Charged-Particle Multiplicity Fluctuations in 200 GeV Au+Au Collisions

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Phobos Collaboration



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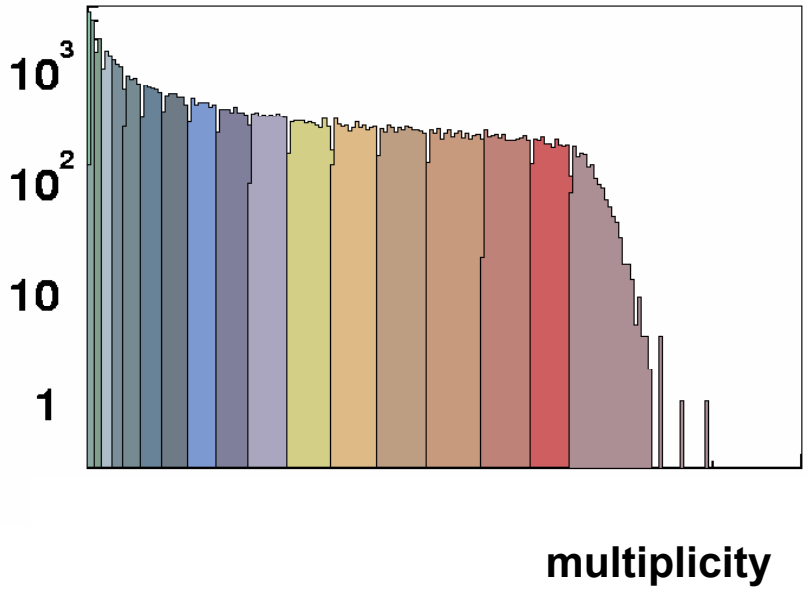
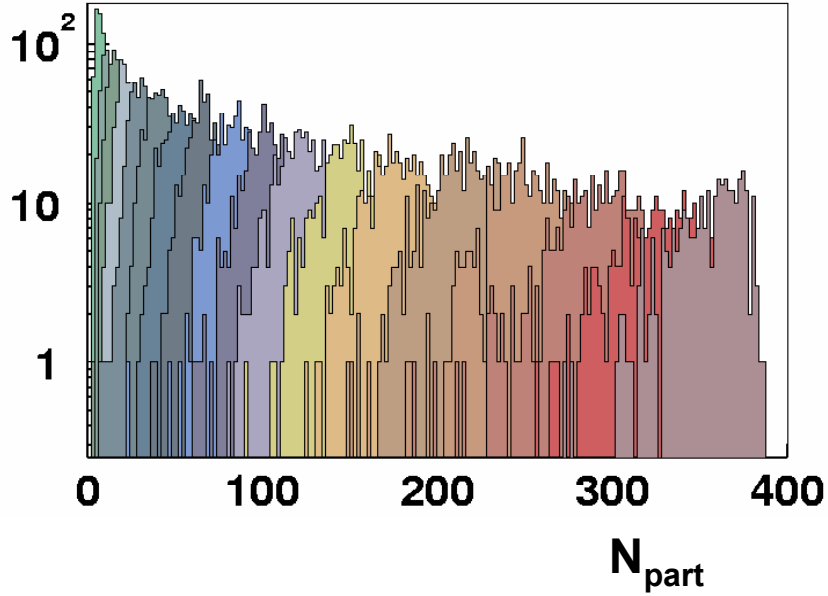
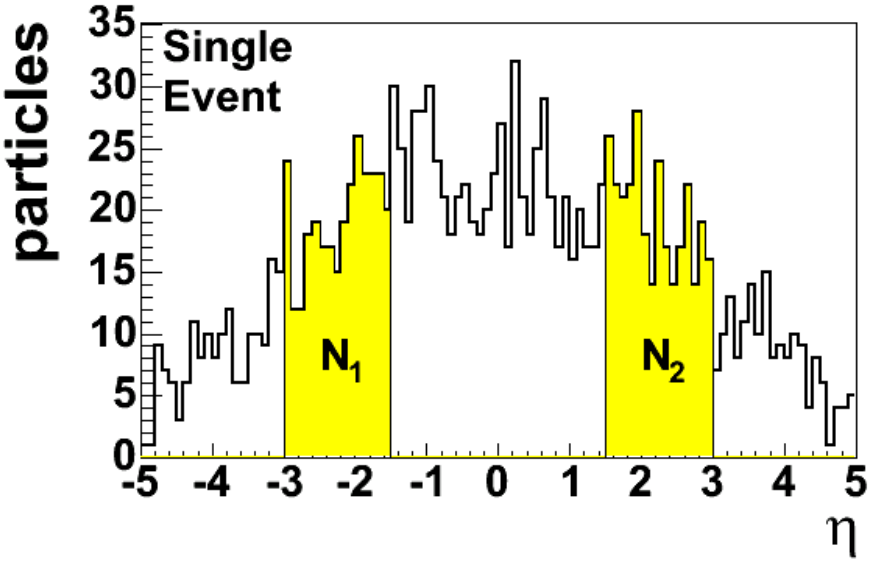
Fluctuations in particle production

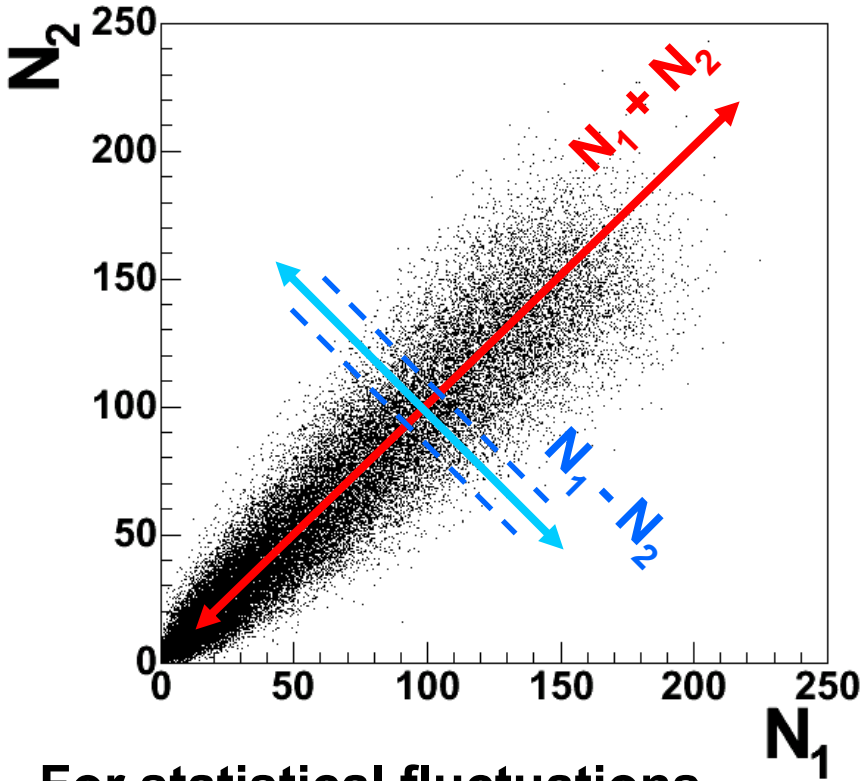




- **In Au+Au collisions particle production is dominated by the geometry of the collision**
- **We want to search for dynamical fluctuations which are not simply due to N_{part} fluctuations**

Event by event fluctuations
C parameter used in the studies





We will use the parameter:

$$C = \frac{N_1 - N_2}{\sqrt{N_1 + N_2}}$$

For statistical fluctuations

$$\sigma^2(C) = 1$$

Independent of multiplicity

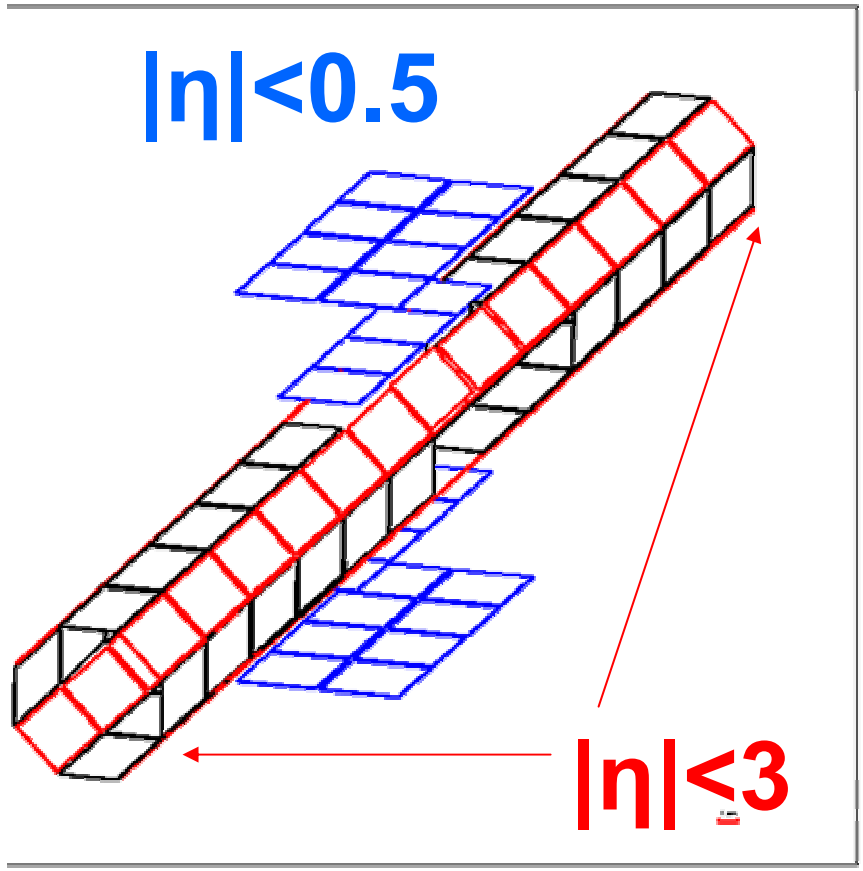
Multiplicity reconstruction in the octagon and vertex detectors

We use 200 GeV/nucleon AuAu data measured without magnetic field.

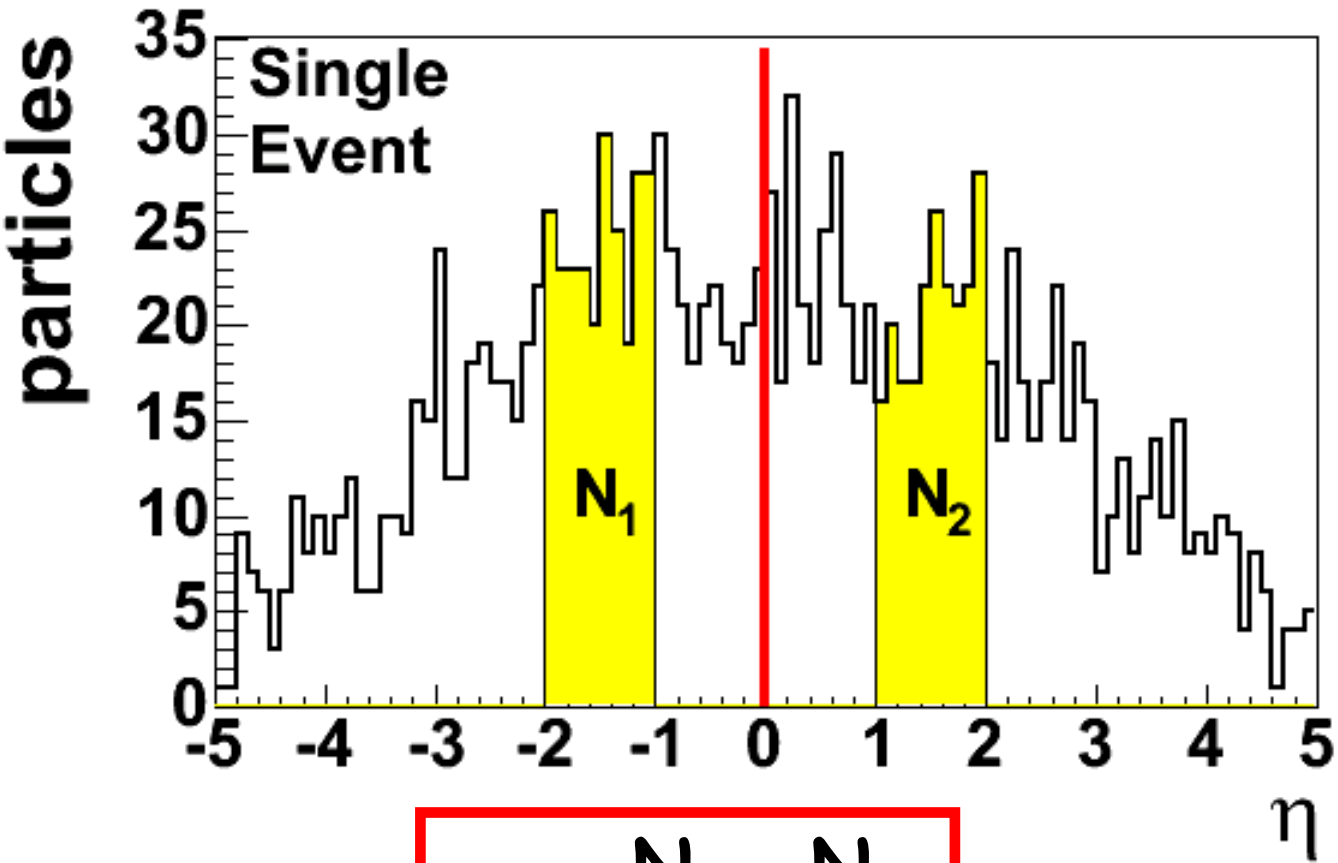
Four complete octants of octagonal multiplicity detector covering $|\eta|<3$.

$$N = \Sigma dE_{norm} / dE_1$$

Vertex detector: $|\eta|<0.5$ in about 25% of azimuthal angle range
It is used for cross checks.

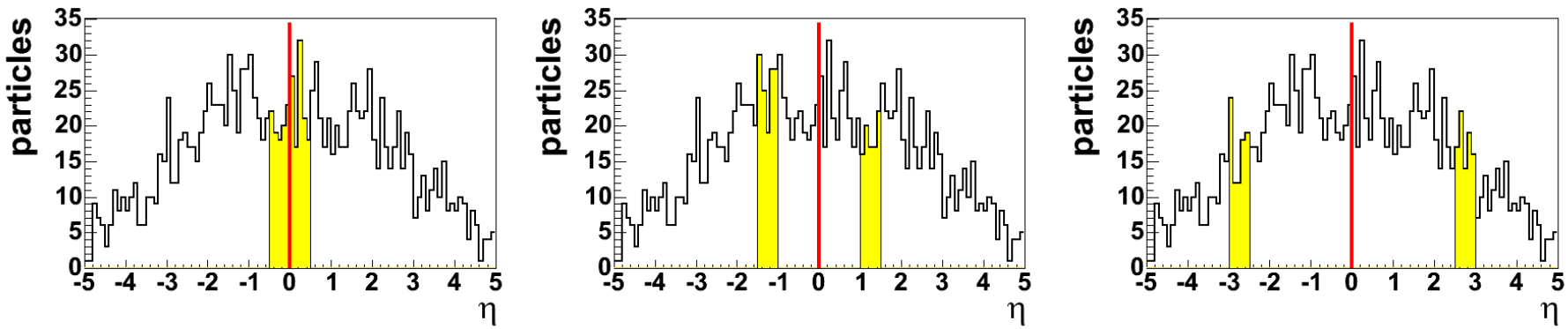


C parameter calculation

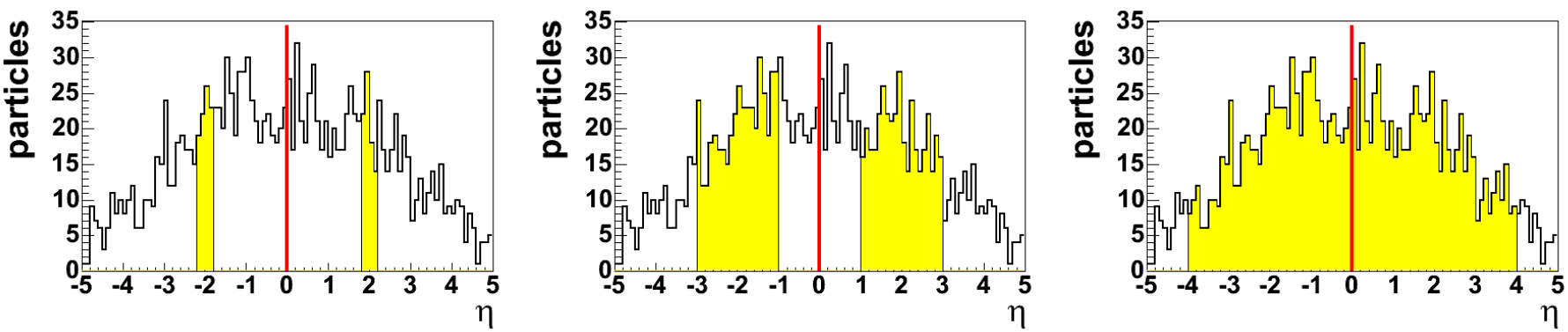


$$C = \frac{N_1 - N_2}{\sqrt{N_2 + N_2}}$$

C parameter dependencies studies

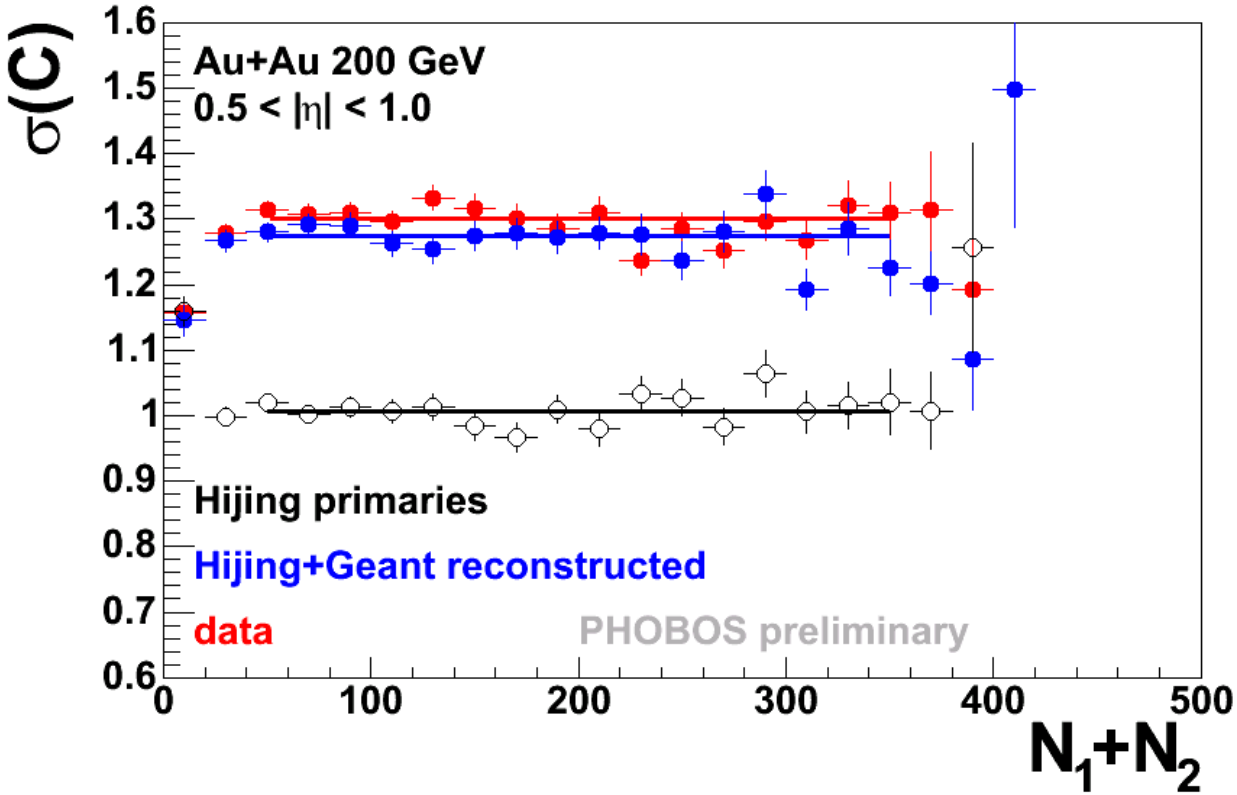


Dependence on the position in η



Dependence on the width of η bin

Results for C parameter



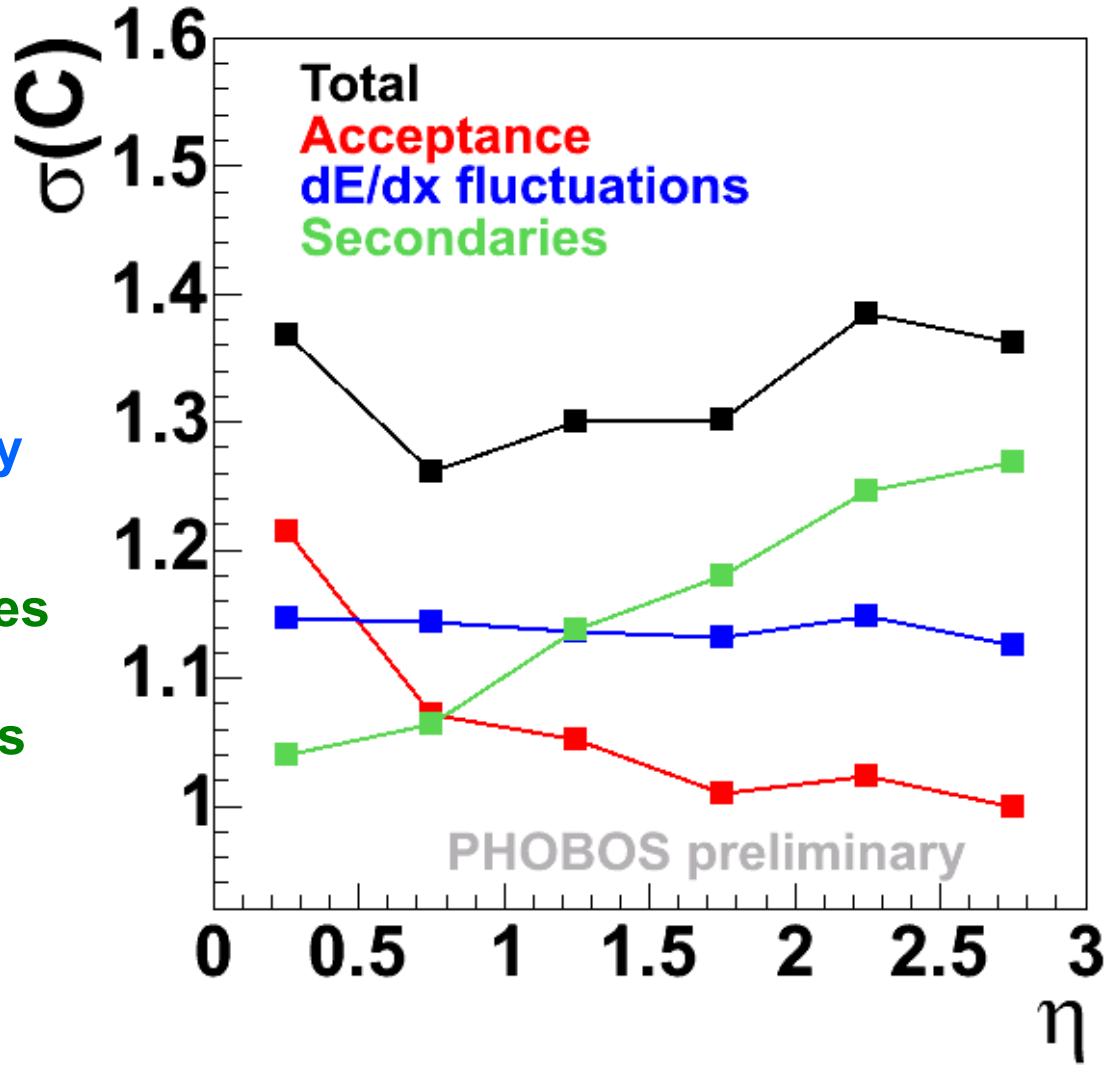
Data and reconstructed Hijing+Geant show similar fluctuations, increased due to detector effects.

The σ(C) is approximately independent of multiplicity N_1+N_2, so we use the fitted constant value.

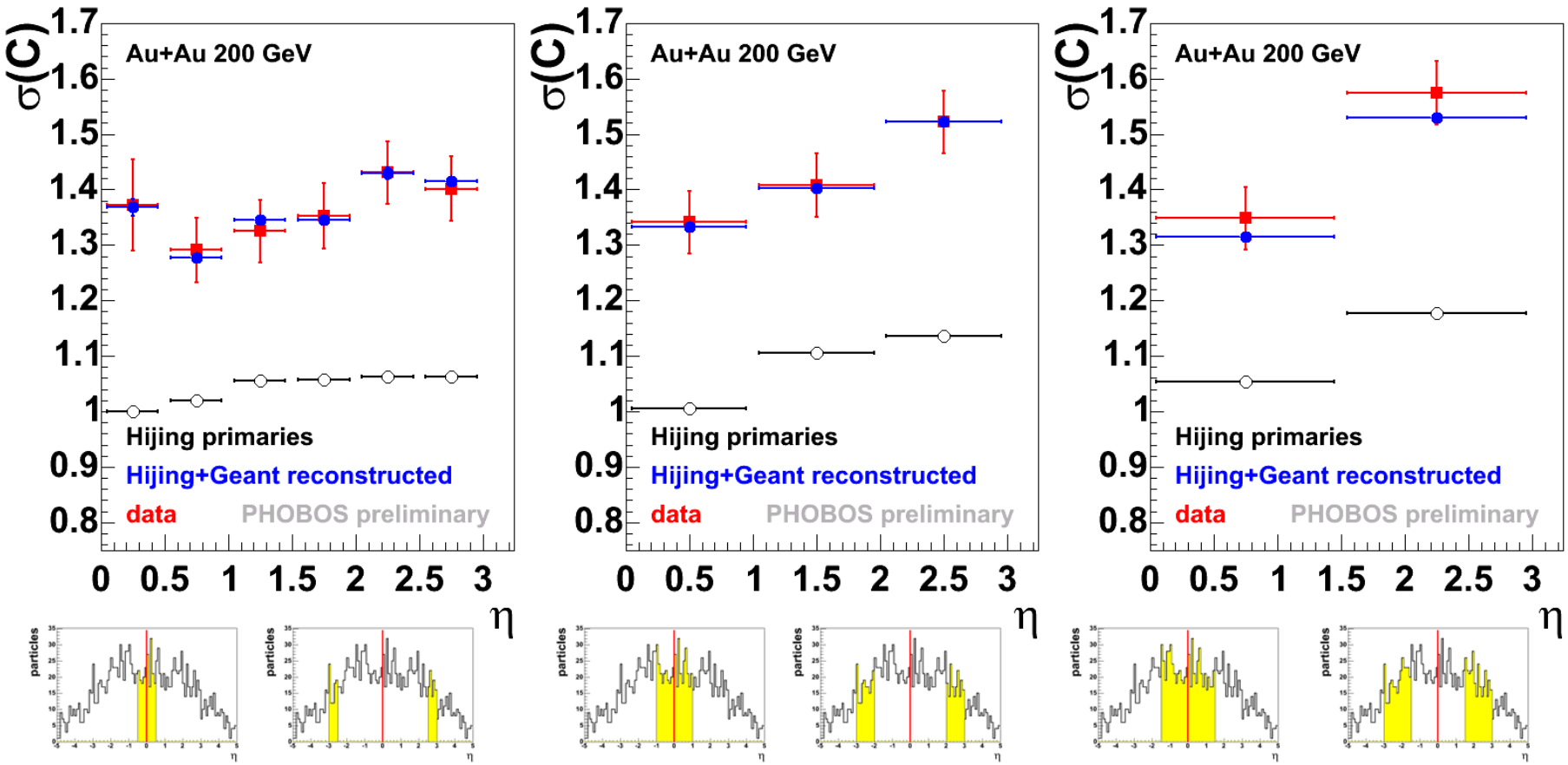
Sources of detector induced fluctuations

Deconvolution of the increase of σ(C):

- **Acceptance**
- **dE/dx fluctuations (Landau and β-velocity distribution)**
- **Addition of secondaries (from decays and secondary interactions of primary particles)**



Results for C parameter



Data are consistent with reconstructed Hijing+Geant

σ(C) is increasing with η and with η bin size

There are fluctuations in Hijing,
which are also present in the data.

But why do they depend on the position
of the bins in pseudorapidity ?

Why do they depend
on the width of bins in η?

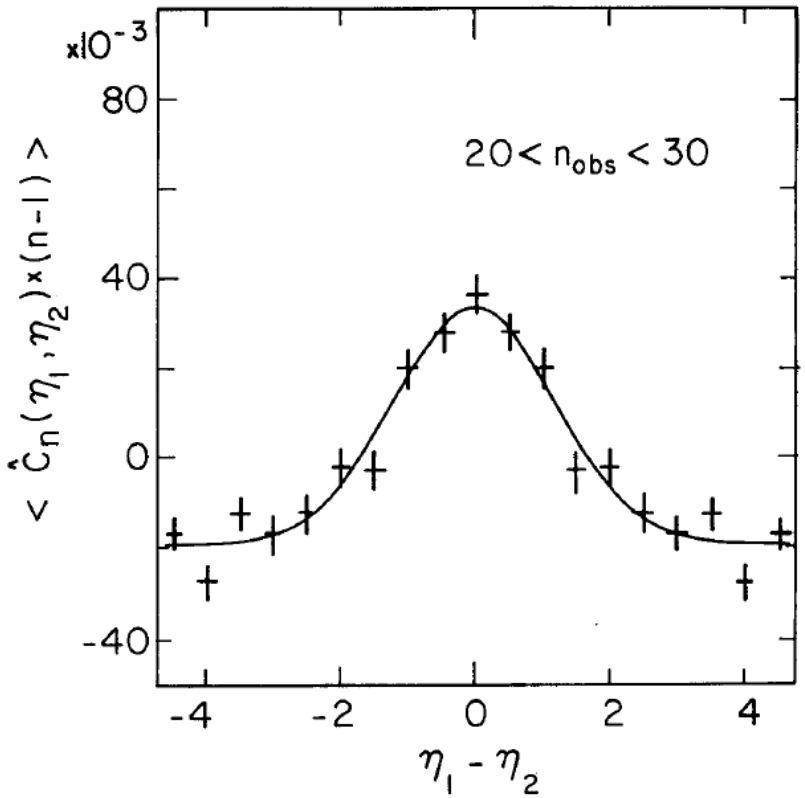
What do we know about the particle production
in elementary interactions?

Short range correlations in p+$\bar{p}$ 540 GeV interactions (UA5)

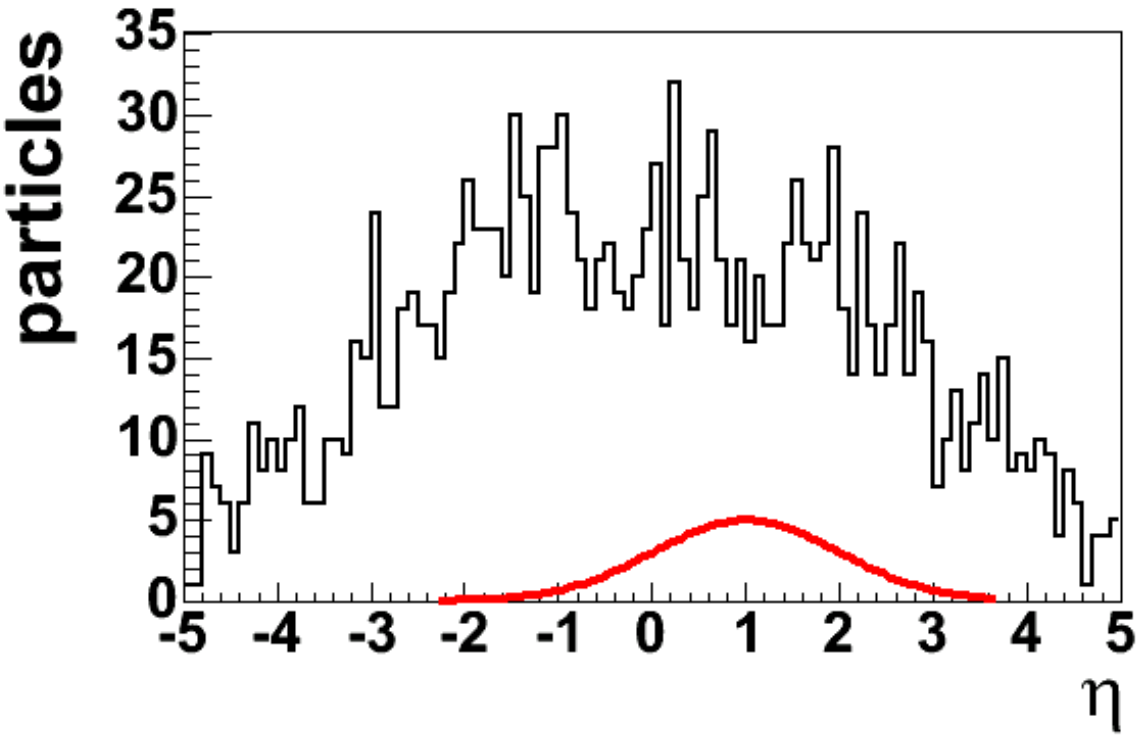
Short range correlations in pseudorapidity have a width of about 1 η unit

It has been interpreted as particle production from clusters

UA5 Collaboration, K.Alpgård at al., Physics Letters B vol. 123B (1983) 361



Simple cluster model of particle production

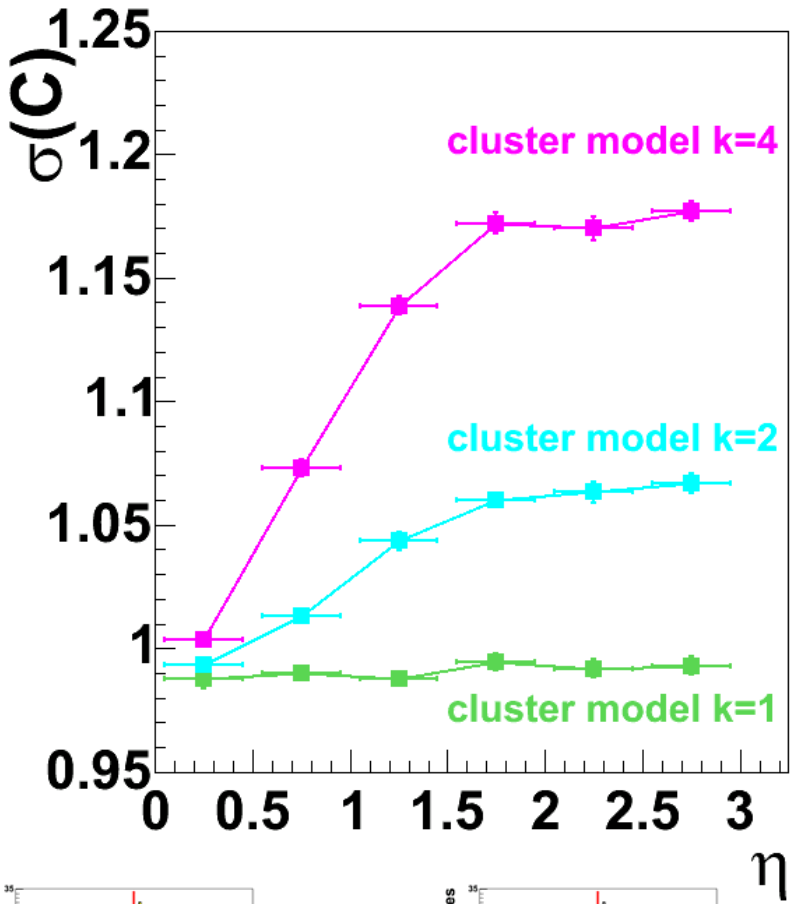


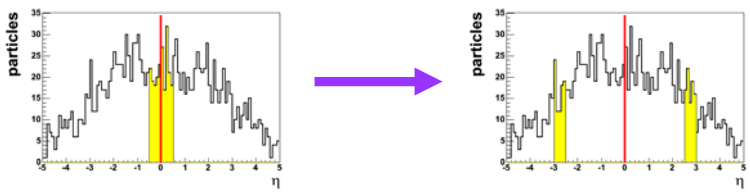
- Randomly distributed clusters according to dN/dη distribution
- Cluster particles generated from a Gaussian distribution in pseudorapidity with a width = 1 (centered at η of the cluster)
- Cluster multiplicity k = 1, 2, 4

Dependence of σ(C) on pseudorapidity in simple cluster model

σ(C) grows with k

σ(C) grows when η bins are more distant



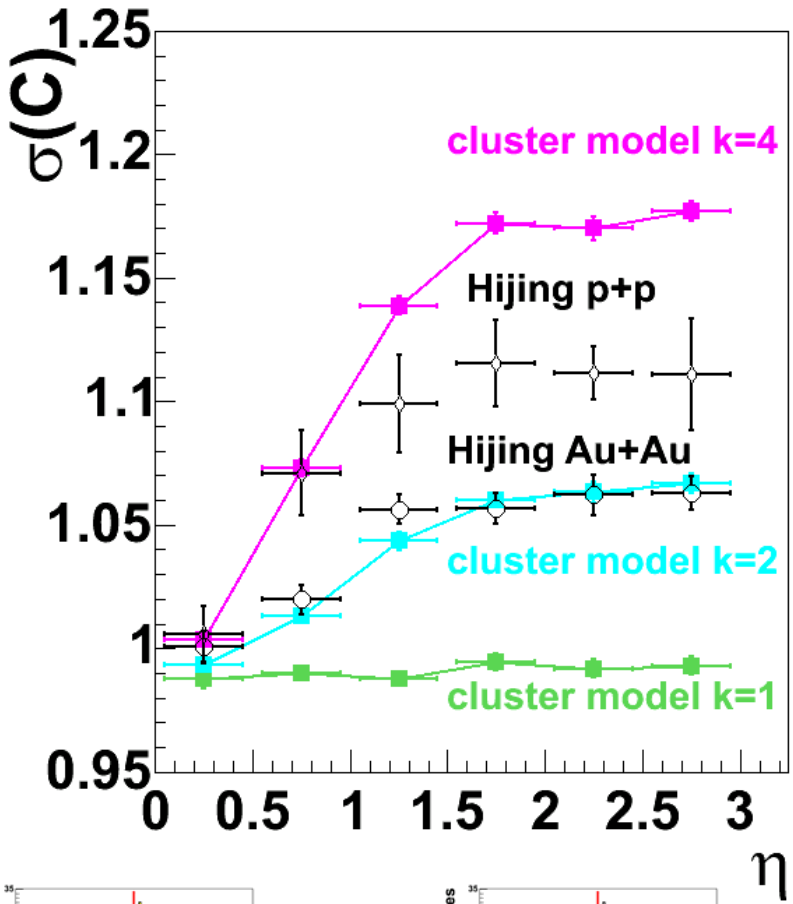


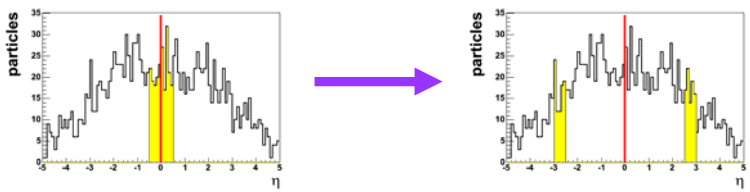
Dependence of σ(C) on pseudorapidity in simple cluster model

σ(C) grows with k

σ(C) grows when η bins are more distant

The η dependence of σ(C) for Au+Au Hijing agrees with cluster size 2

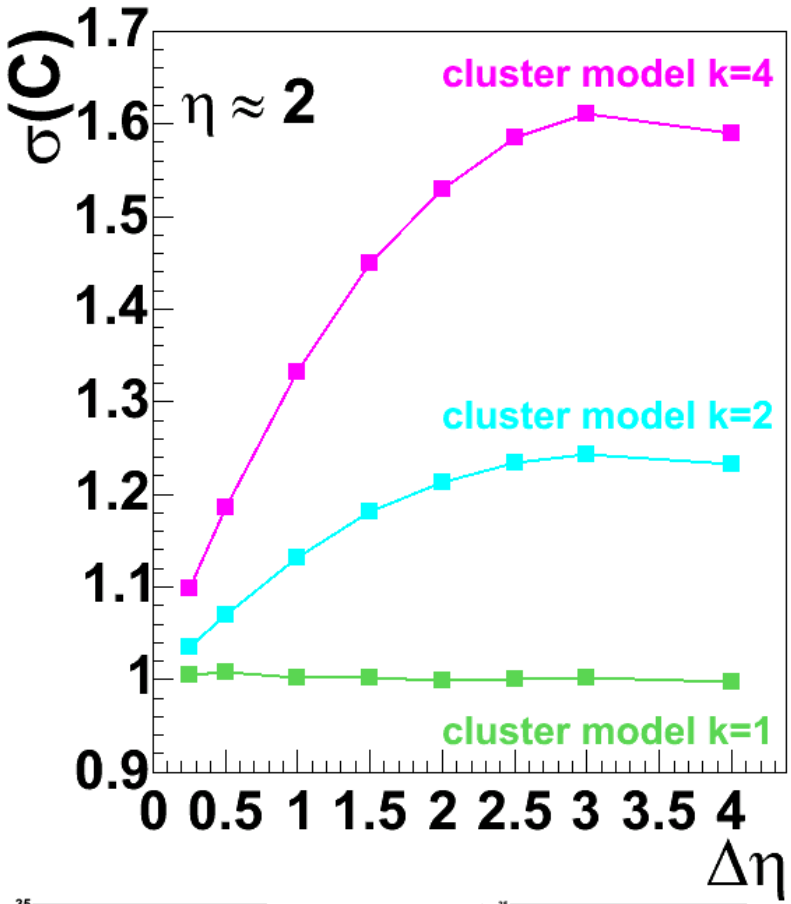


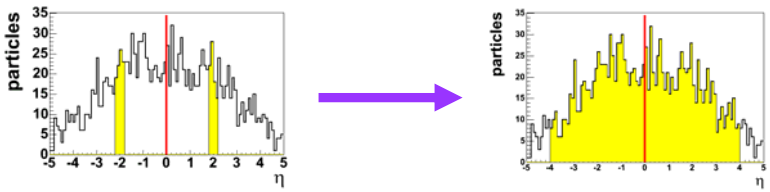


Pseudorapidity bin width dependence of σ(C) in clusters model

η centered at 2

σ(C) increases as the η bin width increases for k>1



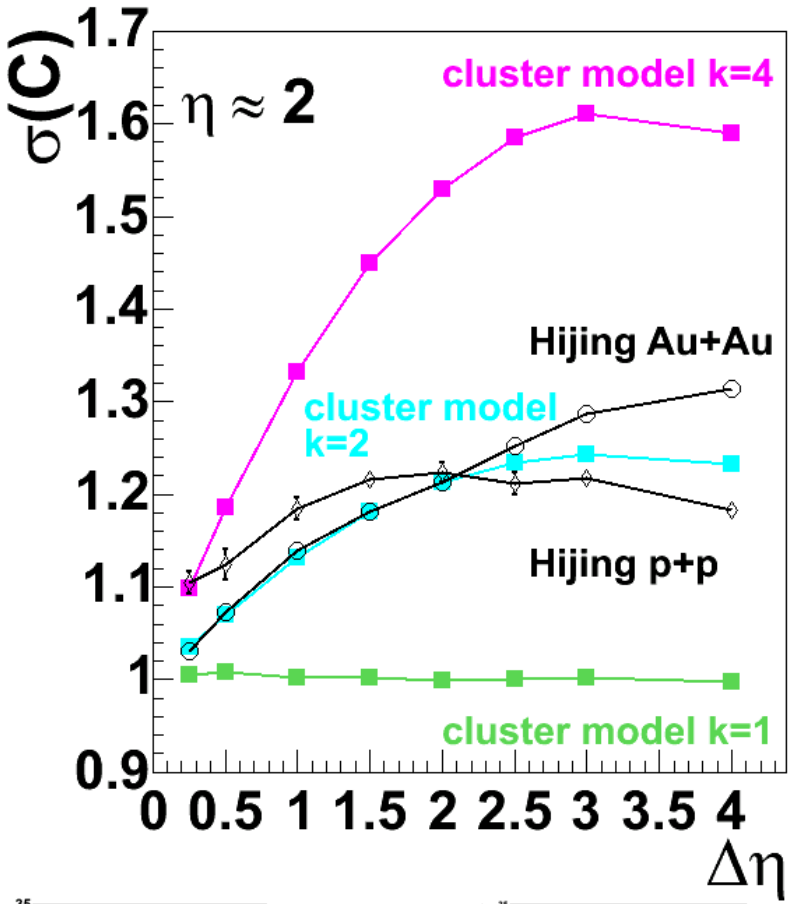


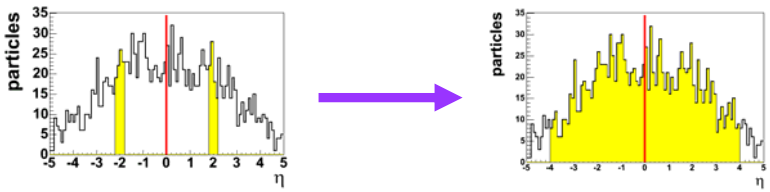
Pseudorapidity bin width dependence of σ(C) in clusters model

η centered at 2

σ(C) increases as the η bin width increases for k>1

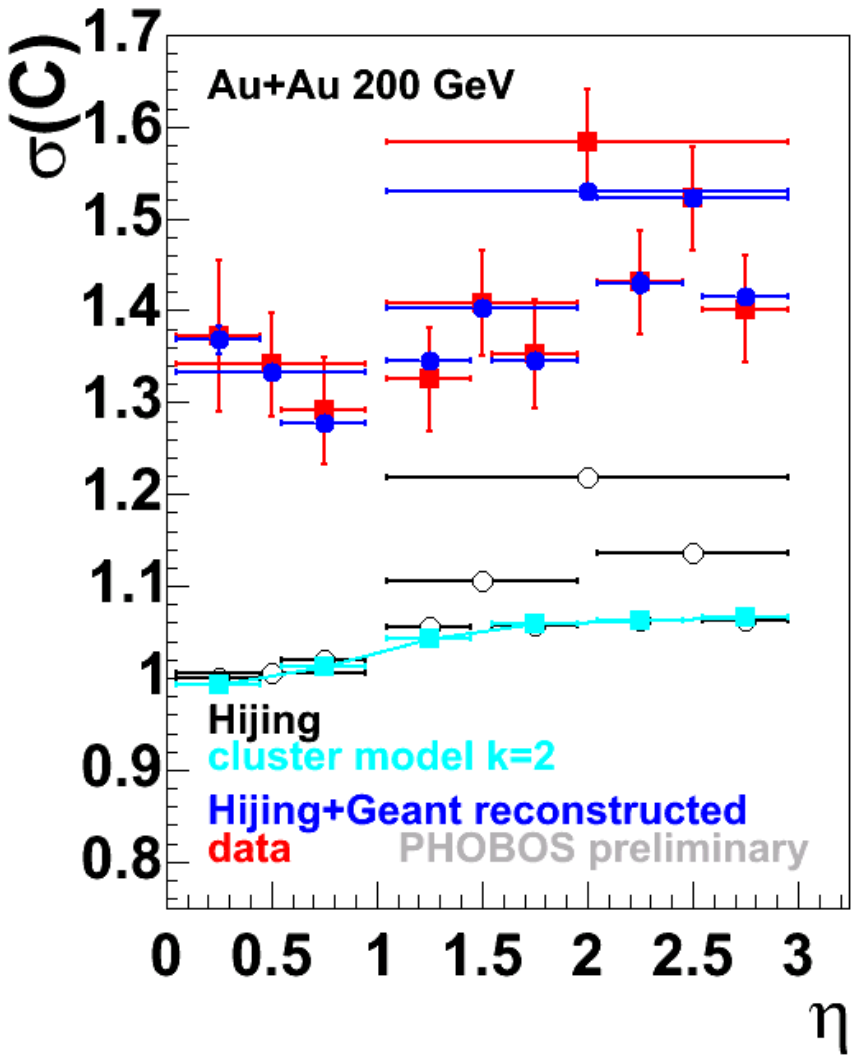
Au+Au Hijing agrees again with cluster size k=2





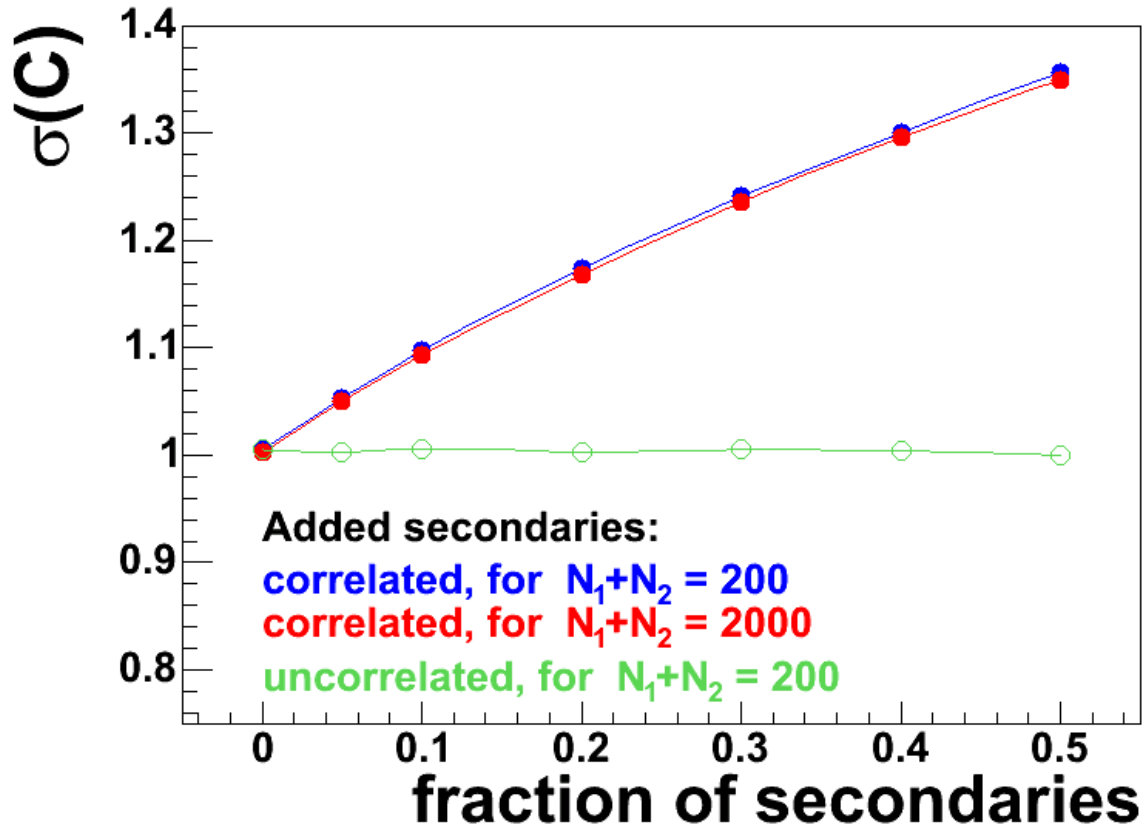
Conclusions

- We have analyzed fluctuations in charged particle production in Au+Au collision at $\sqrt{s_{NN}}$ = 200 GeV over wide pseudorapididty range (|η| < 3).
- Within systematic uncertainties measured σ(C) agrees with that for reconstructed Au+Au HIJING events
- The measured fluctuations are compatible with randomly distributed clusters of particles with charged multiplicity close to 2 and width equal 1 η unit.



Backup

Properties of C parameter



σ(C) increases if secondary particles are added