Measurement of Energy Dependence of K/π fluctuation in STAR Experiment at RHIC

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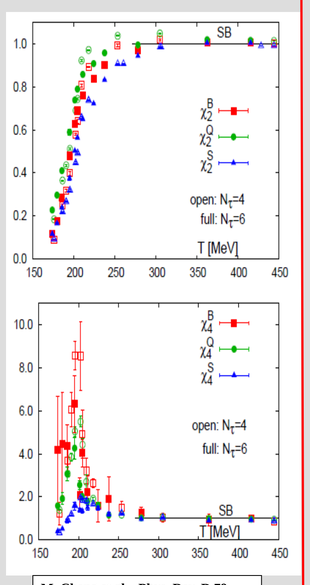
Abstract:
Event-by-event fluctuation in strangeness may reveal the nature of Quark-Gluon Plasma (QGP) to hadron gas phase transition and can be used as a probe for QCD critical point. Dynamical fluctuations in K/π at lower beam energies were reported to increase with decreasing $\sqrt{s_{NN}}$ while they remained constant at higher $\sqrt{s_{NN}}$. STAR results for the study of K/π fluctuations have been reported earlier for Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7, 11.5, 39, 62.4, 130 and 200 GeV. The results have been found to be independent of beam energy. In this poster, we report new results on event-by-event fluctuation in K/π at mid-rapidity from 19.6 and 27 GeV Au+Au collisions. The use of Time Projection Chamber (TPC) and Time of-Flight (ToF) detectors allow particle identification up to p_T = 1.4 GeV/c. The advantage of this large particle identification reach in momentum and using a collider facility for K/π fluctuation studies will be discussed. The results will be compared with the prediction of a transport model (UrQMD) and statistical hadronization model.

Introduction:

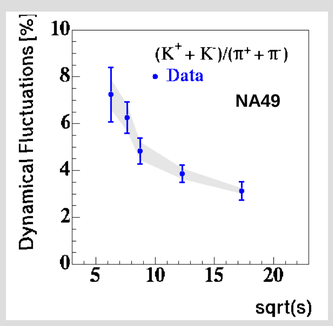
Large fluctuation is expected in a phase transition near QCD critical point.

Finite system size effects may influence fluctuation measurements.

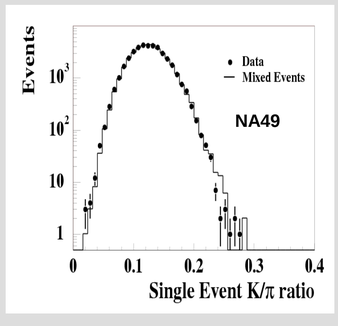
There may be change in behavior of quark susceptibilities .
Aoki, Endrodi, Fodor, Katz and Szabo,
Nature **443**, 675-678(2006)



M. Cheng et al., Phys. Rev. D 79 (2009) 074505



J. Phys. G G30(2004) S1381



Phys. Rev. Lett 86(2001)1965

Measures:

NA49 collaboration at SPS used a measure called,

$$\sigma_{dyn} = \sqrt{\sigma_{real}^2 - \sigma_{mixed}^2}$$

where, σ_{real} is the width of event wise K/π distribution of data over large number of events and σ_{mixed} is that of mixed events.

STAR collaboration at RHIC is using a measure called $\upsilon_{dyn,k\pi}$

$$\upsilon_{dyn} = \frac{< N_K(N_K -1)>}{< N_K>^2} + \frac{< N_\pi(N_\pi -1)>}{< N_K>^2} - 2\frac{< N_K N_\pi >}{< N_K><N_\pi>}$$

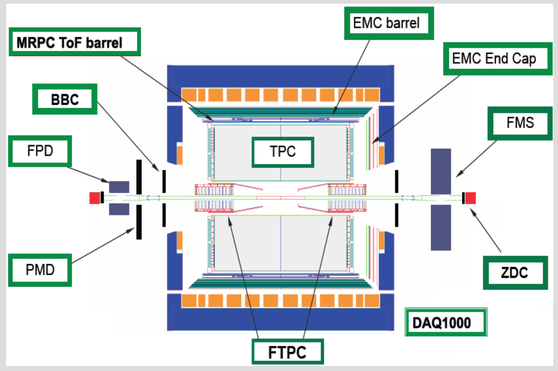
where, N_k is total number of kaons in an event and N_π is the total number of pions in that event. <…> indicates the average over event ensemble.

Both the measures are related by following equations:

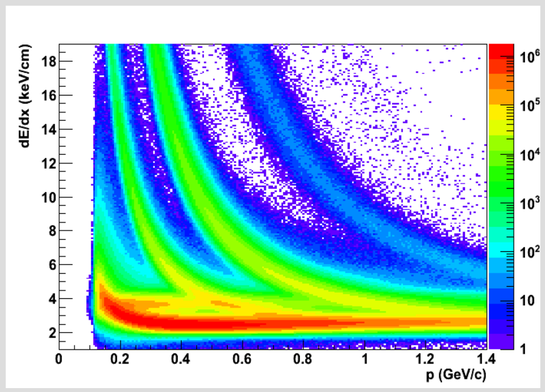
$$\sigma_{dyn} \approx \sqrt{\upsilon_{dyn}}$$

υ_{dyn} is considered to be a robust observable and independent of single particle detector inefficiency. Use of σ_{dyn} may be problematic at lower multiplicities resulting inaccurate results.

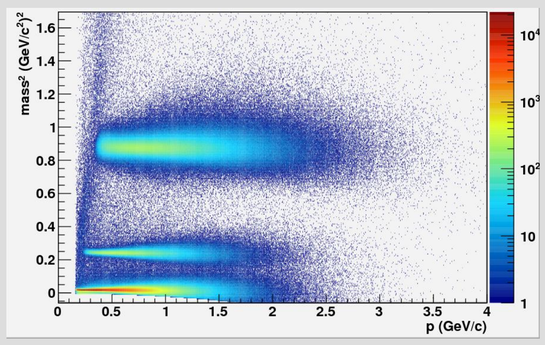
STAR Detectors



Particle Identification (TPC):



Particle Identification (ToF):

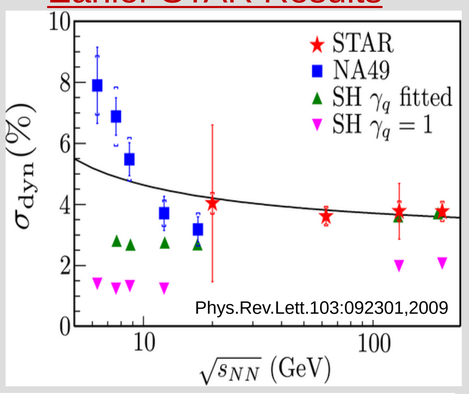


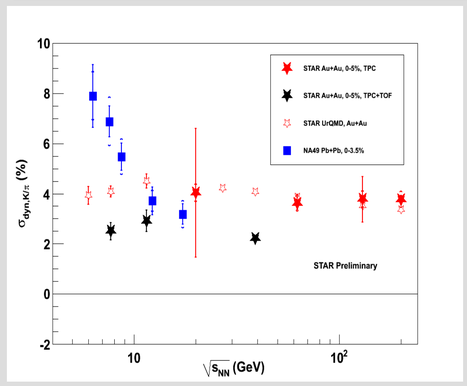
TPC: Extract the number of $K^+ + K^-$ and $\pi^+ + \pi^-$ event by-event using dE/dx curvature in the TPC.
Select kaons and pions with $0.2<p_T<0.6$ (GeV/c) and
$|\eta| < 1.0$
K : $|N_{\sigma,K}| < 2.0$, $|N_{\sigma,\pi}| > 2.0$
π: $|N_{\sigma,\pi}| < 2.0$, $|N_{\sigma,K}| > 2.0$
electrons: $|N_{\sigma,e}| > 1.0$

where, Nσ = log ((dE/dx)/B)/σ
B is the expected mean dE/dx and σ is the dE/dx resolution for a particle type.

TOF PID :
π : $0.6 < p_T < 1.4$ (GeV/c)
K: $0.6 < p_T < 1.4$ (GeV/c)
π: $0.001 < m^2 < 0.07$ $(GeV/c^2)^2$
K: $0.21 < m^2 < 0.29$ $(GeV/c^2)^2$

Earlier STAR Results





Decrease of fluctuation strength with increasing energy from NA49.

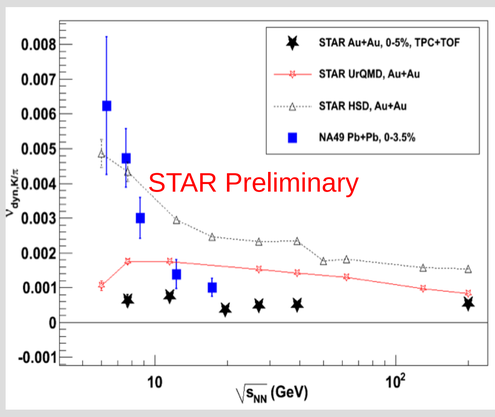
Fluctuation measured by STAR approximately constant as function of energy from 19.6-200 GeV. Statistical Hadronization (SH) model [G. Torrieri, Int. Jour. Mod. Phys. E, 16, 1783 (2007)] underestimate the experimental results at lower energies.

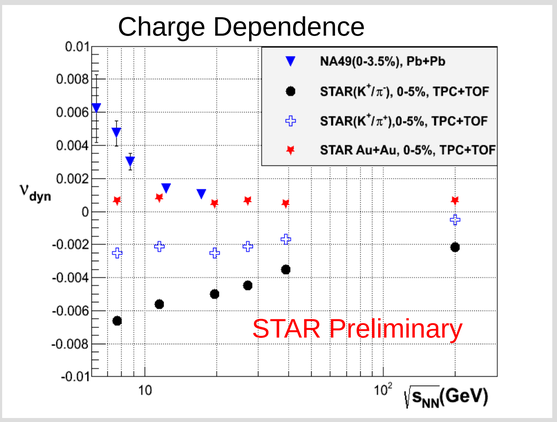
$|\eta| < 1.0$

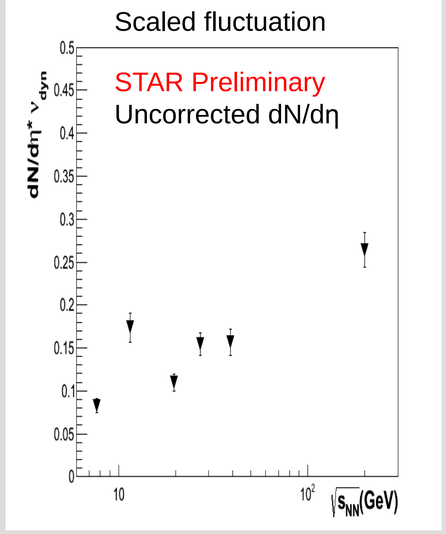
π, K: $0.2 < p_T < 0.6$ GeV/c.

TPC+TOF data from STAR Collaboration, WWND(2011) , SQM (2011).
TPC (GeV/c):
π : $0.2 < p_T < 0.6$
K : $0.2 < p_T < 0.6$
TPC+ToF (GeV/c):
π : $0.2 < p_T < 1.4$
K : $0.2 < p_T < 1.4$
TPC+TOF includes statistical errors only.

New Results(19.6 and 27 GeV included)







• No energy dependence is observed. Only statistical errors shown here for TPC+ToF data.

• Almost same for all energies for same sign combinations.
• Growing difference observed for opposite sign combinations as a function of energy. This could be due to correlated resonance decay.
• Scaled fluctuation strength increases slightly with beam energy.

Summary:

- New results in K/π ratio fluctuation at 19.6 and 27 GeV Au+Au collision are presented in comparison with earlier results.
- No energy dependence is observed.
- The fluctuation strength of same sign charged particles is almost similar at all energies for 0-5% central collisions.
- Difference increases between same and opposite sign combinations with decreasing energy