Heavy Ion Physics Program of CIIT Islamabad.

Dr.Sc. Mais Suleymanov

Department of Physics CIIT Islamabad

First School on LHC Physics: ALICE week
NCP Islamabad, 12-30 October,2009

First discussions

5th Particle Physics Workshop

Organized by

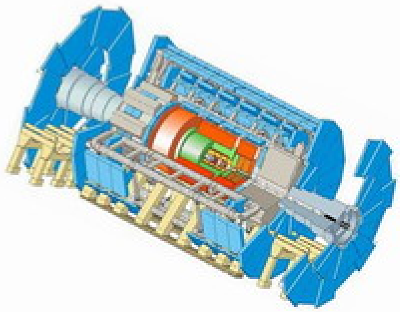
NATIONAL CENTRE FOR PHYSICS

Islamabad, Pakistan

Co-sponsered by

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

20-25 November , 2006

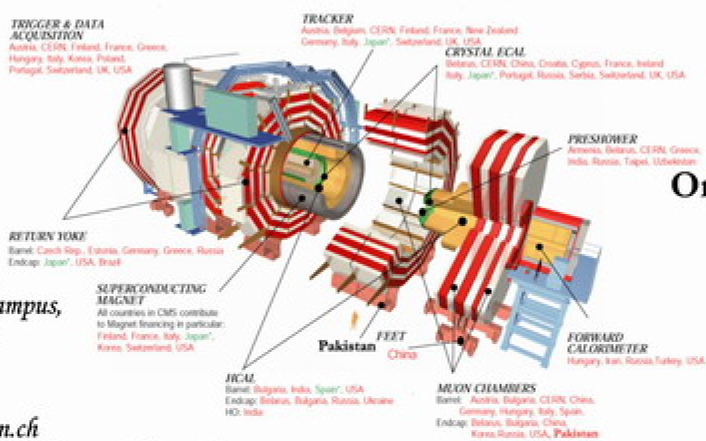


Speakers

Robert Fleischer
Alain Blondel
Hans Braun
Walter Wuensch
Oliver Buchmuller
Federico Antinori
Rinaldo Santonico
Andreas Hoecker

Topics

Flavour Physics
Neutrino Physics
Linear Collider
Accelerator Physics
Standard Model
Heavy Ion Physics
Resistive Plate Chamber
LHC Detector



Dr. Hafeez Hoorani
National Centre for Physics
Quaid-i-Azam University Campus,
Islamabad, 44000, Pakistan
Telephone: 92-51-9219038
Fax: 92-51-9205753
Email: Hafeez.Hoorani@cern.ch
URL: http://www.ncp.edu.pk/5th_particle_ws.htm

Organizing Committee

Chairman: Riazuddin
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M. Jamil Aslam

Deadline: 20 October, 2006

Second Step

In 2007 Rector CIIT Dr. S. M. Junaid Zaidi was in CERN and has discussions on CIIT participation in the ALICE experiment

Why CIIT ?

1.CIIT is an Institute of new information technologies.
2.CIIT has Department of Physics with High Energy Physics stream; Materials Science stream ; Radiation Physics stream ; Leaser Physics stream; Quantum Optic stream.
3.CIIT has Department of Computer Science .
4.CIIT is yang and fast improve Institute

CERN (Geneva Switzerland)

ALICE LHC **Project**

Heavy flavor production, quarkoni suppression, Percolation cluster formation, transparency and coalescence effects, jet production, central collisions, electronics,...

JINR (Dubna Russia)

NICO Nuclotron **MOU**

Mixed phase, cental collisions, electronics,...

CERN-CIIT

1

Proposal for collaboration between Comsats and the ALICE experiment at CERN

We propose to set up a collaboration between Comsats and the ALICE experiment at the CERN Large Hadron Collider. The collaboration would revolve around two subjects: the study of the production of heavy flavour particles and distributed computing.

1. Study of Heavy Flavour Production

Collisions of heavy nuclei at ultrarelativistic energies allo
study in the laboratory strongly interacting systems with
density in the several GeV/fm^3 range. The study of the p
systems provides crucial information on the behaviour of st
in a regime where the average distance between two hadr
than the hadron radius, and may ultimately shed light on
responsible for confinement and for the breaking of chi
strong interactions. The Large Hadron Collider (LHC), s
operating at CERN near Geneva this year, will allow to st
heavy ions at the unprecedented c.m.s. energy per nucleon-
of 5.5 TeV.
A particularly promising tool for investigating the propertie
formed in ultrarelativistic nucleus-nucleus collisions is pr
flavour particles, which allow to explore the medium with
mass and colouring charge. Suppression of the production o
momentum (p_T) charged particles (predominantly light
observed at the Relativistic Heavy-Ion Collider (RHIC) a
due to energy loss at the partonic level ("quenching", see
and references therein). Theoretically [2], the energy loss
to be parton-specific (stronger for gluons than for quarks du
higher colour charge) and flavour-specific (weaker for hea
quarks, due to the so-called dead-cone effect [3]). One
expect less high p_T quenching for heavy flavour particles, th
heavy quark jets, than for light flavour particles, that are
gluon and (mostly light) quark jets. Experimentally, howe
quenching of "non-photonic electrons", thought to be mo

2

heavy flavour decays, is found to be rather similar to that of light hadrons [4,5]. The interpretation of these results is complicated by the fact that, while the quenching effect is expected to be very different for charm and beauty quarks, there is no obvious way experimentally to disentangle the charm and beauty contributions to the RHIC non-photonic elect
At the LHC, where much higher heavy flavour yi
100 $c\bar{c}$ pairs and about 5 $b\bar{b}$ pairs per central Pb-Pb c
able to study the production of heavy flavour hadrons
at an unprecedented level of detail. In addition, u
detectors, ALICE is equipped with a vertex detect
System – which allows measuring the separation fro
the heavy flavour decay tracks, with a track impa
expected to be better than 50 μm for p_T > 1.3 GeV/c.
should be possible to fully reconstruct heavy flavour
separately the production of charm and beauty hadr
experiment also offers good electron identification
the information from the Transition Radiation Detec
of the candidate track in the Time Projection Cham
identified as electrons within a suitable range of tra
should be possible to extract a high purity sample o
comparison of the quenching for beauty and char
allow to isolate the parton mass dependence of
comparing the D and light hadron results one als
information on its colour charge dependence.
The Comsats group would like to get involved with
in order to participate in the physics analysis prog
measurement of charm and beauty hadrons in t
nucleus–nucleus collisions. The experiment will star
this year. This offers us the unique occasion to partic
new accelerator, in a new energy regime. In ord
opportunity, it is essential for the group to particip
right from the start. In order to ensure this, we pr
physicist to CERN for one year, in order to get acq
the data analysis, to provide a link between CER
crucial initial phase, while the collaboration is being
the transfer of the knowledge of the details of the AL
analysis to the rest of the group in Comsats.

3

2. Distributed Computing

The second area where we propose to set up a strong collaboration with ALICE is Distributed Computing. The rapid evolution of Distributed
Computing (Grid) technology is one of the major current IT devel
and CERN has taken a leading role in this field. We think a collabo
this area between Comsats and CERN would be of strategic valu
institute. We propose to proceed in parallel in the following directio

a) Inclusion of a Comsats cluster in the ALICE Grid

We would like to start the collaboration by setting up an ALICE G
in Comsats. We plan to start with an initial configuration of (minim
state-of-the-art dual processor boxes with (minimum 2) GB R
(minimum 0.5) TB of disk space per core, and to evolve to larger ca
We propose to proceed via the following steps:

- installation and certification of standard gLite/LCG software
- installation and certification of an LCG/ALICE VOBOX
- installation and certification of ALICE-specific Grid software
  VOBOX (together with ALICE experts)

After this step, Comsats would become a regular node in the ALICE
In preparation for these installations, we propose to appoint a per
system administrator competence to serve as liaison between
personnel and CERN. We estimate this task to require about 50
person's time. In preparation for the installations, we plan to
appointed person to CERN for 4 weeks, in order to acquire the
experience. Upon return to Comsats the expert would take the
performing the installations and in ensuring the maintenance of
cluster and the monitoring and tuning of its performance.

b) Collaboration of Comsats in the ALICE Core Offline

Besides participating in the ALICE Distributed Computing effort
the data processing nodes, we would also like to take an active ro
development of the ALICE Offline code. In order to start this colla
as efficiently as possible, we propose to send a young physicist
scientist to CERN to collaborate with the ALICE Core Offline gr
period of one year. In this way the person will be assigned to
compatible with his/her competence and will be trained in the work

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operation of the ALICE Grid. This person should be ready to then continue to be active in the ALICE / Comsat collaboration when back in Pakistan. He/she will have the task of taking the leading role in collaborating with the ALICE core offline group, and of supporting the community of Pakistani physicists working in ALICE.

3. Summary and cost estimate

In summary, we intend to set-up a collaboration with the ALICE experiment at CERN, by participating both in the physics analysis, in the field of heavy flavour physics, and in the computing effort, by setting up an ALICE Grid node in Comsats and by participating directly in the ALICE core offline development. We intend to apply for full membership in the Collaboration in the course of 2007.
To this end, we would like to apply for a sum of 107 kCHF, according to the following breakdown:

2 physicists at CERN for 1 week, to establish the collaboration	4 kCHF
1 physicist/comp. scientist at CERN for 4 weeks	5 kCHF
1 physicist at CERN for 1 year	49 kCHF
1 physicist/comp. scientist at CERN for 1 year	49 kCHF

These sums include estimates of the travel costs.
We intend to then follow up with additional contacts with CERN for the following year, we expect this to require a similar amount of money.
The machines for the Grid node will be financed separately.

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[1] C A Salgado and U A Wiedemann: Phys. Rev. D 68 (2003) 014008
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[3] Yu L Dokshitzer and D E Kharzeev: Phys. Lett. B519 (2001) 199
[4] S S Adler et al. (PHENIX Collaboration): Phys. Rev. Lett. 96 (2006) 032301
[5] B I Abelev et al. (STAR Collaboration): nucl-ex/0607012
[6] ALICE Collaboration: Physics Performance Report, Volume II. J. Phys. G 32 (2006) 1295

Project

Memorandum of Understanding
on Academic Exchange
Between
Joint Institute for Nuclear Research, Dubna, Russia
and
COMSATS Institute of Information Technology, Islamabad, Pakistan

The **Joint Institute for Nuclear Research,** Dubna, Russia (**JINR**) and the **COMSATS Institute of Information Technology**, Islamabad, Pakistan (**CIIT**) (hereinafter referred as **Parties**) have agreed as follows:

Both **Parties** are convinced that academic exchange and cooperation will promote the development of research and other academic activities in each organization.

Article 1

The **Parties** agree to promote research cooperation in the field of nuclear physics through the following:

- Exchange of researches
- Conducting joint research
- Holding joint organized symposia
- Exchange of information and academic publications

Article 2

Concrete proposals pertaining to the implementation of the exchange (based on the preceding Article 1) shall be made in close contact between both organizations to carry out the specific projects hereunder.

Article 3

Both **Parties** shall make efforts to raise funds to make programs for cooperation feasible.

Article 4

This Memorandum of Understanding (**MoU**) shall remain in force for a period of five (5) years from the date of the last signatures, with the understanding that it may be terminated by either party giving six month's written notice to the other party. The **MoU** may be extended or amended by the exchange of letters between the two parties. Such amendments, once approved by both parties, will become part of this Memorandum of Understanding.

Article 5

In the event of termination and amendment, the participants in the programs at such a time shall be permitted to complete their activities at the host institution in accordance with the terms of this Memorandum of Understanding.

Article 6

This **MoU** is executed in duplicate, both in Russian and in English versions respectively, both of which shall be deemed as originals.

The **Parties** hereto establish understanding by duly singing it as of the respective dates written below.

For:
Joint Institute for Nuclear Research

Dr. A.N. Sissakian
Director

Date:

For:
COMSATS Institute of Information Technology

Dr. S. M. Junaid Zaidi
Rector

Date: 13/X/200

Witness-I

Dr. Mais Suleymanov
Foreign Professor
Leader Scientific Researcher
JINR (Dubna), Russia

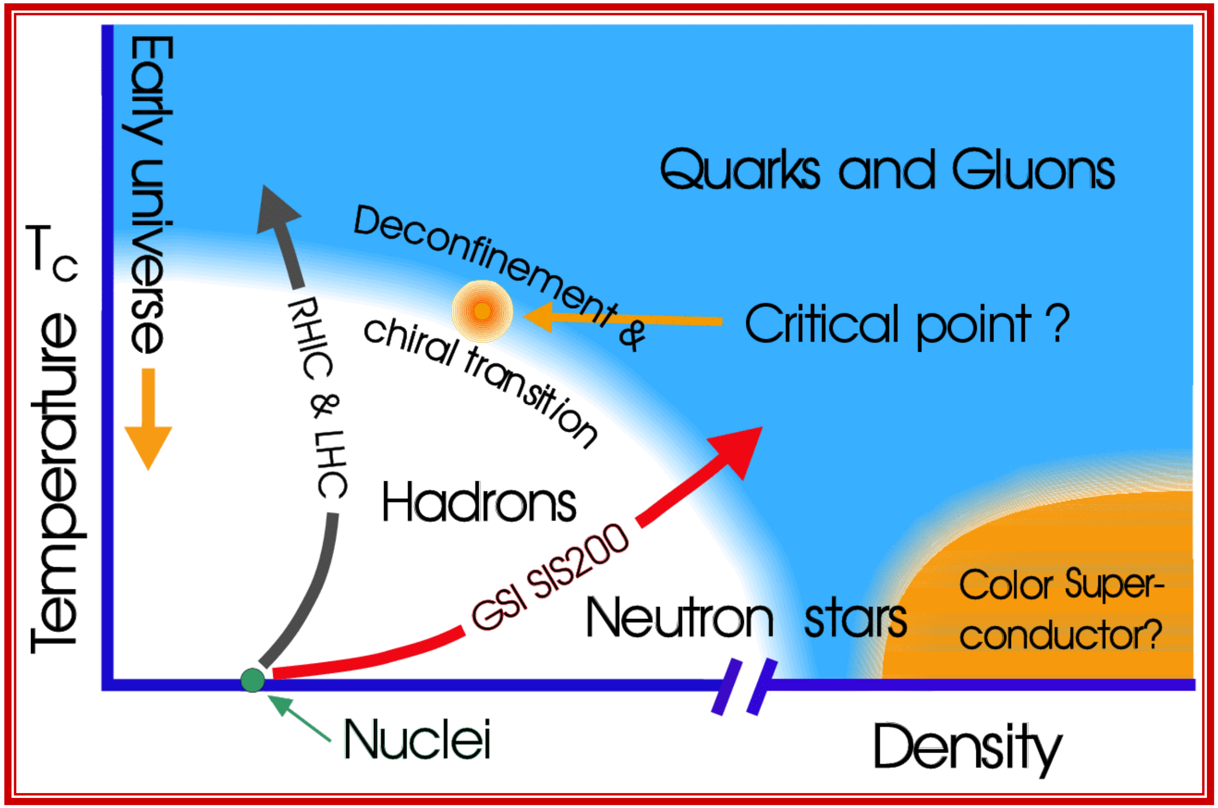
Witness-II

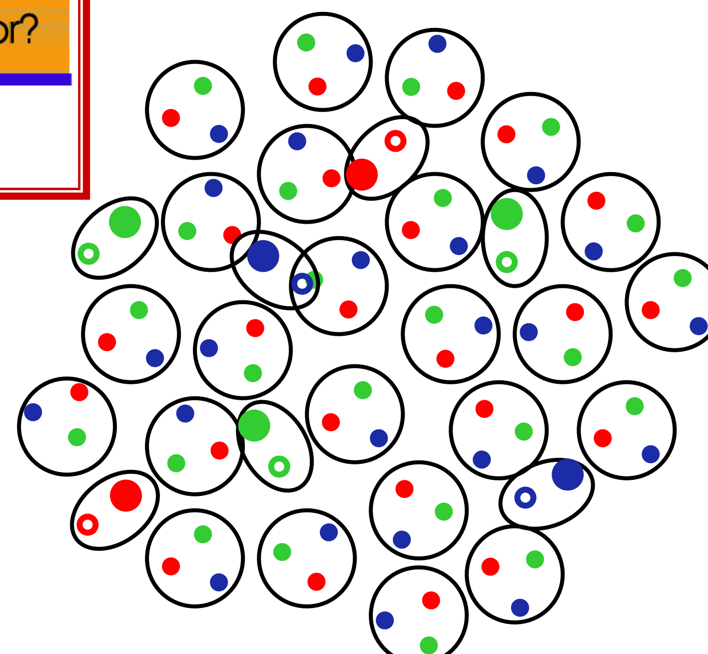
Dr. Ehsan Ullah Khan (T.I.)
Professor and Dean,
Faculty of Sciences
CIIT Islamabad – Pakistan

CIIT-CERN –JINR Collaboration : Responsible person is Prof. Arshad Bhatti, Chairmen of Department of Physics CIIT

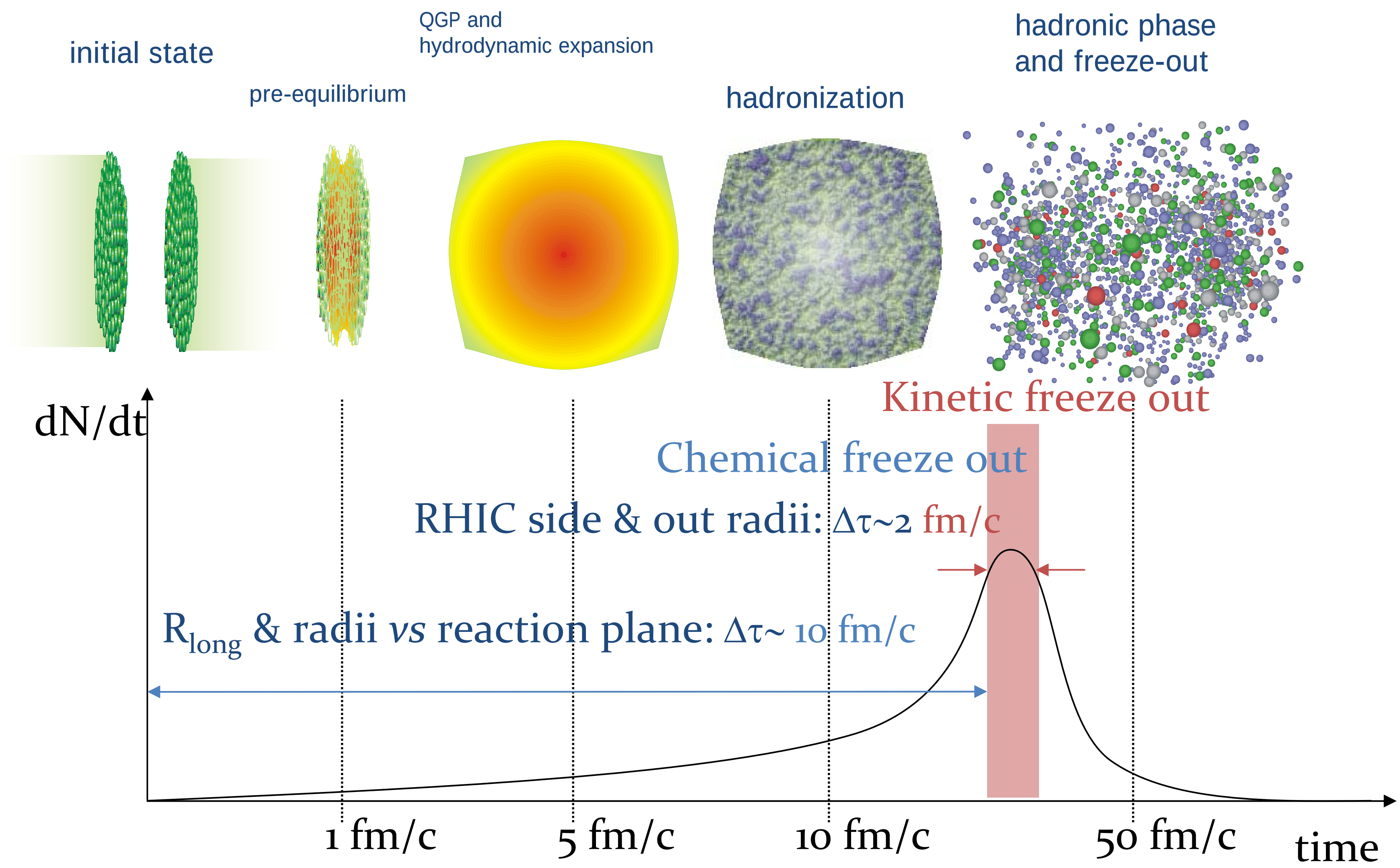
Our Suggestions for ALICE CERN

- **Percolation cluster formation – to fix onset state of deconfinement**
- **New criteria for fixing the centrality of collision**
- **Nuclear Transparency – to fix the onset state of QGP formation**
- **Light nuclear production – to fix the final state of QGP formation**
- **Jet Production in heavy ion collisions**
- **Applying the new methods on base of Random Matrix Theory to process the data.**


Quarks and Gluons
Early universe
Deconfinement &
chiral transition
Critical point ?
T_C
Temperature
RHIC & LHC
Hadrons
GSI SIS200
Neutron stars
Color Super-
conductor?
Nuclei
Density

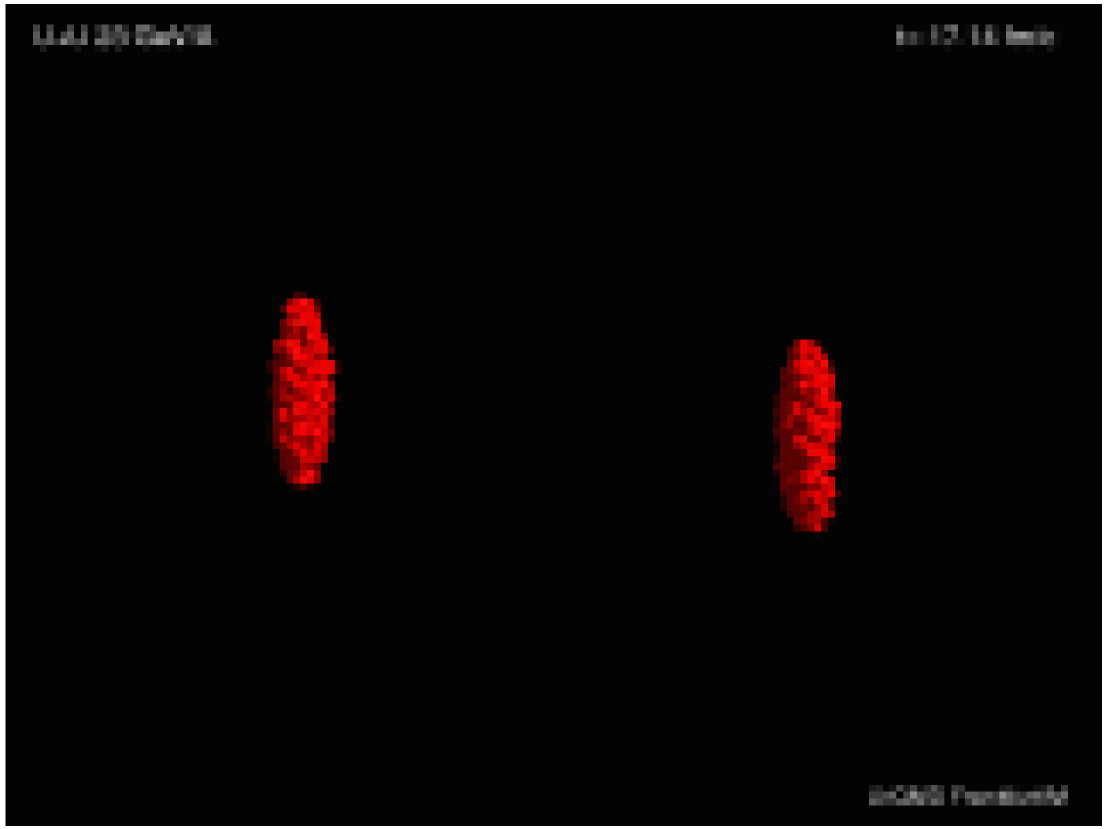


Expected evolution of HI collision vs RHIC data



Where could be QGP formed ?

Central collisions of ultrarelativistic heavy ions



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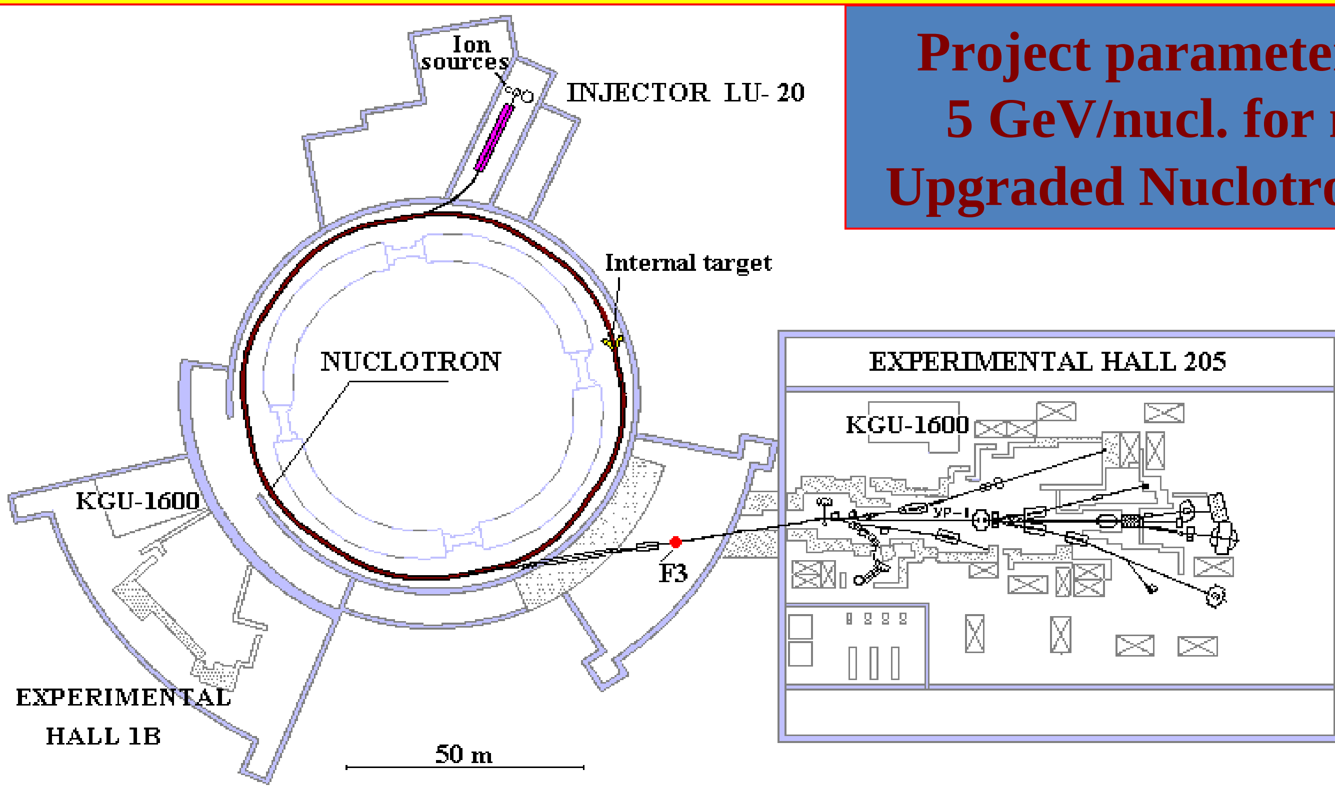
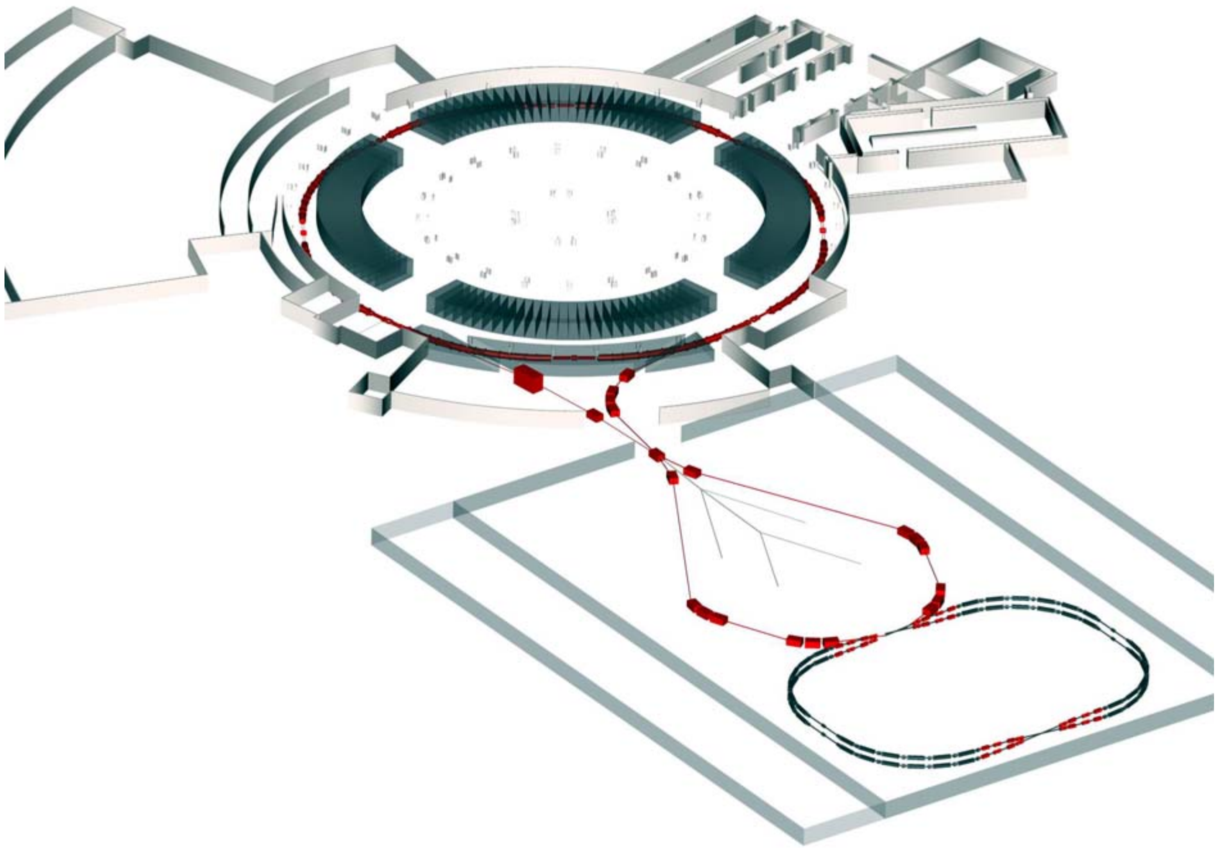
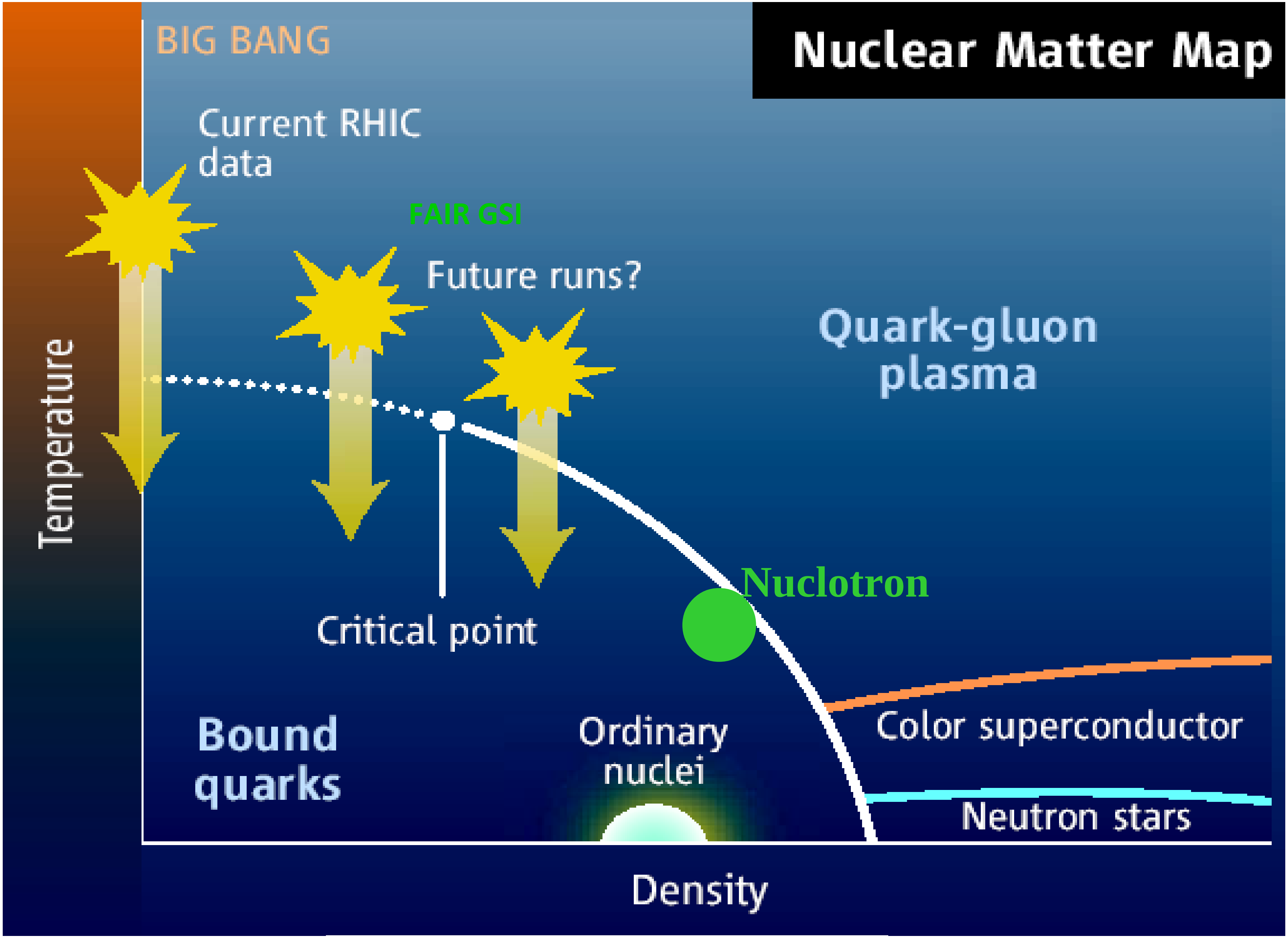
NUCLOTRON JINR



Project parameters: maximum energy 5 GeV/nucl. for nuclei with A ~ 200.
Upgraded Nuclotron: up to 10 GeV/nucl.



Layout of the accelerator facility



14 APRIL 2006 VOL 312 SCIENCE www.sciencemag.org

SEARCH FOR A MIXED PHASE OF STRONGLY INTERACTING MATTER AT THE JINR NUCLOTRON

A.N.Sissakian, A.S. Sorin, M.K. Suleymanov, G.M. Zinovjev. ***SEARCHING FOR A MIXED PHASE OF STRONGLY INTERACTING MATTER.*** *Selected Transactions of the University "DUBNA". Collected Articles., 44-68 (2004)*

A.N.Sissakian, A.S. Sorin, M.K. Suleymanov,V.D. Toneev, G.M. Zinovjev. ***Towards searching for a mixed phase of strongly interacting QCD matter at the JINR nuclotron.*** *E-Print Archive: nucl-ex/0601034 (2006).*

A.N.Sissakian, A.S. Sorin, M.K. Suleymanov,V.D. Toneev, G.M. Zinovjev. ***Search for a mixed phase of strongly interacting matter at the JINR nuclotron.*** *To appear in the proceedings of 8th International Workshop on Relativistic Nuclear Physics: From Hundreds MeV to TeV, Dubna, Russia, 23-28 May 2005 (http://lhe.jinr.ru/RNP_2005/306.pdf); e-Print Archive: nucl-ex/0511018 (2005).*

A.N. Sissakian, A.S. Sorin, M.K. Suleymanov. ***Search for the Mixed Phase of Strongly Interacted Matter at the JINR Nuclotron. Very High Multiplisity Phisics.*** *Proceedings of the Sixth International Workshop. Dubna, Russia, April 16-17, 2005, pp. 14-30*

A.N.Sissakian, A.S. Sorin, M.K. Suleymanov,V.D. Toneev, G.M. Zinovjev. ***Properties of strongly interacting matter and search for a mixed phase at the JINR Nuclotron.*** *Phys.Part.Nucl.Lett.5:1-6,2008*

1. **A study of the phase diagram in the domain populated by heavy-ion collisions with the bombarding energy ~ 5 ÷ 10 GeV/nucleon to search for the mixed phase seems to be a very attractive task.**

2. **The use of the isospin asymmetry as an additional conserving parameter to characterize the created hot and dense system attracts new interest in this problem (critical end-boundary hypersurface ?).**

3. **The available theoretical predictions are strongly model dependent giving rather dispersive results. There are no lattice QCD predictions for this highly nonpertubative region. Much theoretical work should be done and only future experiments may disentangle these models.**

4. **A JINR Nuclotron possibility of accelerating heavy ions to the project energy of 5A GeV and increasing it up to 10A GeV can be realized in two-three years. This will enable us to effort a unique opportunity for scanning heavy-ion interactions in energy, centrality and isospin asymmetry. It seems to be optimal to have the gold and uranium beams in order to scan in isospin asymmetry in both central and semi-central collisions at not so high temperatures.**

THEORETICAL AND EXPERIMENTAL STUDIES AT JINR

In this regard the following theoretical and experimental studies at JINR are considered as perspective:

1) investigation of the hadron properties in hot and/or dense baryonic matter. A spectral function change is expected, first of all for the σ meson as a chiral partner of pions, which characterizes a degree of chiral symmetry violation. The rare specific channels of ρ-meson decays are also quite attractive.

Solving these issues assumes a proper understanding of reaction mechanisms of high-energy colliding ions, knowledge of properties of interacting matter and its equation of state. In this respect more general research is in order;

2) analysis of multiparticle hadron interactions, targeted at the development of new statistical treatment as well as codes for space-time evolution of heavy nuclei collisions at high energies. Particular attention should be paid to signals of new phase formation during this evolution;

3) study of the system size, evolution time, freeze-out duration in the femtoscopic analysis (noticeable volume expansion is expected if the mixed phase is formed), scanning in atomic number and energy;

4) study of the energy and centrality dependences of the pion, hadron resonance and strange particle multiplicities, and the ratio of their yields, together with the transverse momentum, including K^--, K^*- and ϕ-meson spectra as well as manifestation of baryon repulsion effects on hadron abundances;

5) study of dilepton (electron and muon pairs) production to see in-medium modification of hadron properties at high baryon densities;

6) study of angular correlations in the transverse plane as well as radial, directed and elliptic flows;

7) fluctuation study of particle multiplicities, electric charges and transverse momenta (their energy dependences could give information on the phase transition range);

8) study of nuclear fragments characteristics vs centrality (change of behavior compared to the peripheral collisions is expected), universality of nuclear fragmentation;

9) energy and atomic number scan all characteristics of central collisions of heavy nuclei (this might allow one to obtain information on the equation of state of strongly interacting matter in the transition region), difference between central collisions of light nuclei and peripheral collisions of heavy ions.

The Joint Institute for Nuclear Research (JINR) is an international intergovernmental organization located in Dubna, not far from Moscow, was established within the framework of the Convention signed by the Plenipotentiaries of the governments of the Member States in March 1956 in Moscow.
The Joint Institute was created in order to unify the intellectual and material potential of Member States to study the fundamental properties of matter.
The JINR Charter was adopted in 1956 , the new edition of the Charter was readopted in 1992.
In accordance with the Charter, the Institute's activity is realized on the basis of its openness, mutually beneficial and equal cooperation for all interested parties to participate in research.
The aim of the Institute is :
- to carry out theoretical and experimental investigations on adopted scientific topics;
-to organize the exchange of scientists in carrying out research, of ideas and information by publishing scientific papers, by organizing conferences, symposia etc;
-to promote the development of intellectual and professional capabilities of scientific personnel;
-to maintain contacts with other national and international scientific organizations and institutions to ensure the stable and mutually beneficial cooperation;
-to use the results of investigations of applied character to provide supplementary financial sources for fundamental research by implementing them into industrial, medical and technological developments.

The results of investigations carried out at the Institute can be used solely for peaceful purposes for the benefit of mankind.

JINR is now a large multi-branch international scientific centre with activities incorporating fundamental research of the structure of matter, development and application of high technologies, and university education in the relevant fields.

The participation at the Institute can be realized in different forms: on the basis of membership, bilateral and multilateral agreements to perform separate scientific programs.

JINR Member States contribute financially to the Institute's activity and have equal rights in its management.

JINR has at present 18 Member States:

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Belarus
Bulgaria
Cuba
Czech Republic
Georgia
Kazakhstan
D.P.Republic of Korea
Moldova
Mongolia
Poland
Romania
Russian Federation
Slovak Republic
Ukraine
Uzbekistan
Vietnam

The main fields of the Institute's research are:

- *theoretical physics,*
- *elementary particle physics,*
- *relativistic nuclear physics,*
- *heavy ion physics;*
- *low and intermediate energy physics;*
- *nuclear physics with neutrons;*
- *condensed matter physics;*
- *radiation biology and radiobiological research;*
- *networking, computing and computational physics;*
- *educational programme.*

The principal facilities of the Institute for experimental investigations are:

- *nuclotron;*
- *U-200, U-400 and U-400M heavy ions cyclotrons;*
- *IBR-2 pulsed reactor with neutron ;*
- *synchrophasotron;*
- *phasotron;*
- *computer centre.*

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of Random Matrix Theory

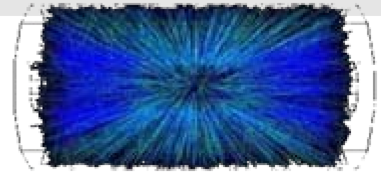
E.I. Shahaliev[1)] and .K.Suleymanov[1,2)]

1) High Energy Physics Laboratory, JINR Dubna Moscow region, 141980, Russia;

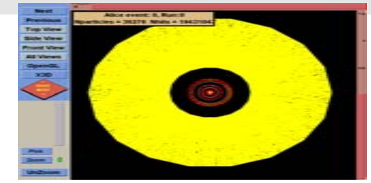
2)COMSATS Institute of Information Technology, Department of Physics centerline, sector 30, H8/1, Islamabad, Pakistan,44000

Over the last 25 years a lot of efforts have been made to search for new phases of strongly interacting matter. These Phases are relevant for understanding the evolution of the early Universe after Big Bang . Heavy ion collisions are of great importance since they open a way to reproduce these phases in the Earth laboratory. But in such new conditions the volume of information increases sharply as well as the background information. The latter can grow faster than useful signal (it is very essential in case of central collisions). So how can we get the useful information in this situation? Best way to do it would be to apply some principal new methods to process the data which could not be depend on the background of measurements and need any initial information about studying object.

an event expecting from:



Au+Au $\sqrt{s_{NN}}$ = 200 GeV
STAR RHIC BNL



PbPb $\sqrt{s_{NN}}$= 5.5 TeV
Alice LHC CERN

The Ref[C. E. Porter, Statistical Theories of Spectra: Fluctuations (Academic, New York, 1965)] introduced a method on the basic of Random Matrix Theory to explain the statistical fluctuations of neutron resonances in compound nuclei which doesn't depend on the background of measurements and need any initial information about studying object. To analyze the energetic levels of compound nuclei the function of distances between two energetic levels p($s_{i)}$ is defined. It can be defined using the general distributions for probability of all kinds of ensembles [T.Ghur,A.Muller-Groeling, and H.A. Weidenmuller, Phys.Rep. 299 (1998) 189]. At values of the index of universality ν =0 it will change to Poisson type distributions pointing to absence of any correlations in the system under consideration [O.Bohigas, Lecture Notes in Physics 263 Springer-Verlag, Berlin, (1986) 18.] and at the values of ν =1 it will change to Wigner type behavior directing to some correlation in the studying ensemble [M. L. Mehta, Random Matrices Amsterdam: Elsevier, 2004, Third Edition]. Experimentally observation of the changing of behavior of the distribution from Passion behavior to Wigner one ... a signal on

$$P(E_1,\cdots,E_N) \sim \prod_{n>m}(E_n-E_m)^{\nu} exp\left(-A\sum_n E_n^2\right)$$

$$\int_0^{\infty} p(s)ds = 1,$$

$$\int_0^{\infty} sp(s)ds = 1.$$

$$p(s) = \int_{-\infty}^{\infty} dE_1 \int_{-\infty}^{\infty} dE_2 P(E_1,E_2)\delta(s-|E_1-E_2|) =$$

$$= C\cdot\int_{-\infty}^{\infty} dE_1 \int_{-\infty}^{\infty} dE_2 |E_1-E_2|^{\nu} \exp\left(-A\sum_n E_n^2\right)\times\delta(s-|E_1-E_2|.$$

$s = |E_{n+1}-E_n|/D$ ν=0 -- Poisson

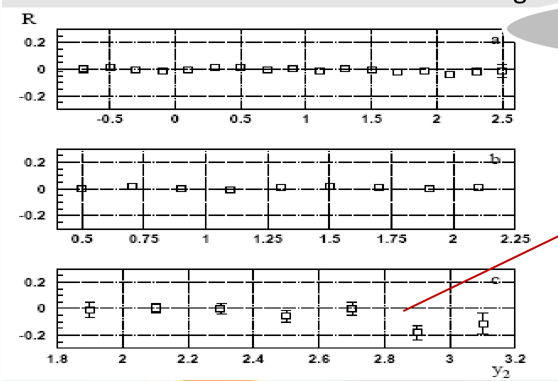
ν=1 -- Wigner $P_w(s) = \frac{\pi}{2}\cdot s\cdot e^{-\frac{\pi}{4}s^2}, \qquad s\geq 0$

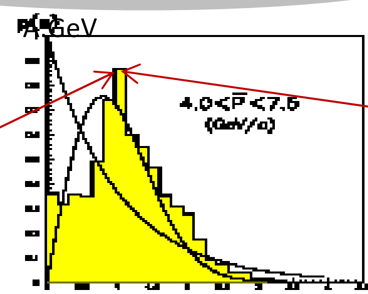
It is possible to propose that the energetic distributions of secondary particles produced in ultrarelativistic heavy ion collisions may be treated in analogy with eigenstates of a composite system, just like the eigenstates of the compound nucleus and apply the method mentioned above to get information on correlations.

First signal:

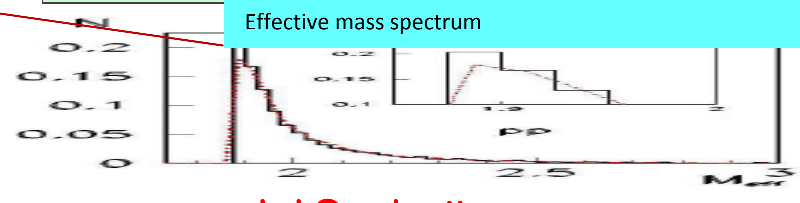
CC-interactions at 4.2 A GeV

C o r r e l a t i o n





Effective mass spectrum



shah@sunhe.jinr.ru

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Study for the Low p_T *Hadron Correlations Using New* Method on Basis of Random Matrix Theory

M.K. Suleymanov and E.I Shahaliev
COMSATS Institute of Information Technology, Department of Physics Islamabad Pakistan
High Energy Physics Laboratory, JINR Moscow region, 141980, Russia

Motivation : M. L. Mehta, Random Matrices, Second ed.(Academic, New York, 1991) introduced a method on the basics of Random Matrix Theory to explain the statistical fluctuations of neutron resonances in compound nuclei (C. E. Porter, Statistical Theories of Spectra: Fluctuations (Academic, New York, 1965))which doesn't depend on the background of measurements and need any initial information about studying object

$$P(E_1, \cdots, E_N) \sim \prod (E_n - E_m)^{\nu} exp\left(-A \sum E_n^2\right)$$

T. Ghur. A. Muller-Groeling. and H. A. Weidenmuller, Phys. Rep. 299, 189 1998.

$$s = |E_{n+1} - E_n| / D$$

the distance between two neighbor levels

D average distance between the levels

$$p(s) = \int_{-\infty}^{\infty} dE_1 \int_{-\infty}^{\infty} dE_2 P(E_1, E_2) \delta(s - |E_1 - E_2|) =$$

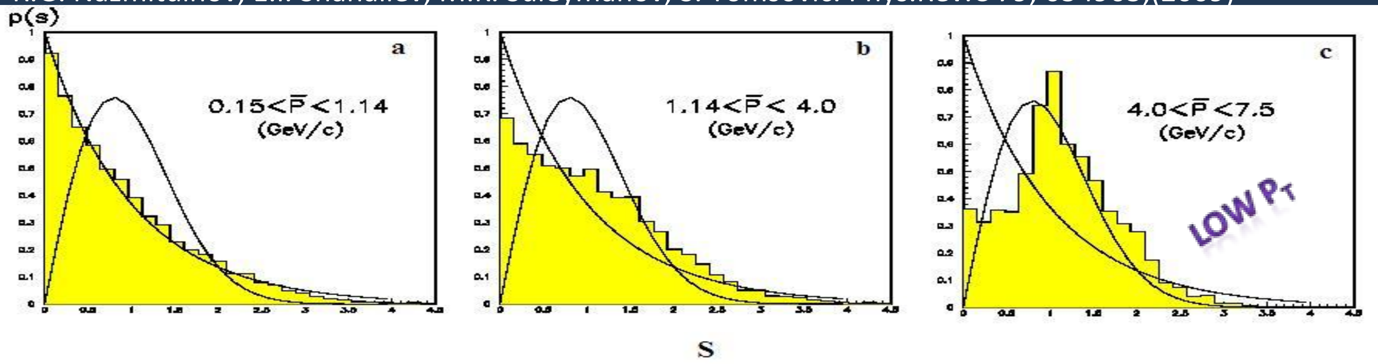
$$= C \cdot \int_{-\infty}^{\infty} dE_1 \int_{-\infty}^{\infty} dE_2 |E_1 - E_2|^{\nu} \exp\left(-A \sum_n E_n^2\right) \times \delta(s - |E_1 - E_2|$$

$$\int_0^{\infty} p(s) ds = 1,$$

$$\int_0^{\infty} s p(s) ds = 1.$$

ν is index of universality which can get the values 1,2 or 4 for different statistics. If ν=0 so we will get the Poisson type distributions

Sources : E. I. Shahaliev, R. G. Nazmitdinov, A. A. Kuznetsov, M. K. Syleimanov, and O. V. Teryaev, Physics of Atomic Nuclei 69, 142 (2006); R.G. Nazmitdinov, E.I. Shahaliev, M.K. Suleymanov, S. Tomsovic. Phys.Rev.C 79, 054905,(2009)



Experiment :
20407 ^{12}CC interactions at a momentum of 4.2A GeV/c ; 4226 events with more than ten tracks of charged particles.

Results: The *p*(*s*) distributions in region of low p_T (higher momentum) have Wigner type behavior , though for I (Fig.a) and II (Fig .b) regions they do the Passion type behavior.

Appearance the correlation for low p_T hadrons (the Wigner type behavior) can be connected with final state interaction effect for high momentum baryons.

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JOINT INSTITUTE FOR NUCLEAR RESEARCH

COMSATS Institute of Information Technology, Islamabad

Centrality of collision and method on basis of Random Matrix Theory

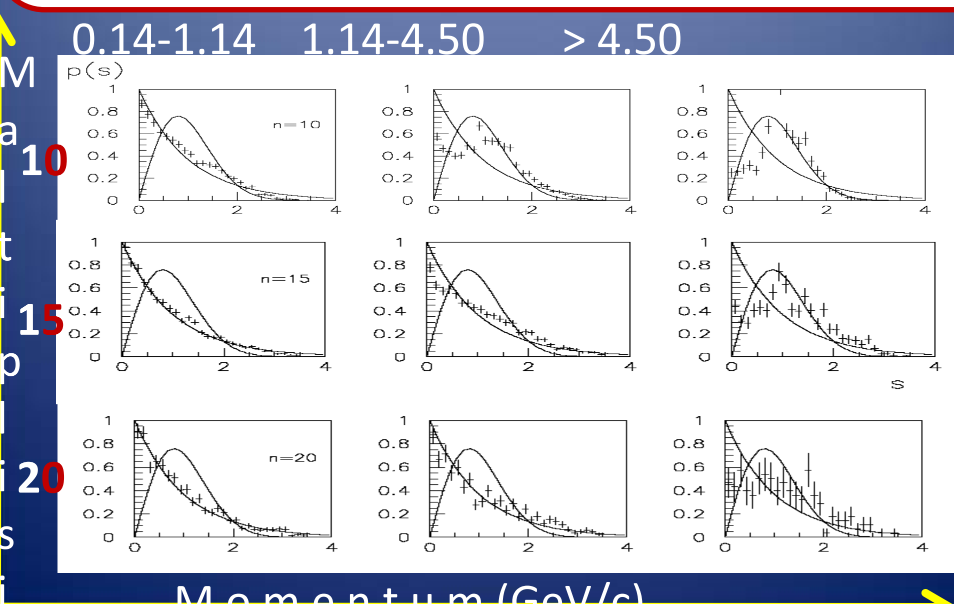
Z.Wazir, R. G. Nazmitdinov, E.I. Shahaliev, M.K. Suleymanov

We discuss the experimental results of applying the new method to separate the central ^{12}CC-interactions at a momentum of 4.2A GeV/c.

The method, based on the ideas of Random Matrix Theory [M. L. Mehta, Random Matrices, Second ed.(Academic, New York, 1991)].

The important advantage of the method is that it is free from unwanted

To analyze the experimental data on nucleus-nucleus collisions the function of distances between two particles energies *p*(*si*) is defined. It can be defined using the general distributions for probability of all kinds of ensembles [T.Ghur,A.Muller-Groeling, and H.A. Weidenmuller, Phys.Rep. 299, (1998) 189]**. At values of the index of universality *ν* = 0 the *p*(*si*) distributions have to get Poisson type behavior pointing to absence of any correlations in the system under consideration** [O. Bohigas, Lecture Notes in Physics 263 Springer-Verlag, Berlin, (1986) 18] **and at the values of *ν* = 1 it will get Wigner type behavior pointing to some correlation in the studying ensemble** [M. L. Mehta, *Random Matrices* (Amsterdam: Elsevier, 2004) Third Edition]**.**



We used the 20407 ^{12}CC interactions at 40 GeV/c [The BBCDHSSTTU-BW Collaboration, A. U. Abdurakhimov et al., Phys. Lett. B 39, 371(1972);.N. Akhababian et al., JINR Report No. 1-12114, 1979].

The distributions of p(s) for charged particles were studied as a function of a number of the particles in three momentum intervals of the particles.

The examples in pictures show that the behavior of p(s) function depend on the momentum and a number of charger particles. The last could be considered as some clue to use the method to separate the central collisions

Thank you