Multiplicity associated to high p_T events and percolation of color sources

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based on the work done in colaboration with J.Dias de Deus and C.Pajares

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Multiplicity associated to high p_T events and percolation of color sources

- What rare (self-shadowed) events are
- Universal relation among multiplicity distributions: $P_C(n) = \frac{n}{<n>} P(n)$
- Independent color sources scheme: $\frac{<n>_C}{<n>} = 1 + \frac{D^2}{<n>^2}$
- Introducing colectivity via percolation of color sources:

  $\frac{<n>_C}{<n>} = 1 + \frac{1}{k}$
- RESULT:clear bump for $\frac{<n>_C}{<n>}$ at the centrality class for which the system is more disordered.

Self-Shadowed events

- Considering a nucleon-nucleus collision as a superposition of independent nucleon-nucleon collisions:
  $\sigma^{hA}(b) = \sum_{n=1}^{A} \binom{A}{n} (\sigma T(b))^n (1 - \sigma T(b))^{A-n}$

- Each independent elementary collision can only be of type C or not of type C in a binomial fashion:
  $\sigma = \sigma_C + \sigma_{NC}$
  $(\sigma T(b))^n = \sum_{i=0}^{n} \binom{n}{i} (\sigma_C)^i (\sigma_{NC})^{n-i} T(b)^n$

- At least one elementary interaction is of type C ($C \otimes NC = C$):
  $\sigma_C^{hA}(b) = \sum_{n=1}^{A} \binom{A}{n} \sum_{i=1}^{n} \binom{n}{i} (\sigma_C)^i (\sigma_{NC})^{n-i} T(b)^n$
  $= 1 - (1 - \sigma_C T(b))^A$

- σ_C shadowed by itself,
  if $\sigma_C(b) << 1$, $\sigma_C^{hA} \simeq A\sigma_C$ if $\sigma_C(b) \simeq \sigma(b)$, $\sigma_C^{hA} \simeq A^{2/3}$

Universal law for probability distributions

- Consider $N(\nu)$ to be the total number of events produced with ν collisions:

  $N(\nu) = \sum_{i=0}^{\nu} \binom{\nu}{i} (1-\alpha_C)^{\nu-i} \alpha_C^i N(\nu)$

- for small α_C (rare event):
  $N_C(\nu) = \alpha_C \nu N(\nu)$ and $\quad N_{NC}(\nu) = (1-\alpha_C \nu) N(\nu)$

- For $\sum_\nu N(\nu) = N$, $\quad \sum_\nu \nu N(\nu) = <\nu> N$
  $\sum_\nu N_C(\nu) = \sum_\nu \alpha_C \nu N(\nu)$,

- $P_C(\nu) = \frac{\alpha_C \nu N(\nu)}{\sum_\nu N_C(\nu)} = \frac{\nu N(\nu)}{<\nu>\sum_\nu N(\nu)} = \frac{\nu}{<\nu>} P(\nu)$ UNIVERSAL

Universal law for probability distributions

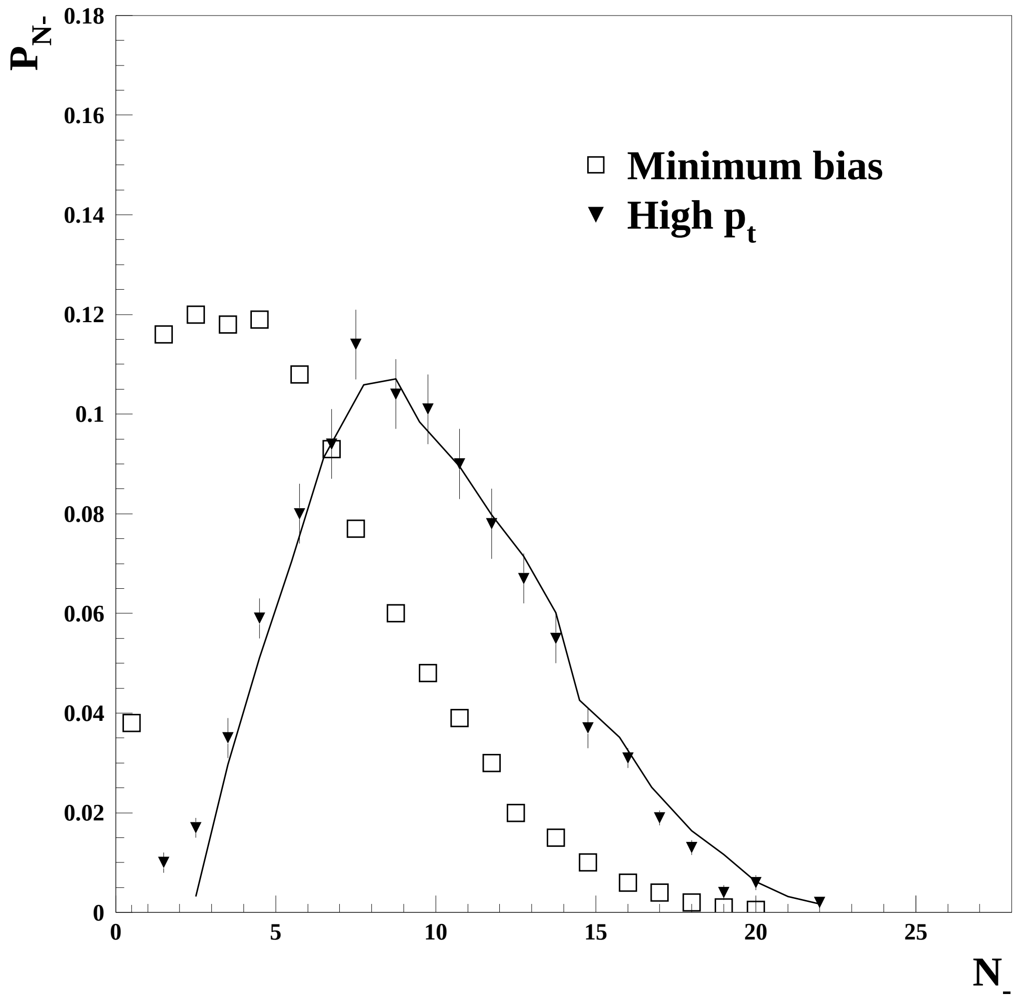
- $P_C(\nu) = \frac{\nu}{<\nu>} P(\nu)$

- KNO for particles is well aproximated by KNO for collisions:
  $< n > P(n) =< \nu > P(\nu)$

  - $n = \nu \overline{n}_0$
  - $\frac{D^2}{<n>^2} = \frac{D(\nu)^2}{<\nu>^2} + \frac{d^2}{\overline{n}_0^2 <\nu>}$

  - assume dominance of the fluctuations in the number of collisions
  - the dominance increases with increasing $< \nu >$
  - the same kind of aproximation for all other moments ...

- $P_C(n) = \frac{n}{<n>} P(n) \longrightarrow$ also in $\mathrm{E_T}$!



- $P_C(n) = \frac{n}{<n>} P(n)$
- Data for $\alpha - \alpha$ at ISR
- C means $p_T > 3$GeV/c

Universal law for probability distributions

- $P_C(n) = \frac{n}{<n>} P(n) \longrightarrow \frac{<n>_C}{<n>} = 1 + \frac{D^2}{<n>^2}$
  - dominance of the fluctuations in the number of collisions
  - smallness of α_C
  - linearity ($N_C \propto \nu$)

- and all based on the idea of superposition, independent emitters

  and this is no longer valid at RHIC energies! for which colectivity manifests through the absence of scalling with collisions
  but eq still valid as we will see

Percolation of color sources

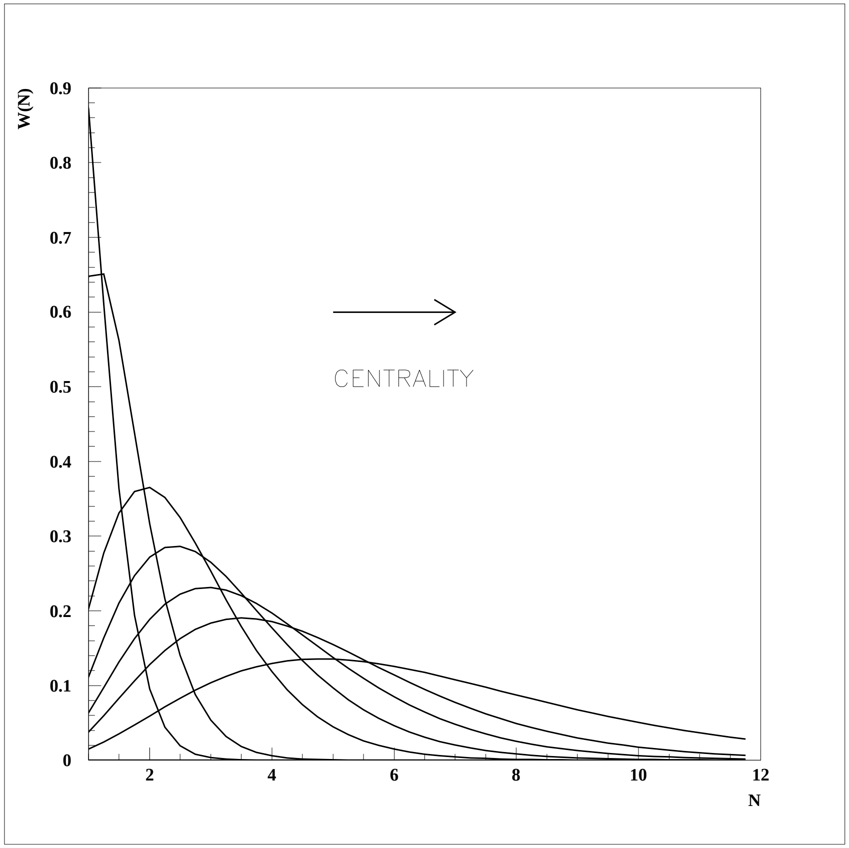
- $P(n) = \int_0^\infty dN W(N) P(N,n)$

- P(n): particle distribution, the negative bynomial is a good fit to data:
  - $P(n) = \frac{\gamma^k}{\Gamma(K) n!} \frac{\Gamma(n+K)}{(1+\gamma)^{n+K}}$

- P(N,n) particle distribution for a cluster composed by N individual sources, usually taken to be poissonian.

- W(N): configuration, cluster size distribution:
  - $W(N) = \frac{\gamma}{\Gamma(K)} (\gamma N)^{K-1} \exp(-\gamma N)$

Percolation of color sources

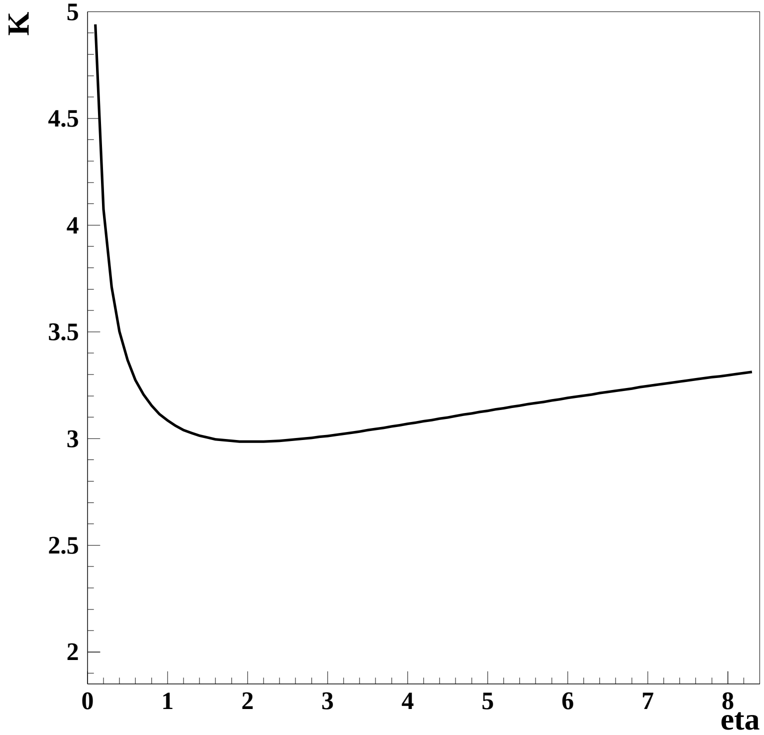


$\frac{<N^2>-<N>^2}{<N>^2} = \frac{1}{K}$,K is a measure of the dispersion on the size of the emitting clusters

Percolation of color sources

$$\frac{D(n)^2}{<n>^2} = \frac{1}{K} + \frac{1}{<n>}$$

$$eta = (No.strings * stringsize)/totalsize$$



Percolation of color sources

- $P_C(\nu) = \frac{\nu}{<\nu>} P(\nu) \longrightarrow W_C(N) = \frac{N}{<N>} W(N)$

- elementary collision $\longrightarrow$ elementary cluster

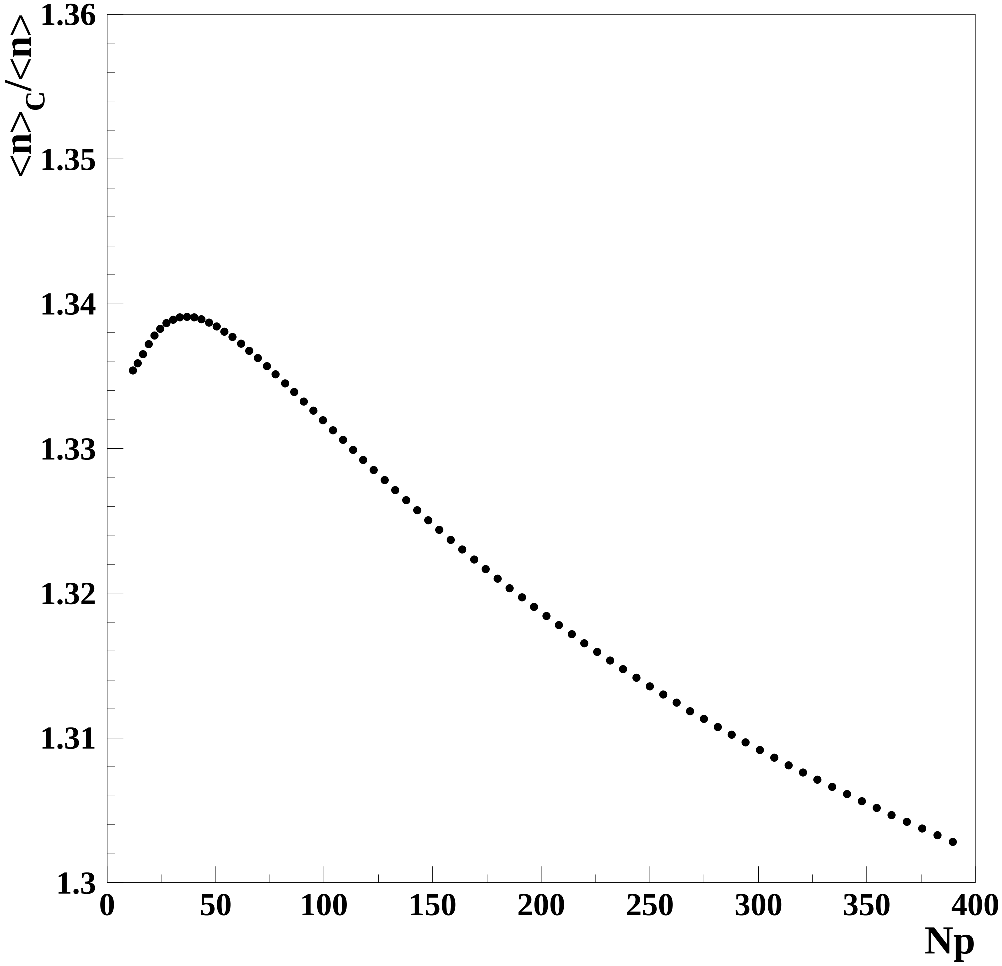
- $P_C(n) = \int_0^\infty dN \frac{N}{<N>} W(N) P(N,n)$

- $P_C(n) = \frac{n+K}{<N>} \frac{P(n)}{\gamma+1}$

- $\frac{<n>_C}{<n>} = \frac{1/K+1/<n>+K/<n>+1}{1+K/<n>}$

- for $< n >>> K$, $\frac{<n>_C}{<n>} = 1 + \frac{1}{K}$

$\frac{<n>_C}{<n>} = 1 + \frac{1}{K}$ for Gold-Gold collisions at 200 GeV/A



Conclusions

-High p_T events at RHIC, heavy flavour production,
particle production with no $\delta y > \psi$...
-The same underlying mechanism