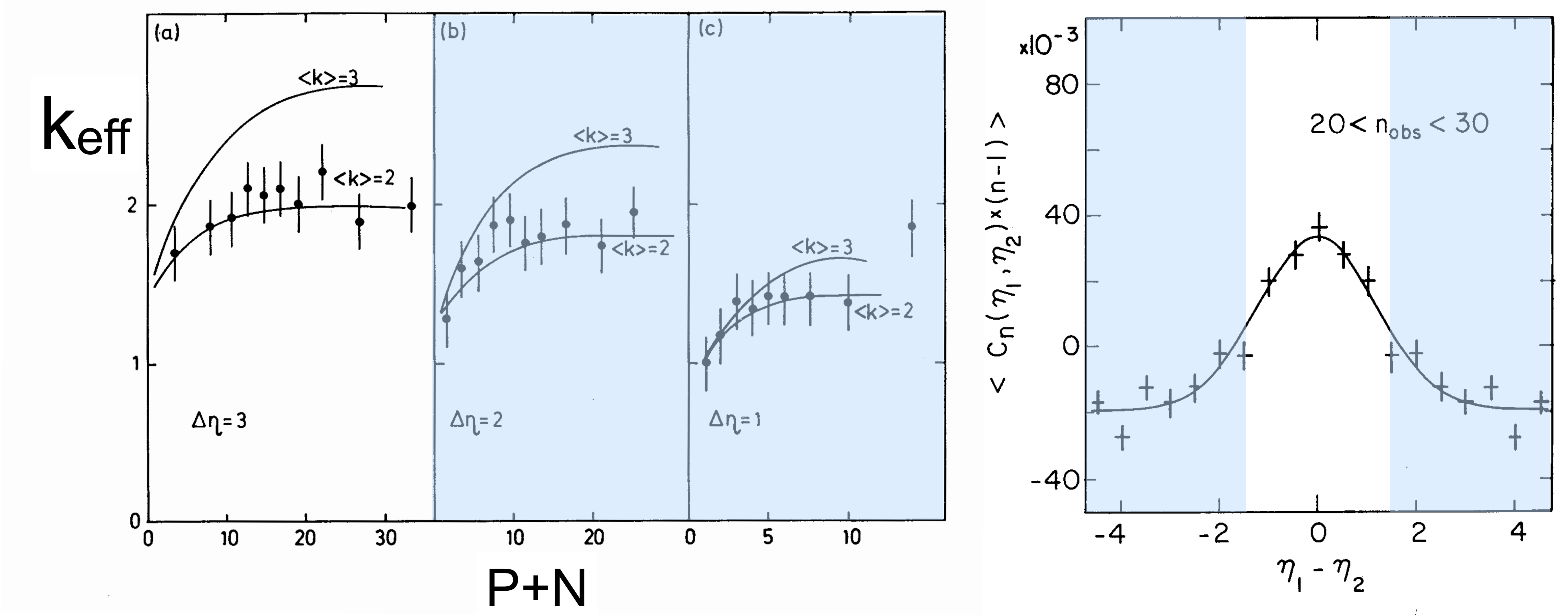

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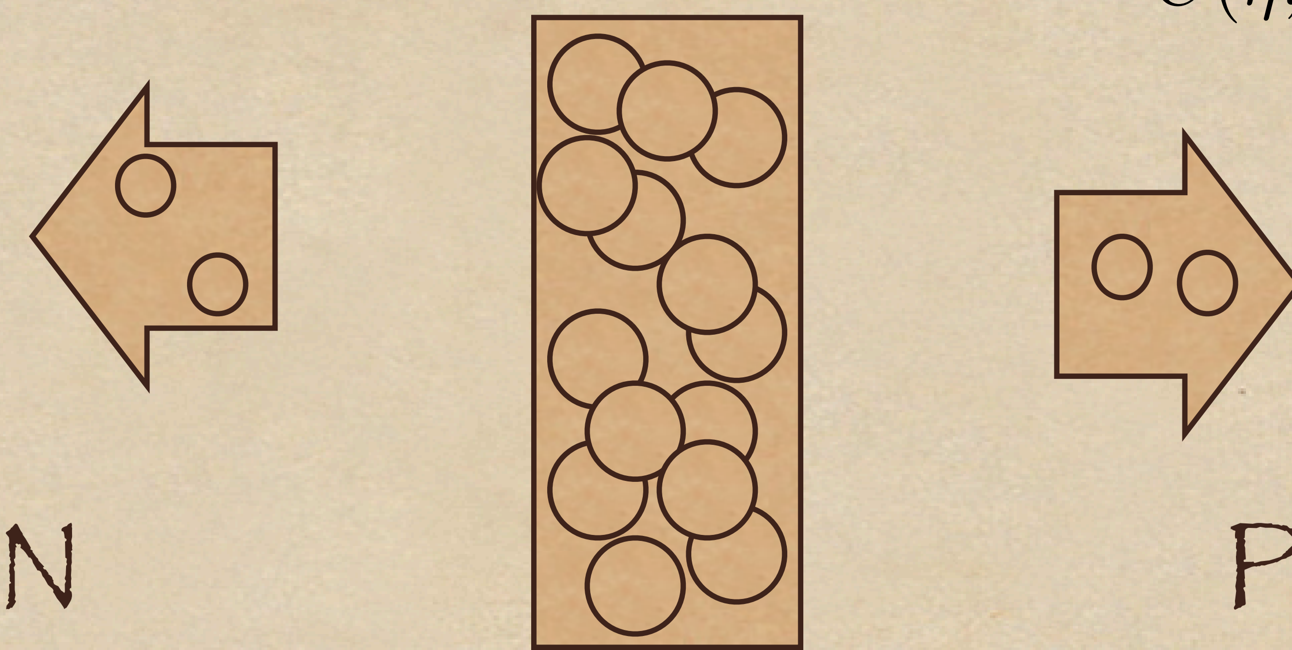
Clusters and $\sigma^2(C)$

$$C(\eta, \Delta\eta) = \frac{P - N}{\sqrt{P + N}}$$



$$P \rightarrow KP$$

$$N \rightarrow KN$$

$$C(\eta, \Delta\eta) = \frac{P - N}{\sqrt{P + N}}$$

$$C \rightarrow \sqrt{K}C$$

$$\sigma_C^2 \rightarrow K\sigma_C^2$$

Forward Backward Multiplicity Correlations give access to cluster structure of particle production

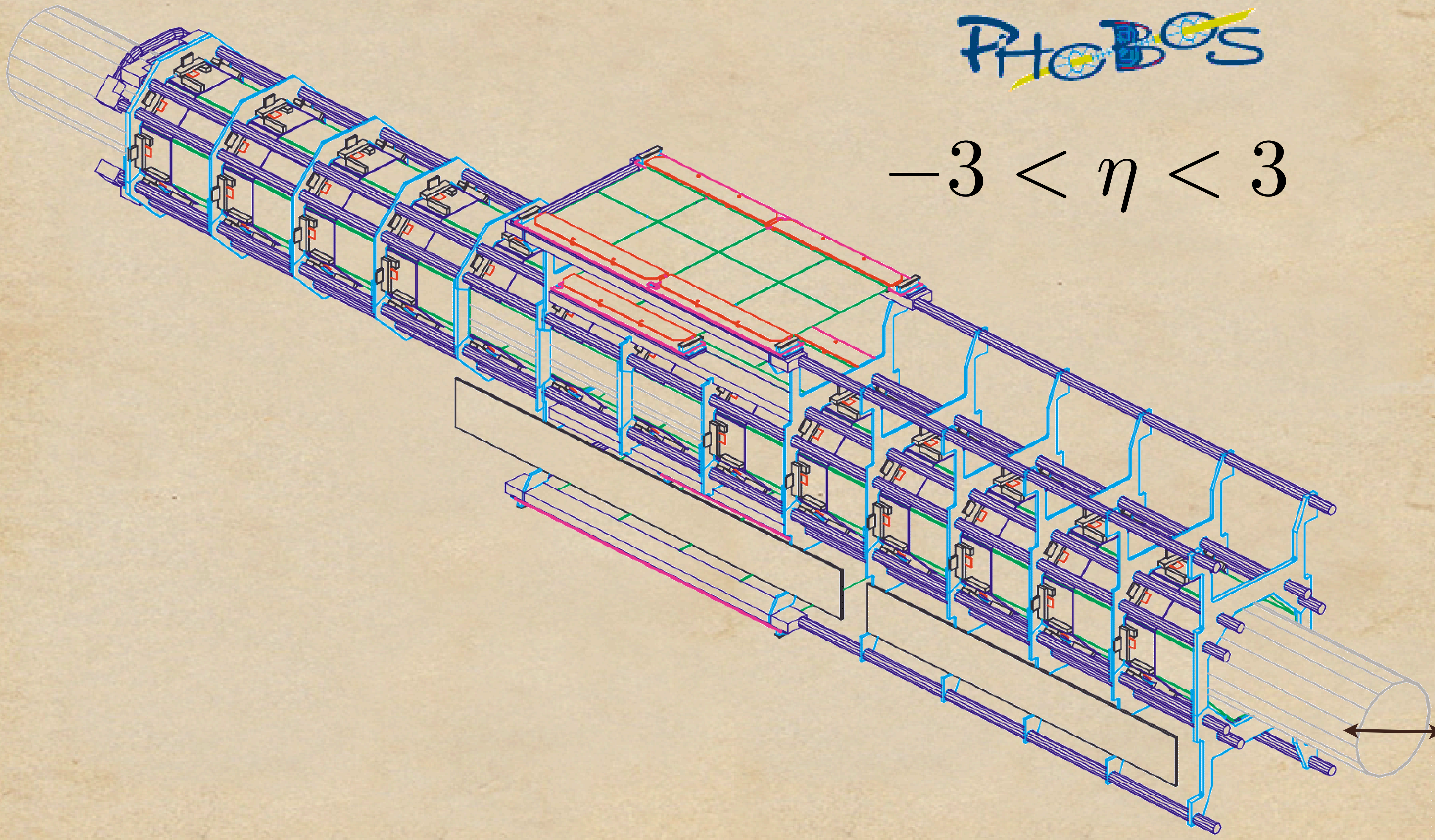
Summary

Intrinsic Long-Range	$\sigma^2_C \to 0$
Binomial Partitioning	$\sigma^2_C \approx 1$
Cluster Emission	$\sigma^2_C \propto k_{eff}$

Could expect combinations of effects

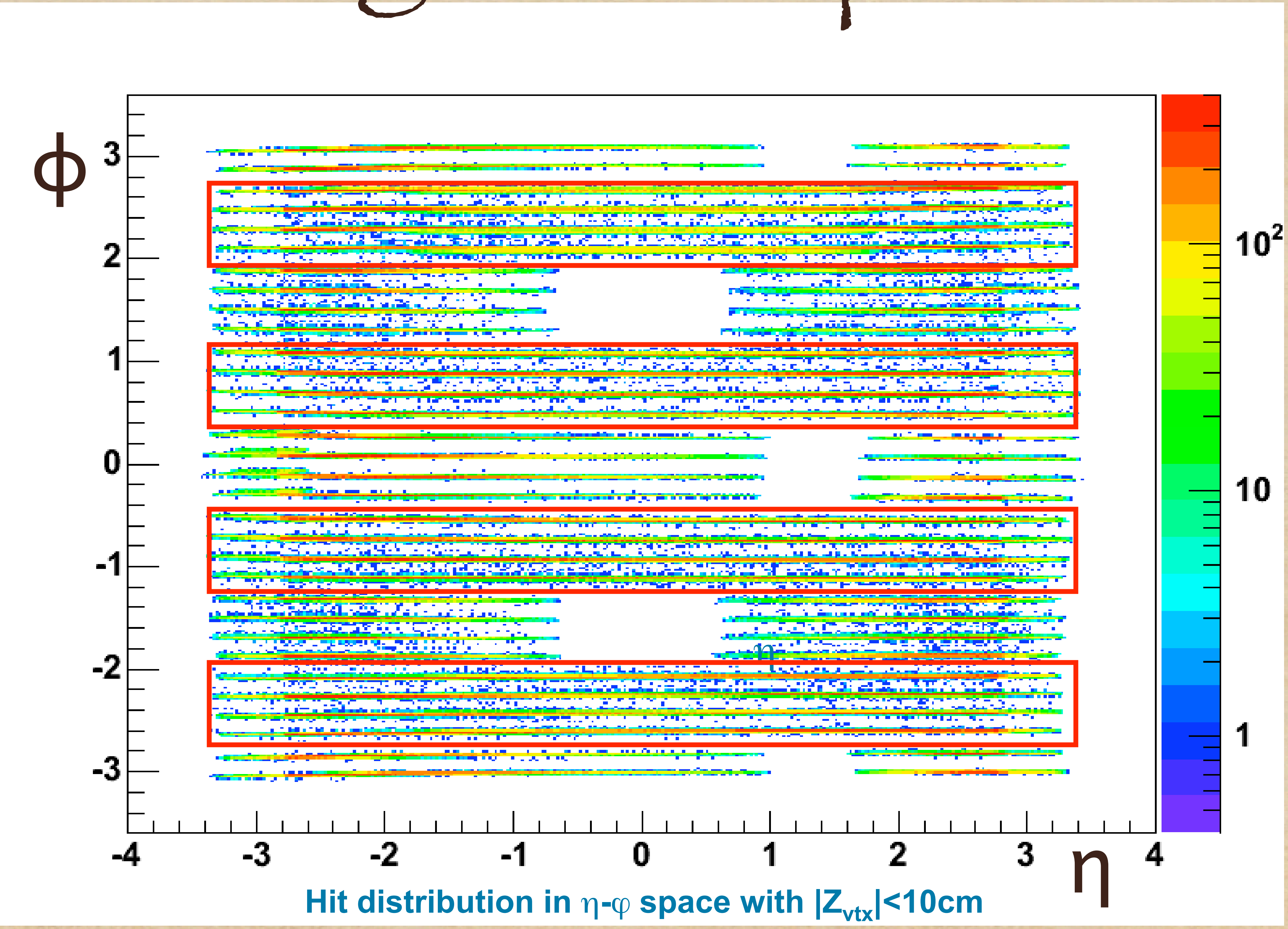
PHOBOS 2004/5

Octagon Detector



$$-3 < \eta < 3$$

Octagon Acceptance



Extraction of σ^2_C

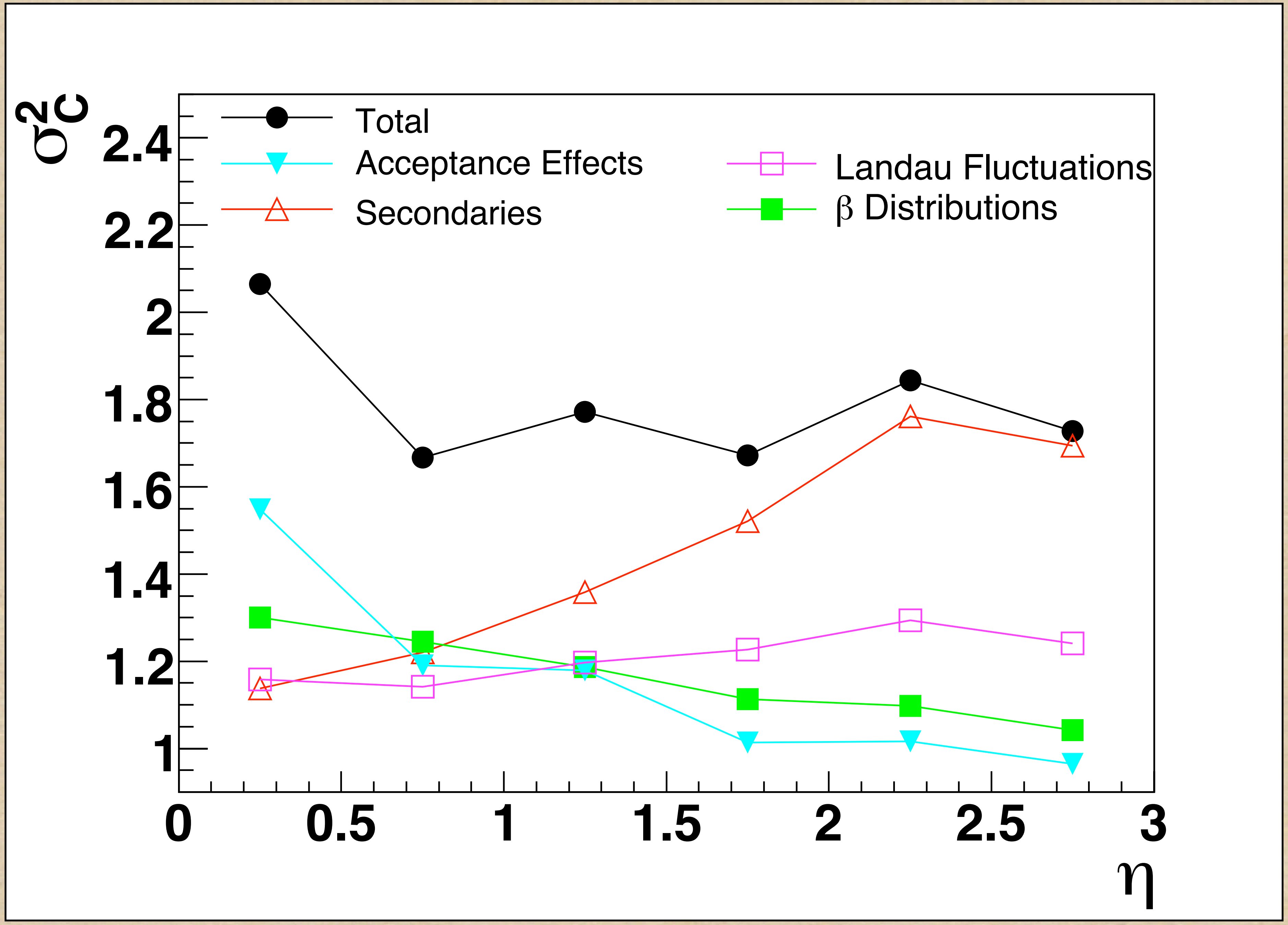
$$\sigma^2_{C,raw} = \sigma^2_C + \sigma^2_{det}$$

$$\rightarrow k_{eff}$$

Removing detector effects gives access to this effective cluster size (modified by acceptance / bin-width)

NEW for QM2005!

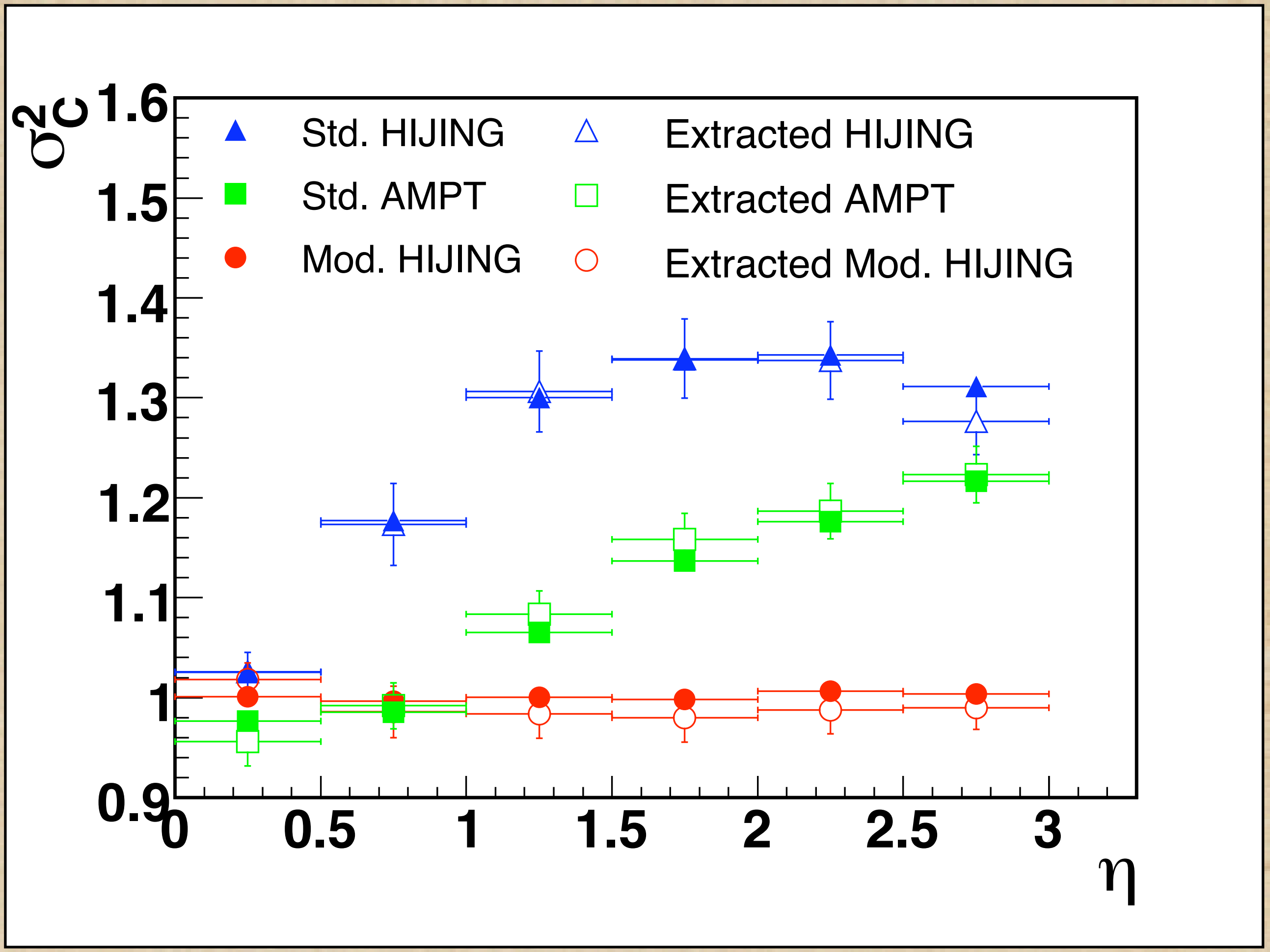
Detector Effects vs. η



Different sources contribute flat in η

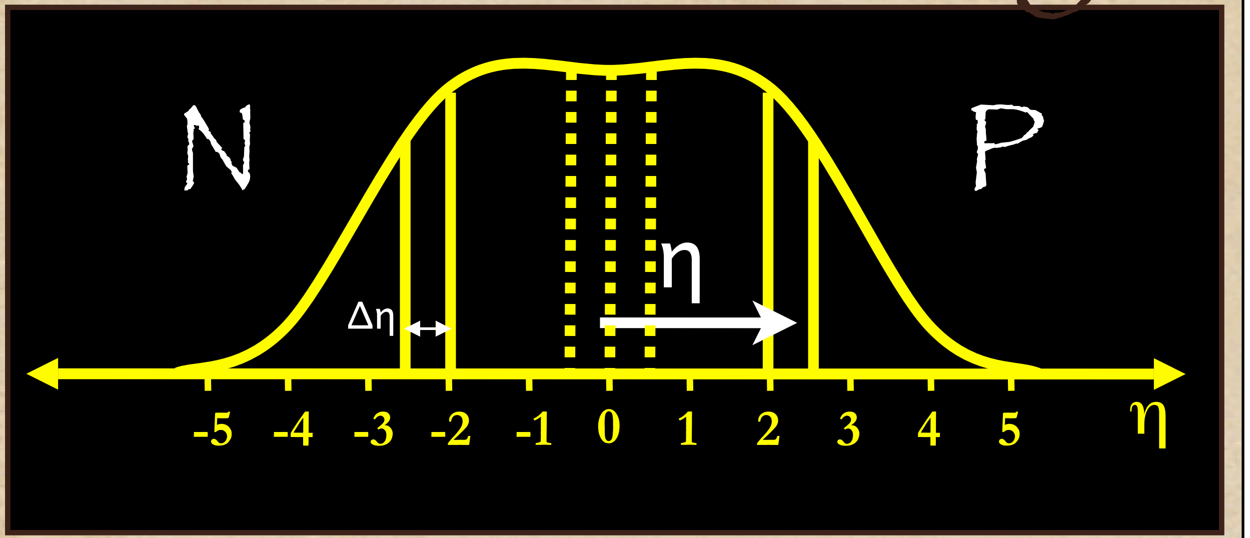
Corrections & Systematics

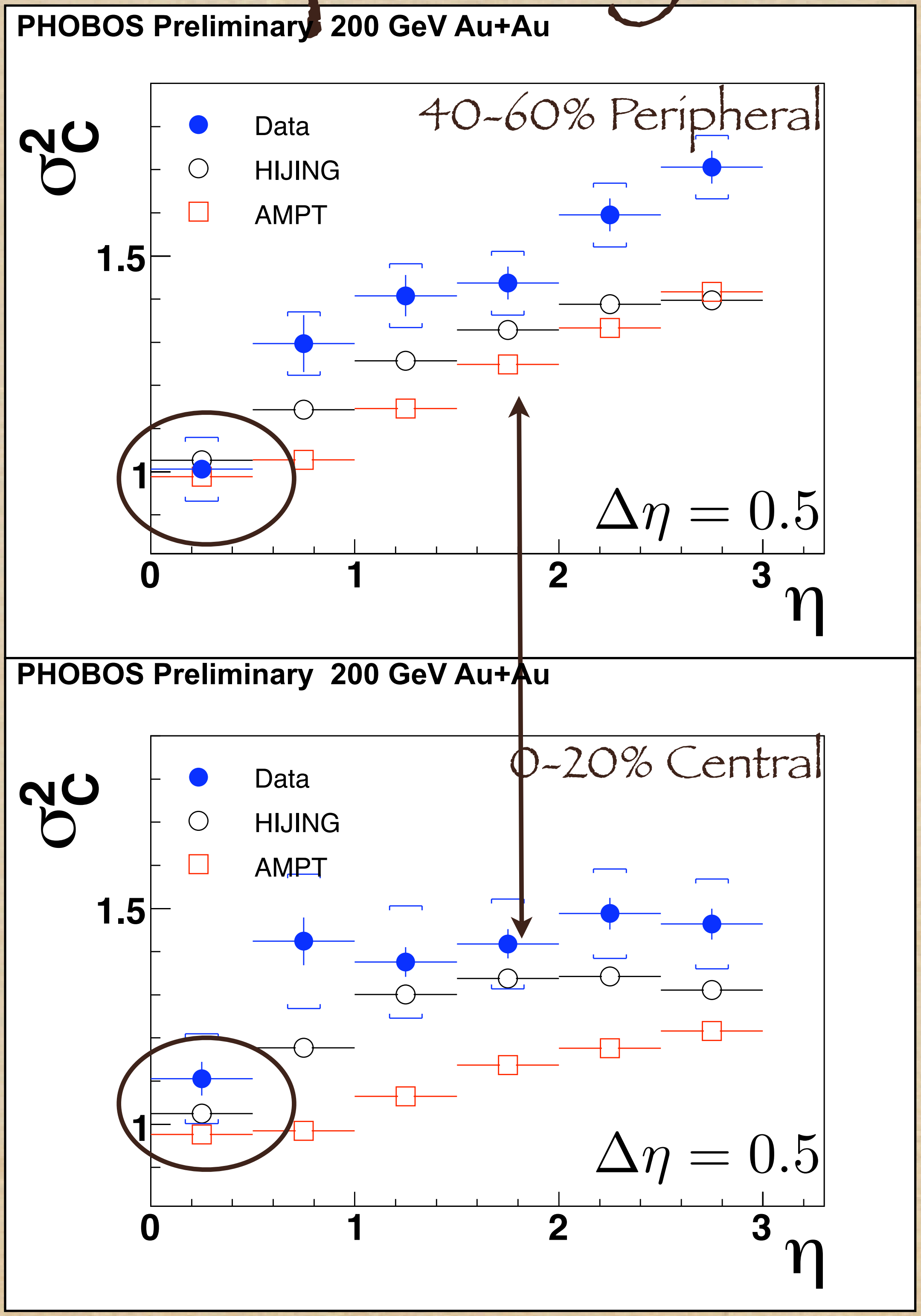
- Residual detector effects: σ^2_{det}
- Acceptance gap effects
- Secondaries contribution at large η
- Half→Full azimuth



Systematics calculated for several sources: use average value of combined error $\Delta\sigma^2_C$~0.1

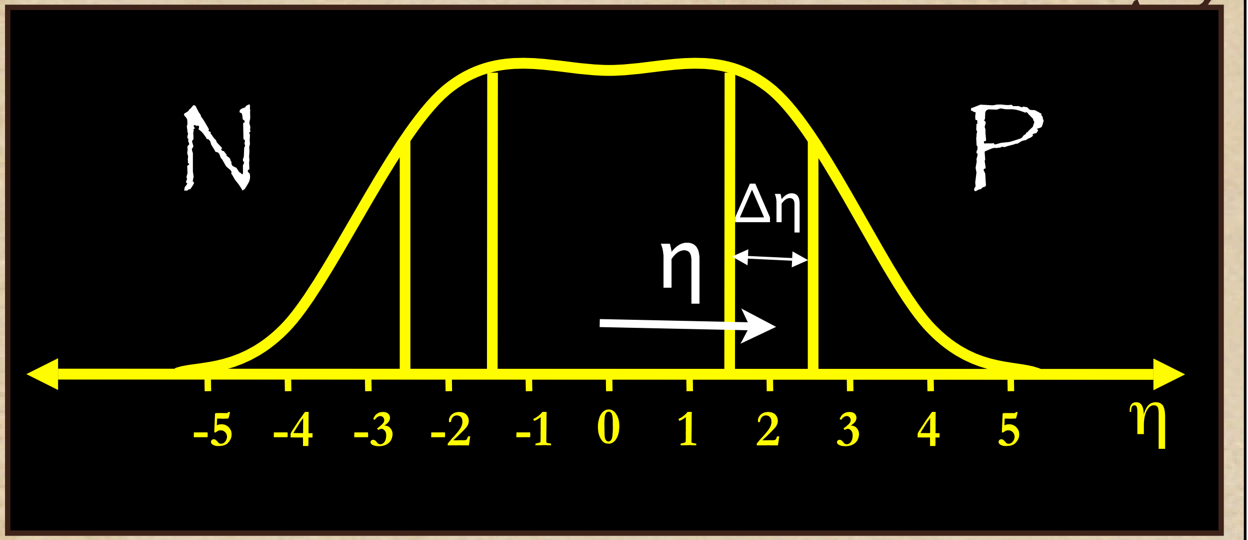
Centrality & Rapidity

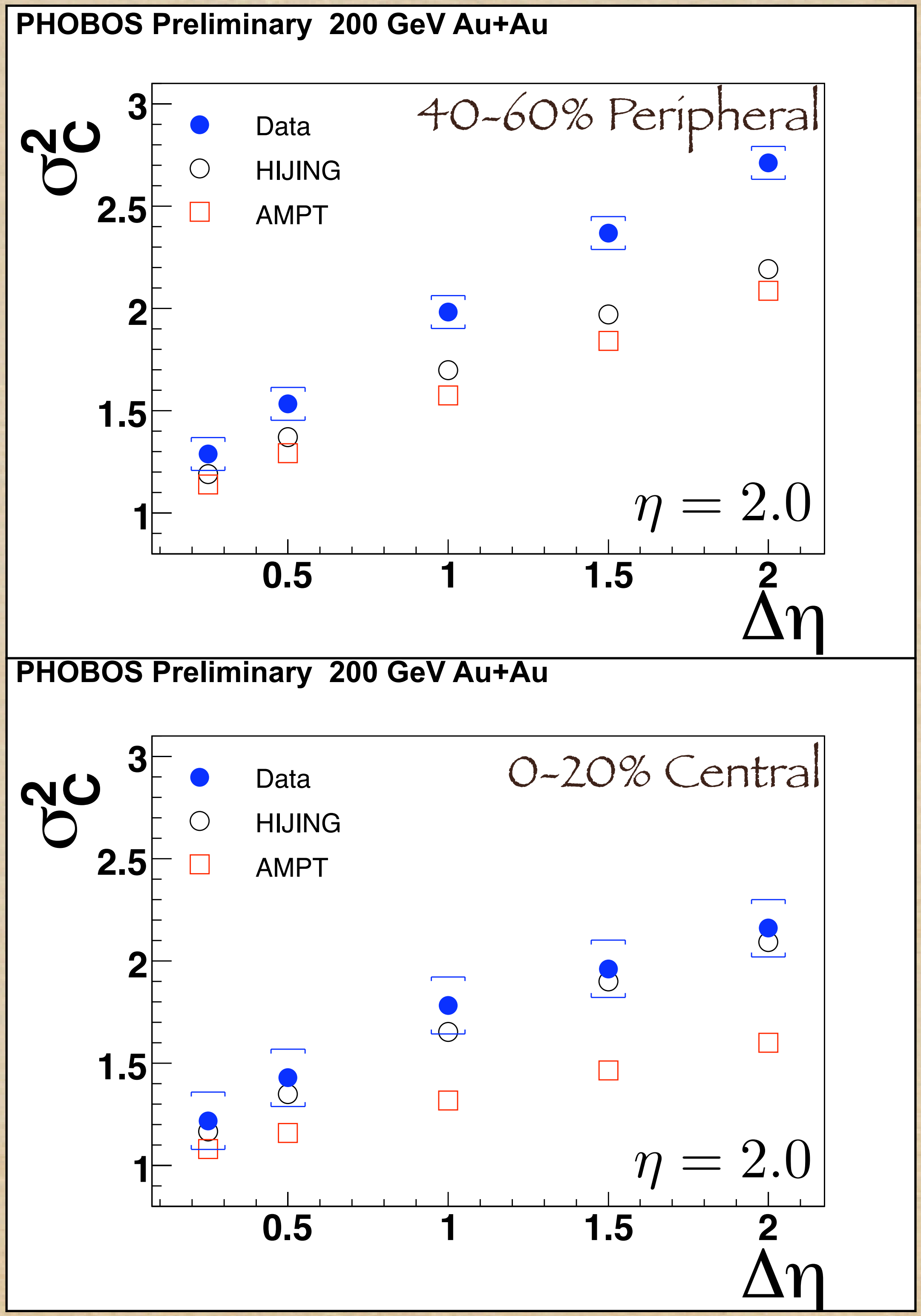




* HIJING & AMPT agree in peripheral events, diverge in central events
* Significant centrality dependence
* Suppression at η≈0 from intrinsic correlation of P&N

Centrality & Width





* Rate of change with bin size, reflects full cluster multiplicity K

* Peripheral data implies larger K than HIJING & AMPT

* HIJING ~ Central data; AMPT ~ Centrality dependence

Summary

- Forward-Backward multiplicity fluctuations provide information about long and short range effects in pseudorapidity
- New PHOBOS data for 200 GeV Au+Au with detector effects corrected
  - Clear short-range correlations observed
  - Non-trivial centrality and rapidity dependence
  - Central data similar to HIJING; centrality dependence qualitatively similar to AMPT

Charge Fluctuations & QGP

Hadron gas creates multi-particle clusters (defined as what is seen in p+p)

QGP should "smooth" out fluctuations, <u>decreasing</u> effective cluster size near $y=0$

Studies by Jeon, et al

nucl-th/0503085

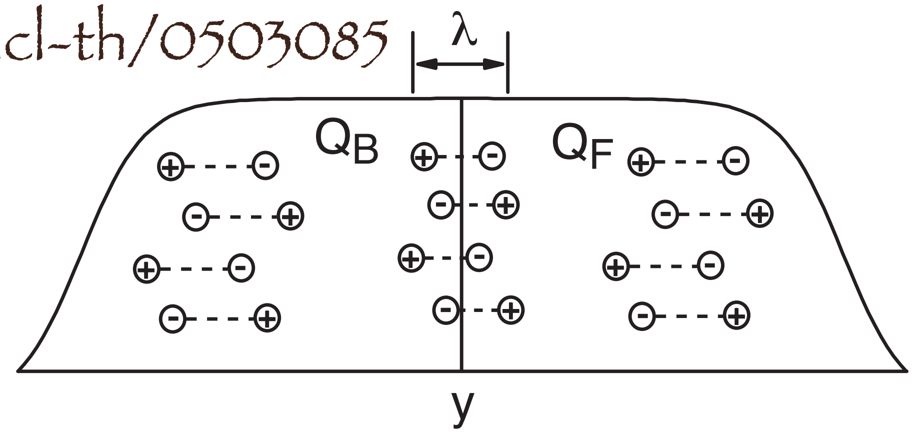


FIG. 1: A schematic illustration of the charge transfer fluctuations in the rapidity space. Only the pairs within $\lambda/2$ of y can contribute to the charge transfer fluctuation $D_u(y)$. Here λ is the rapidity correlation length, or the rapidity distance of the decay particles from a single cluster. If λ is a function of y, then $D_u(y)$ also changes with y.

PHOBOS data should provide limits on such a scenario

PHOBOS

Systematic Errors vs. η