Theoretical ideas and experimental searches of the critical point
Discussion Session 13.11.2020

1. **What is analog of (3)CEP in finite systems?**

Our guesses:

a) surface tension vanishes => power law in mass of bags (KAB+…)

b) drop of σ-meson mass (J.Torres-Rincon+…) =>

What is to σ-meson width? What happens to ω-meson?

c) behavior of susceptibility ratios => in finite systems?

d) other suggestions (next page)?

2. **What do we need to improve our state of the art?**

The situation with CEP from the experimental view

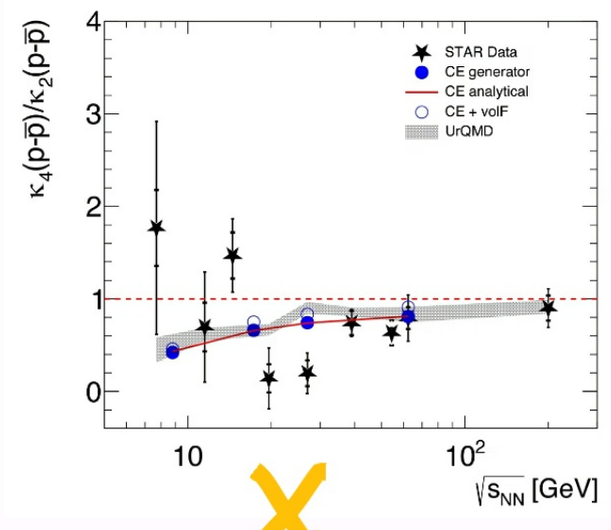
Marek Gazdzicki talk at RFBR & NICA meeting

CRITICAL STRUCTURES

PHASE II: SEARCHING FOR CRITICAL POINT

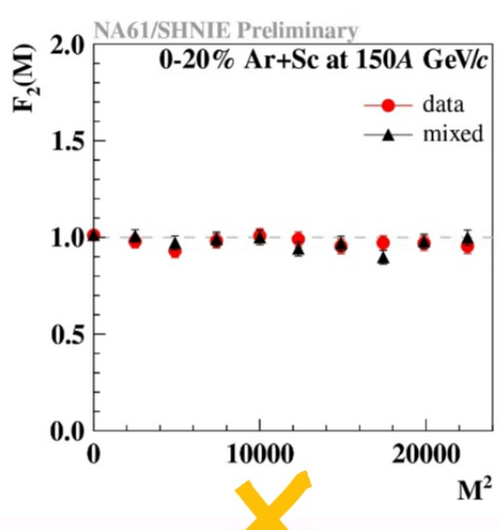
CP INDICATIONS → DIFFERENT ENERGIES/REACTIONS

HIGHER ORDER MOMENTS



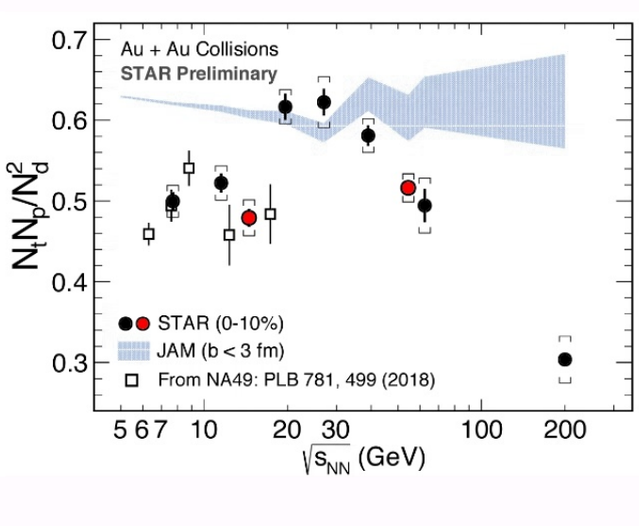
≈ 7 GeV

PROTON INTERMITTENCY



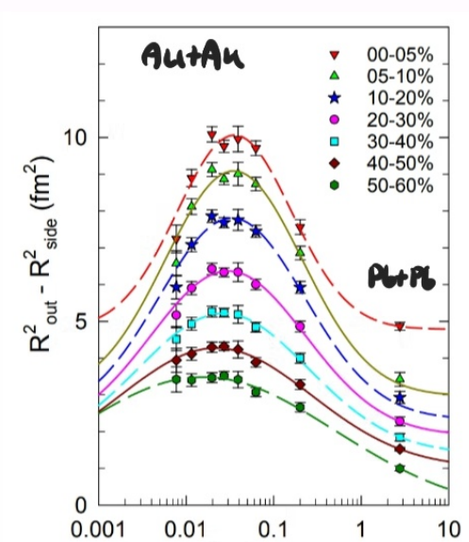
≈ 17 GeV

LIGHT IONS



≈ 20 GeV

SHORT-RANGE CORRELATIONS



≈ 50 GeV

Several talks **J.Torres-Rincon**

What do we need to improve our state of the art?

What do we need to improve our state of the art?

To answer it let us fixed the present situation

Humble phenomenologist opinion from this meeting:

1. **Our colleagues from FRG, Dyson-Schwinger and effective models are doing great job.**

2. **The astrophysics community is doing even greater job with beautiful pictures/movies!**

3. **Colleagues from analytical lQCD are producing very interesting results!**

What about Numerical lQCD?

In 1984 I first studied the lectures on lQCD

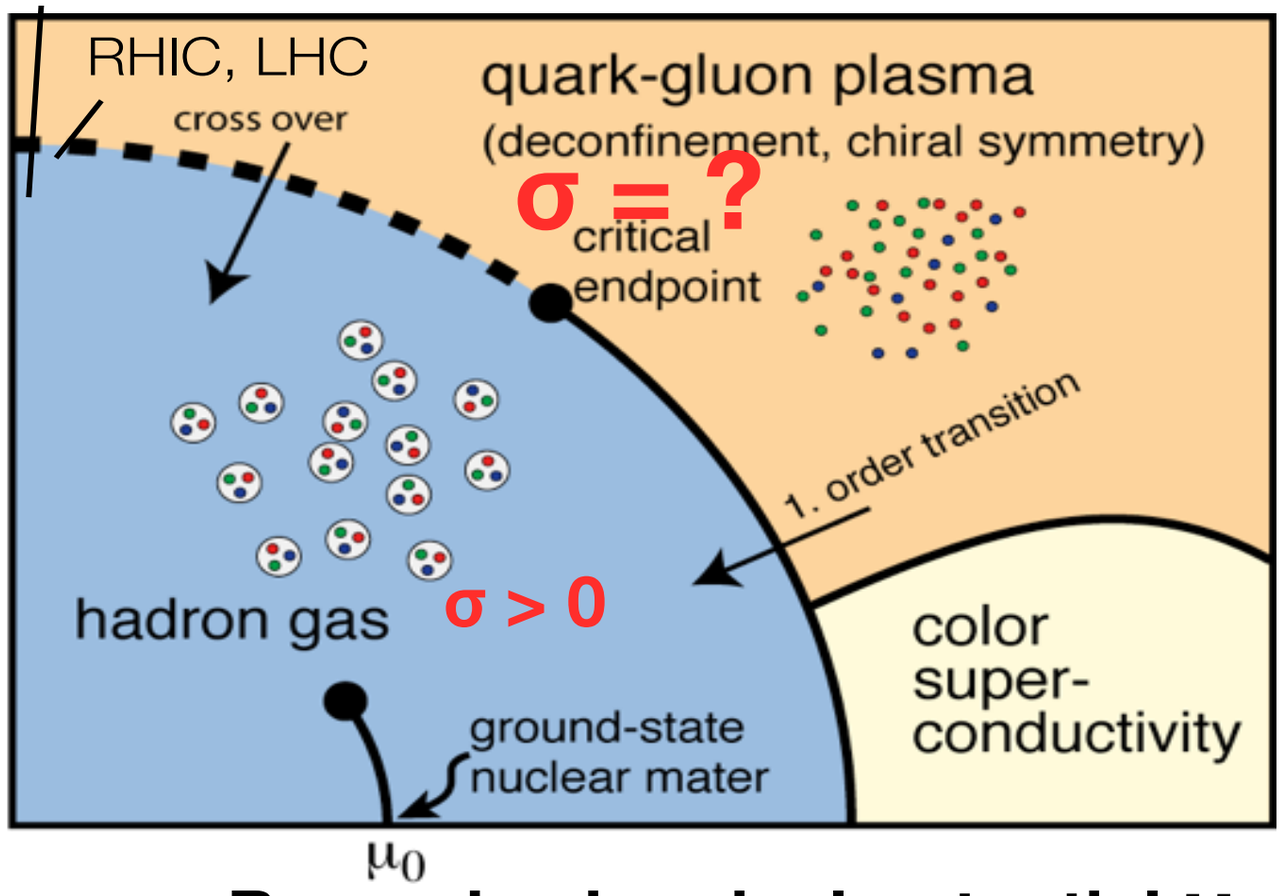
It was a general belief that lQCD will be a guide for phenomenology and experiments

Humble phenomenologist opinion from this meeting:

1. **Numerical lQCD community is preoccupied with its own problems**
2. **To some extent it helps to effective field models**
3. **No any relations to experiments**

Numerical lQCD has a great potential!

1. What is the physical reason that the 1-st Order PT curve Is terminated? What is the reason of CROSS-OVER?



Experiments do not tell us

=>
lQCD can could provide A great numerical experiment using:

Gluodynamics, spin systems With quarks ect

lQCD can provide the values of surface (curvature and Gaussian curvature) tension coefficients to build up exactly solvable models at high baryonic densities! Clusters on lattice can be defined via values of Polyakov loop close to a certain value of Z(N).
See C. Gattringer, Phys. Lett. B 690 (2010) 179

Numerical lQCD has a great potential! 2

2. Study EoS which is more close to the experiments

In experiments we have many jets, e+e- and μ+μ- pairs

From experiments it is known that under irradiation The surface tension coefficient of liquid decreases =>

In experiments the Tcep may be lower under the jets Irradiation! But how?

lQCD could, for example, introduce random defects On the lattice and find the modification of the EoS, and Its characteristics like the surface (curvature and Gaussian curvature) tension coefficients

Numerical lQCD has a great potential! 3

3. The progress of computer technologies is very fast

=> in few years I hope that lQCD can go from static EoS
to a real transport of partons!

4. Are there other suggestions for lQCD? Other opinions?

General questions

Natalia: [To A. Sidorin:]

Do I understand correctly, that it is planned to setup one more cluster in addition to Govorun? Can you comment on its hardware (CPUs, GPUs, ...) and when it is planned to start running?

Input from Prof. Xiaofeng Luo talk

"Search for the QCD Critical Point in Heavy-ion Collisions at RHIC"

1. What's the production mechanism of light nuclei in heavy-ion collisions ? Is it different between high and low energies ?

2. Are the non-monotonic structure observed in light nuclei yield ratio and net-proton fluctuations caused by the same physics ?

3. How to determine the collision centrality to reduce the volume fluctuations at low energies ? This is important for fluctuation analysis.

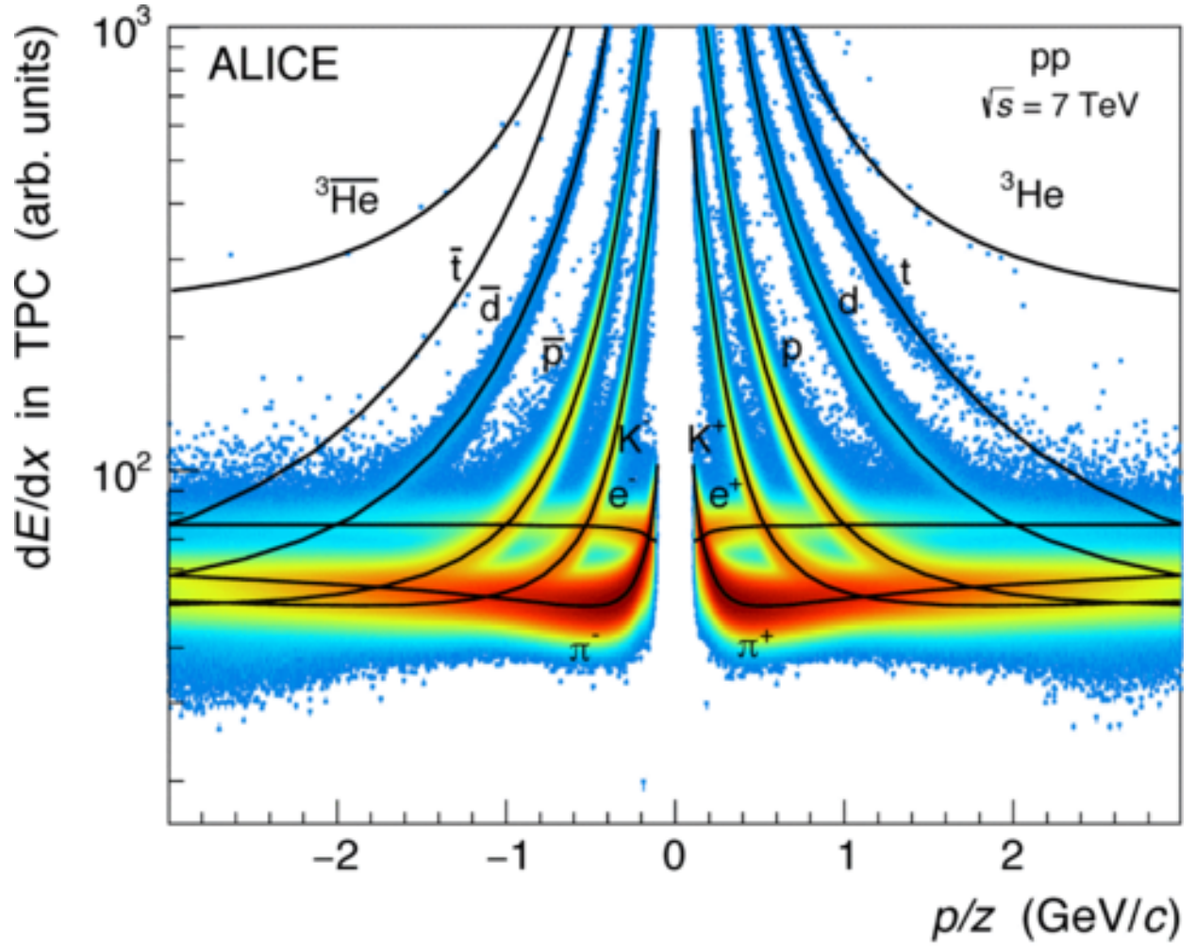
4. Is the chemical freeze-out line still close to QCD phase boundary at muB > 300 MeV ?

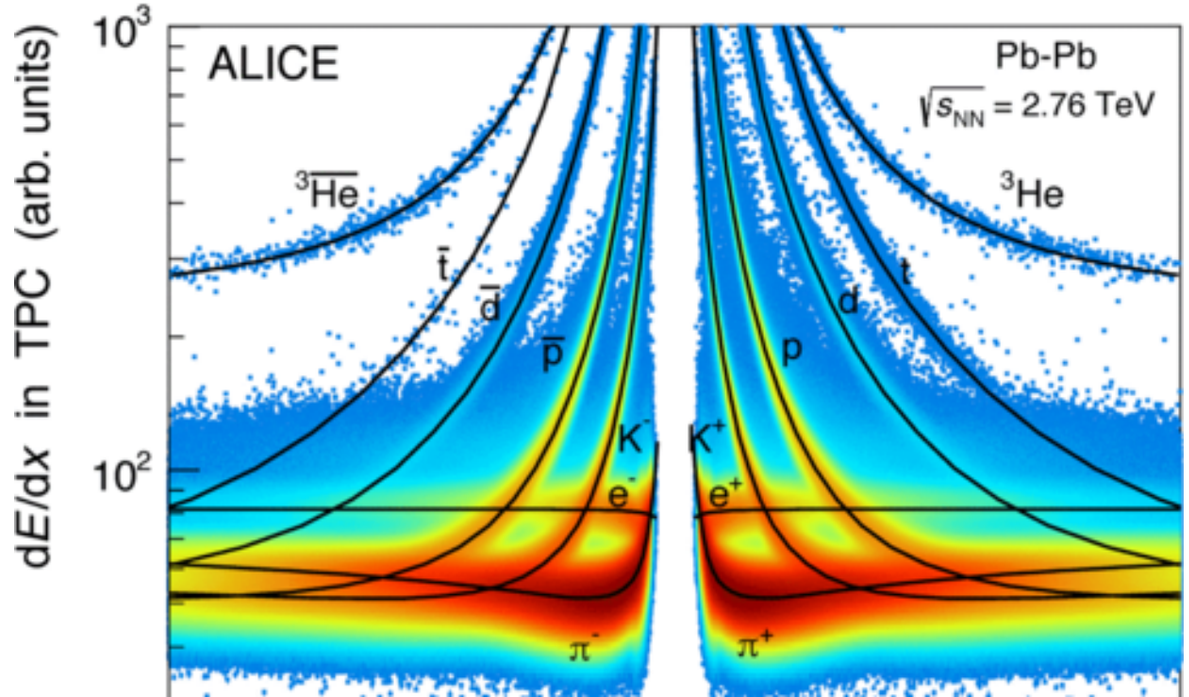
Questions to Prof. Xiaofeng Luo

What is wrong with antitriton measurements at ALICE? (their huge deficit!)

Ratio Nt Np/(Nd)^2 for antiparticles?

What is the CEP definition that you use?

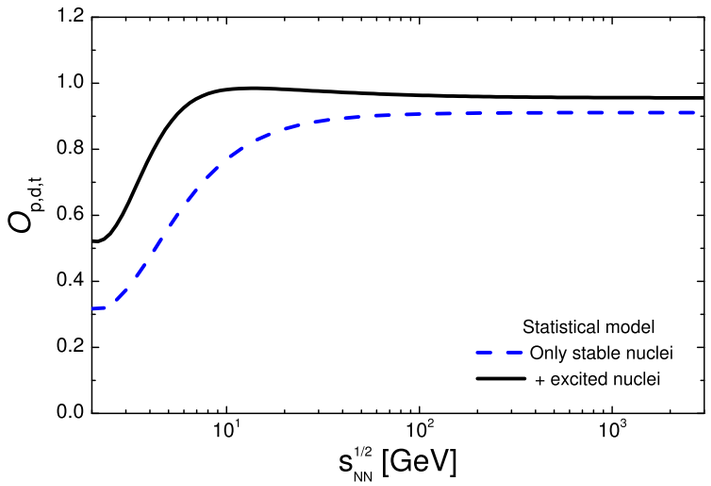




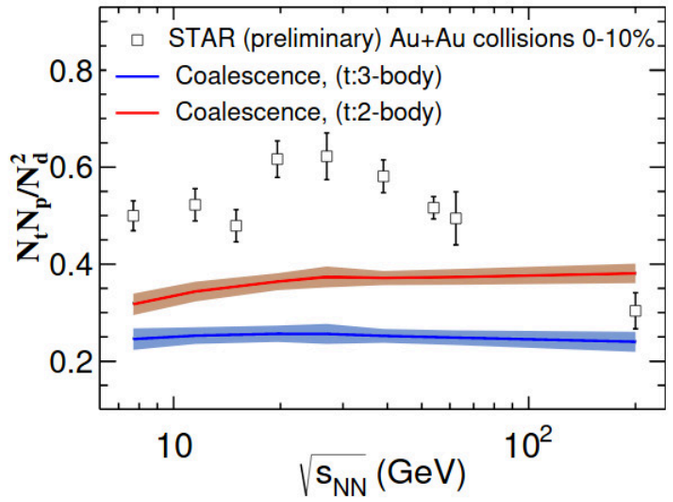
Input from Dr. Juan Torres-Rincon talk

Discussion Session 10 (Nov 13, 2020)

We need solid baseline for $N_t N_p / N_d^2$ **without** critical effects. Both **statistical thermal model** and **coalescence model** give a rather flat energy dependence, but with different reference points

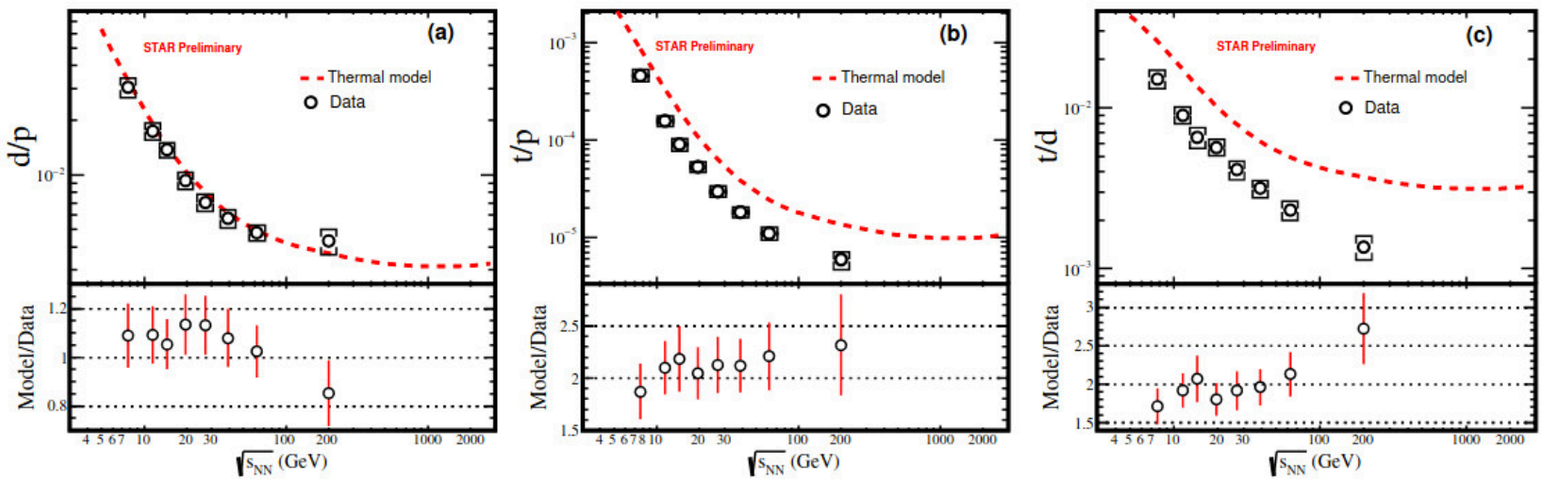


Statistical thermal model Vovchenko et al., *PLB 809 (2020) 135746*



Coalescence model, Zhao et al., *PRC 102, 044912 (2020)*

Triton yield ?
Zhang et al. (STAR)
1909.07028



Questions to Dr. Juan Torres-Rincon

What is to σ-meson width?
What happens to ω-meson? What about their couplings?

kaijia Sun:

what's the difference between pre-clusters and statistical correlations?

How could the effects of modified NN potential survive to the kinetic freeze out at which the NN potential restores to its normal value?

Juan Torres-Rincon:
Pre-clusters ~ bound states with a "broad" spectral function due to T. We think about them as pre-nuclei, but of course they can survive in excited states of nuclei or decay to other physical states depending on their time evolution. For the second question that depends on how separated are freeze-out temperature and Tc. Certainly the normal value is reached at T~0, but the pre-clusters are formed much before.

Input from Prof. Oleg Rogachevsky talk

"Experimental study of QCD phase diagram at NICA energy range"

Questions:

What is the CEP definition that you use?

How to search for it?

More questions? Suggestions?