

# Joint Institute for Nuclear Research International Intergovernmental Organization



## Status of the NICA Project at JINR

A.N.Sissakian, A.S.Sorin  
(for the NICA collaboration)



Round Table Italy-Russia@Dubna  
December 18 – 19, 2009

# I. Status of the NICA project at JINR

The main goal of the NICA project is an experimental study of hot and dense nuclear matter and spin physics

These goals are proposed to be reached by:

- development of the Nuclotron as a basis for generation of intense beams over atomic mass range from protons to uranium and light polarized ions;



- design and construction of heavy ion collider with maximum collision energy of  $\sqrt{s_{NN}} = 11$  GeV and average luminosity  $\sim 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$  (for  $\text{Au}^{79+}$ ), and polarized proton beams with energy  $\sqrt{s} \sim 26$  GeV and average luminosity  $> 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$
- design and construction of the MultiPurpose Detector (MPD)

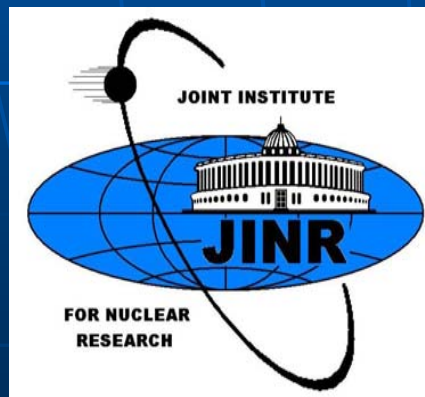
# The NICA Project Milestones

- **Stage 1: years 2007 – 2011**

- Upgrade and Development of the Nuclotron
- Preparation of Technical Design Report of the NICA and MPD
- Designing MPD and NICA elements

- **Stage 2: years 2010 – 2013**

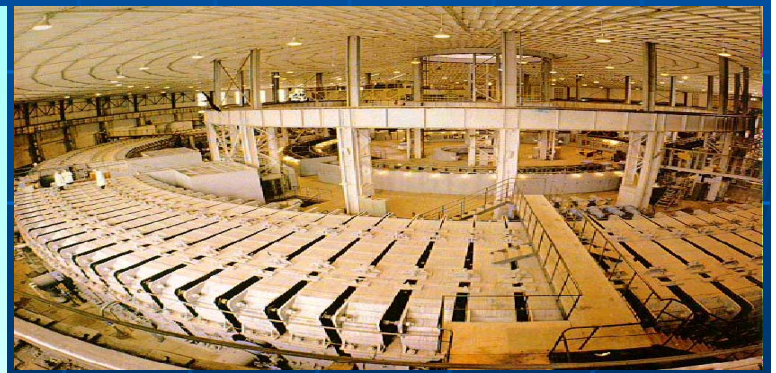
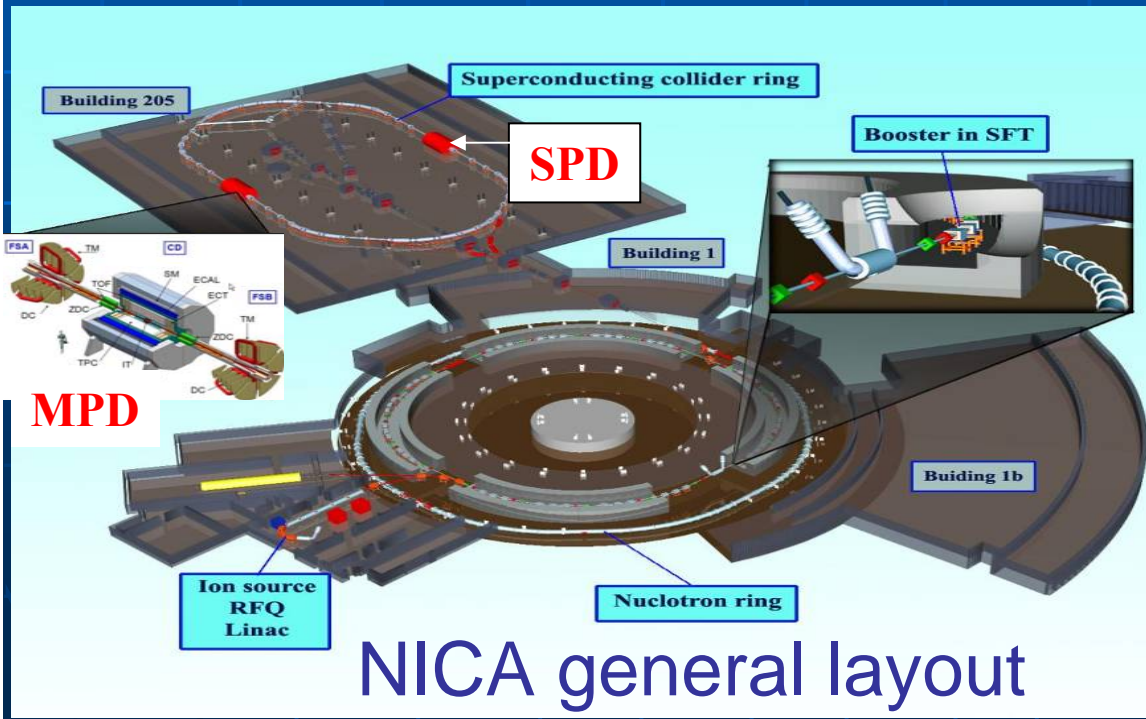
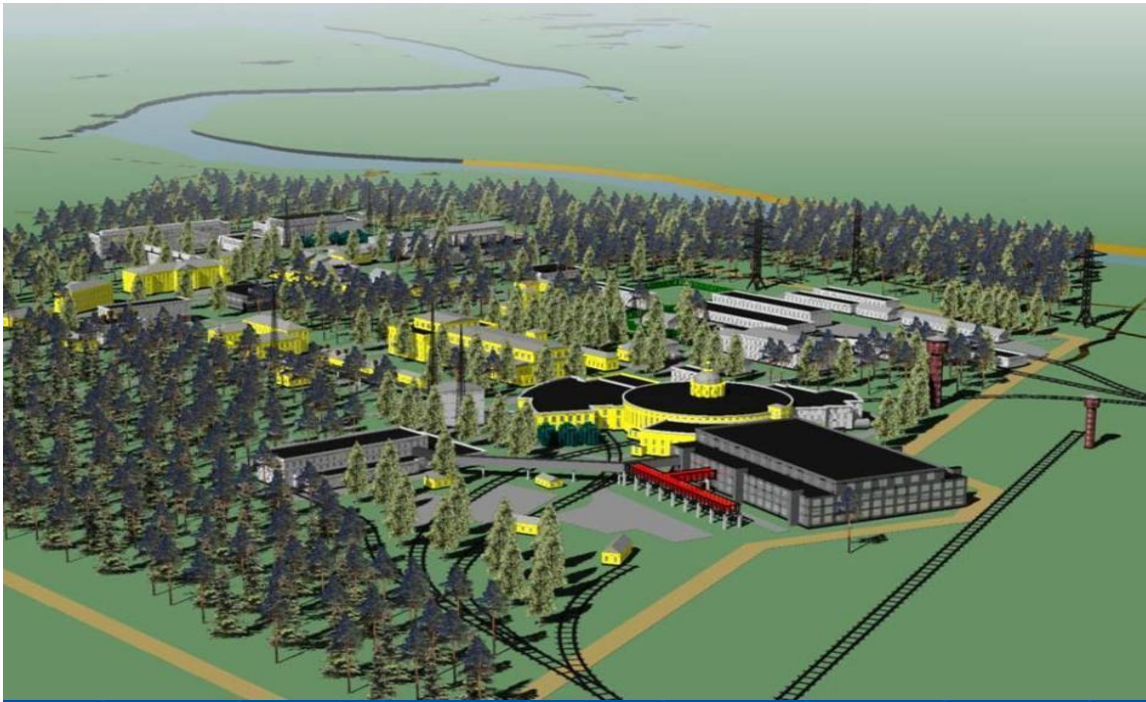
Manufacturing and mounting NICA and MPD



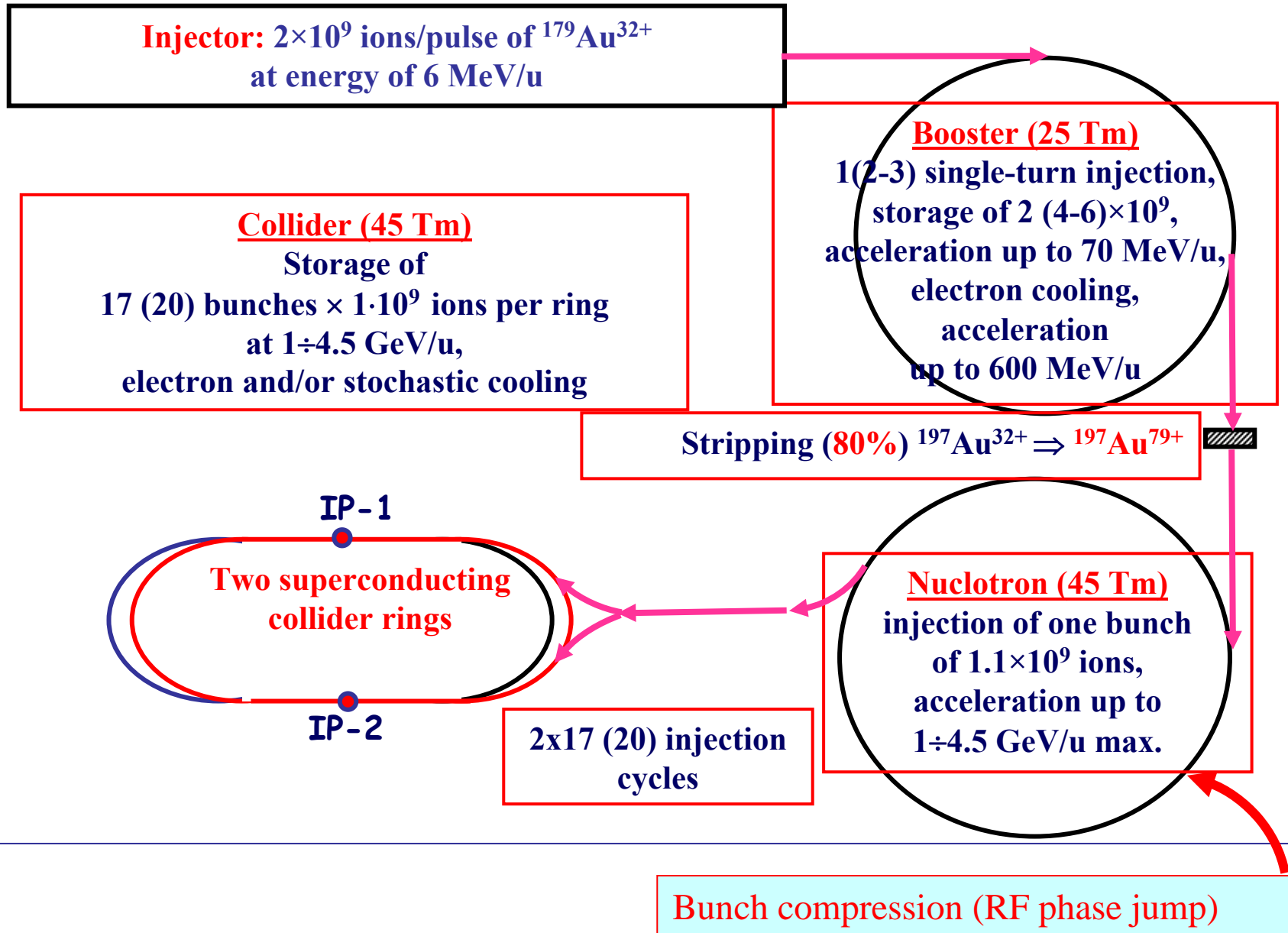
- **Stage 3: year 2014**
- Commissioning

- **Stage 4: year 2015**
- Operation





# Scheme of the NICA complex



# NICA Collaboration

- Joint Institute for Nuclear Research
- Institute for Nuclear Research  
Russian Academy of Science
- Institute for High Energy Physics,  
Protvino
- Budker Institute of Nuclear  
Physics, Novosibirsk
- ITEP
- All-Russian Institute for Electrotechnique
- Corporation “Powder Metallurgy” (Minsk,  
Belorussia):
- MoU with GSI
- FZ Jülich (IKP)
- BNL (RHIC)
- Fermilab
- *Open for extension ...*



Design and Construction of  
Nuclotron-based Ion Collider fAcility (NICA)

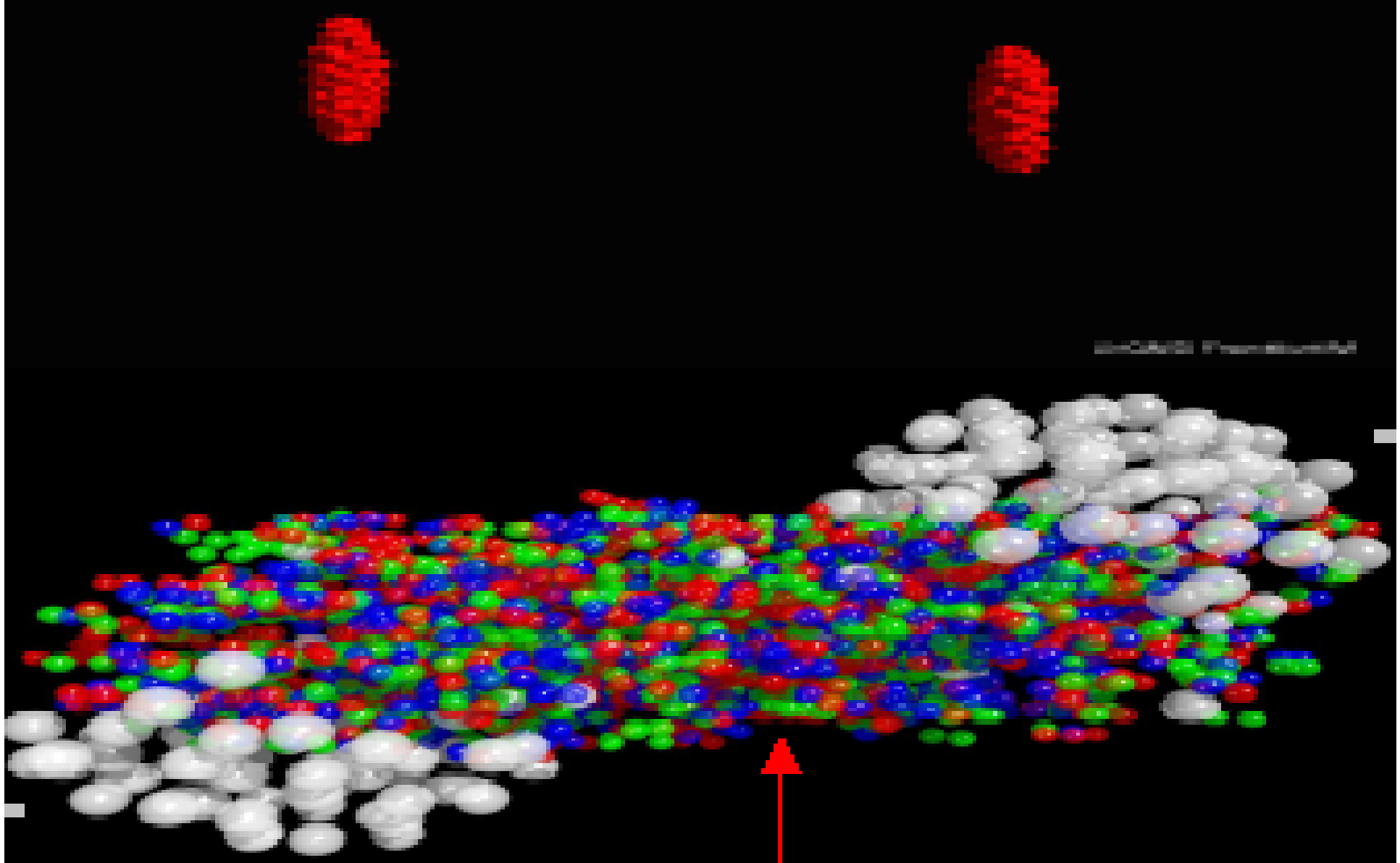
Conceptual Design Report



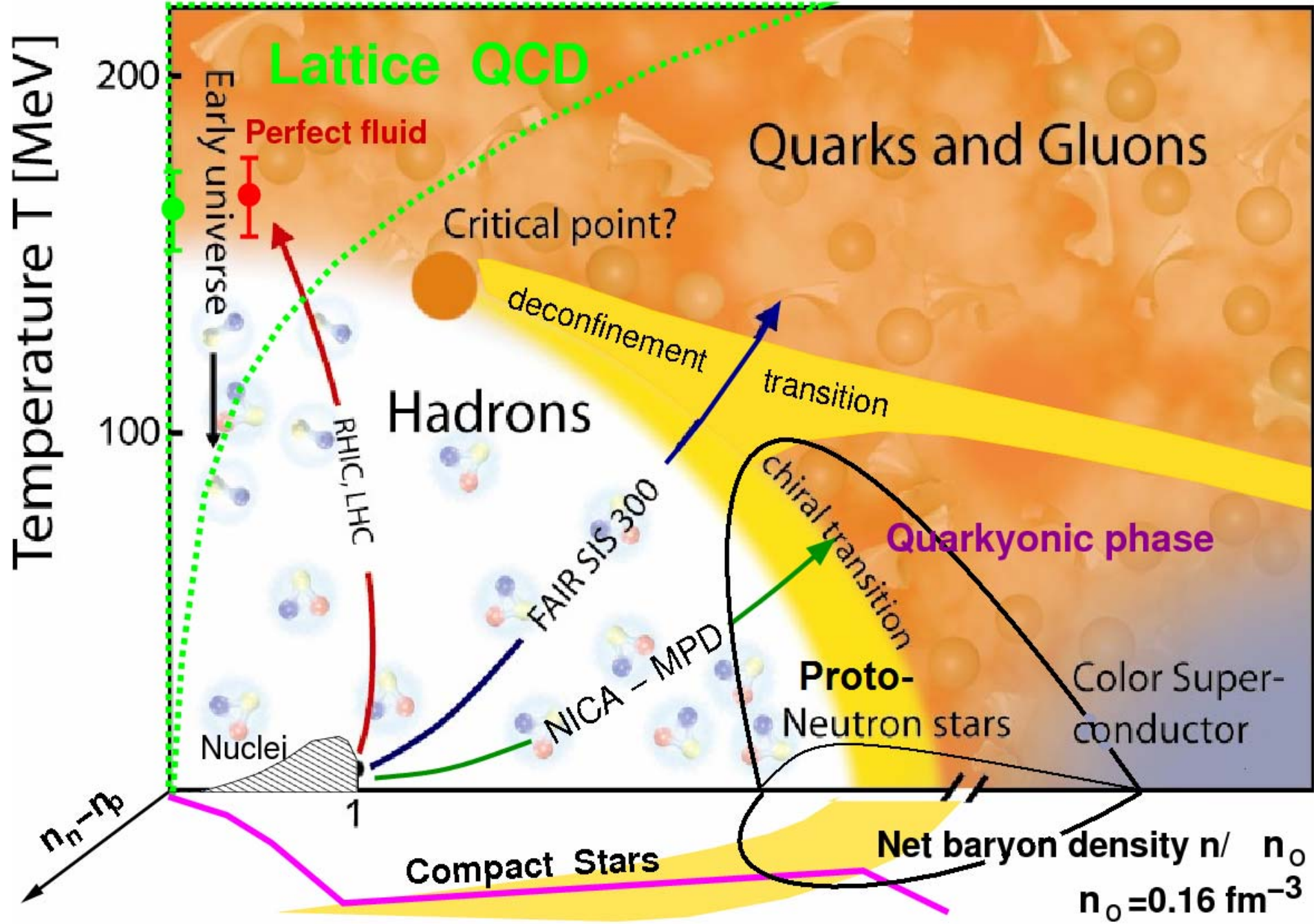
Dubna 2008

<http://nica.jinr.ru>

May 2009:  
the first draft of  
the NICA TDR  
is completed



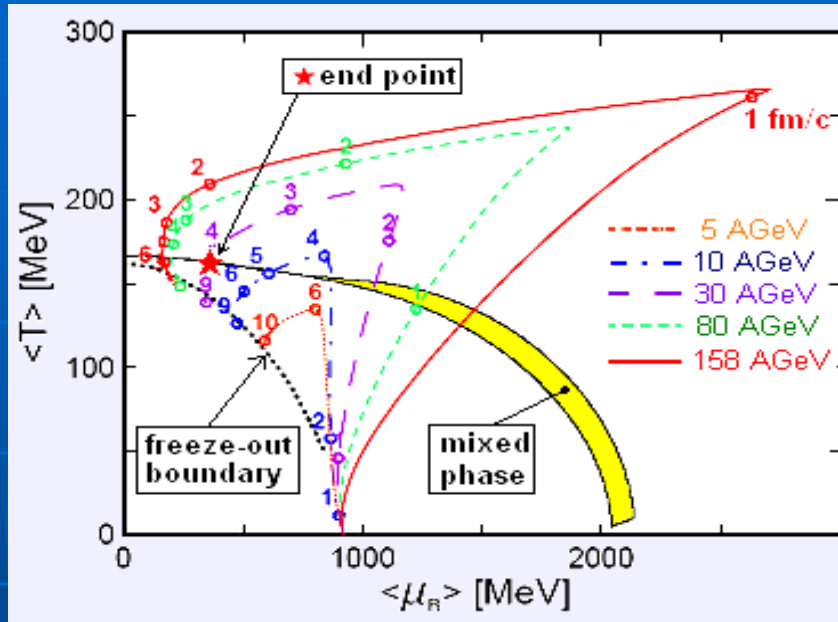
Protein Structure



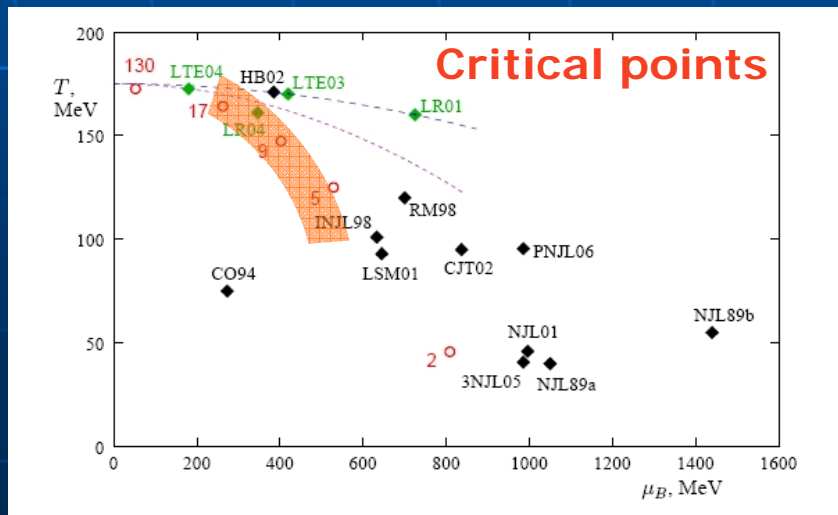
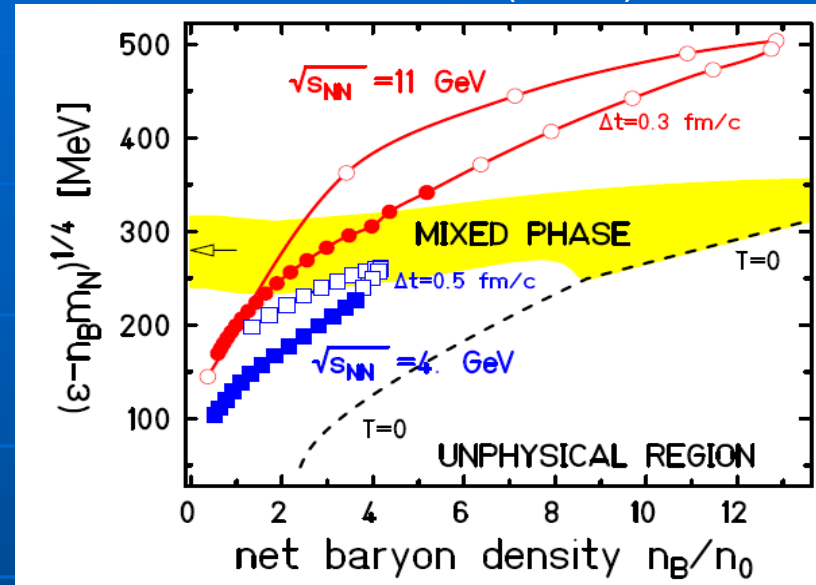


# Phase Diagram

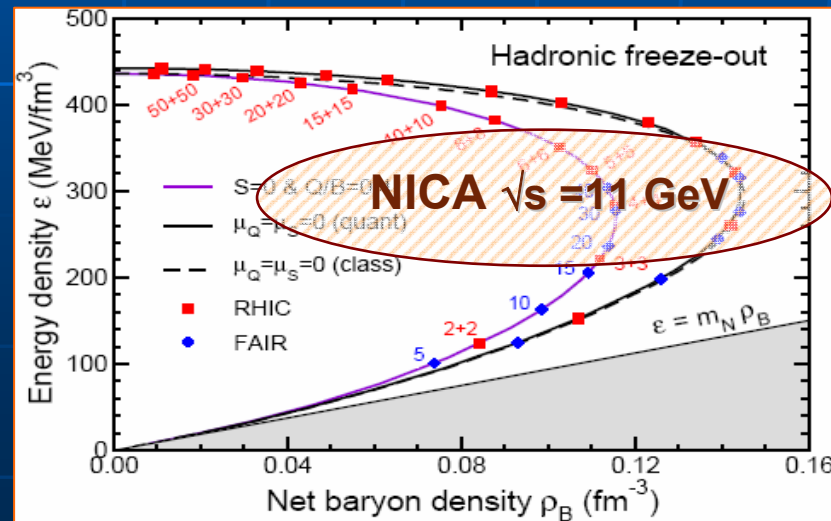
Yu.Ivanov, V.Russkikh, V.Toneev, 2005



MPD CDR (2009)



M.Stephanov, 2006



J.Randrup, J.Cleymans, 2006

# The NICA Physics Program

Study of in-medium properties of hadrons and nuclear matter **equation of state** including a search for possible signs of deconfinement and chiral symmetry restoration **phase transitions** and **QCD critical endpoint**

## Experimental observables:

**Scanning** in beam energy and centrality of **excitation functions** for

- ♣ Multiplicity and global characteristics of identified hadrons including **(multi)strange** particles
  - ♣ Fluctuations in multiplicity and transverse momenta
  - ♣ Directed and elliptic flows for various identified hadrons
    - ♣ particle correlations
    - ♣ Dileptons and photons

**From:** "T.D. Lee" <[tdl@phys.columbia.edu](mailto:tdl@phys.columbia.edu)>  
**To:** "Sisakian A.N." <[sisakian@jinr.ru](mailto:sisakian@jinr.ru)>  
**Sent:** Wednesday, January 14, 2009 7:01 PM  
**Subject:** Comment on the goals of the NICA heavy ion collider

**Dear Prof. Sissakian:**

The NICA heavy ion collider will be a very major step towards the formation of a new phase of quark-gluon matter.

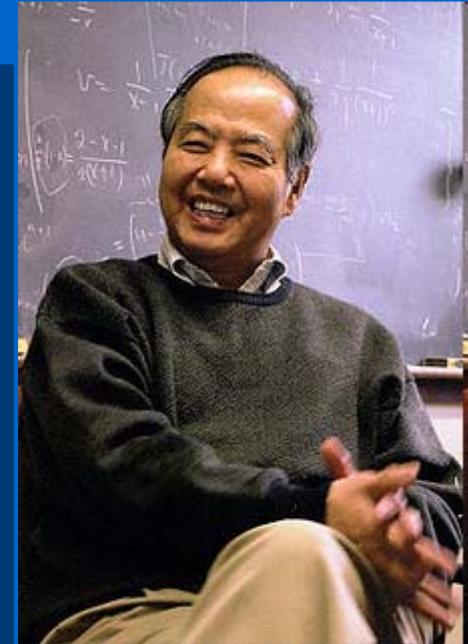
The goal of relativistic heavy ion physics is to modify the properties of the physical vacuum. Of particular interest is a possibility to create a phase of quark-gluon matter where some of the fundamental symmetries may be altered. Recent RHIC results indicate that there may be an evidence of parity violation (on an event-by-event basis) in heavy ion collisions at high energies. It would be of great importance to search for this phenomenon in the energy range covered by the NICA collider where a high baryon density is reached.

I am very much looking forward to the completion and future success of the NICA heavy ion collider. Warm regards and very best wishes,

T. D. Lee

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T. D. Lee  
University Professor  
Dept. of Physics - MC 5208  
Columbia University  
New York, NY 10027



# Spin Physics at NICA

EMC, 1987  $\Delta\Sigma = 0.12 \pm 0.17$

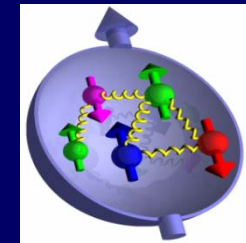
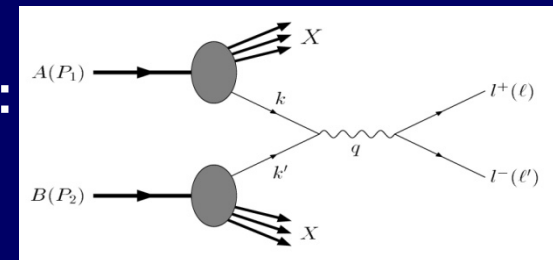


Polarization data has often been the graveyard for fashionable theories. If theorists had their way they might well ban such measurements altogether out of self-protection.

*J.D. Bjorken, 1987*

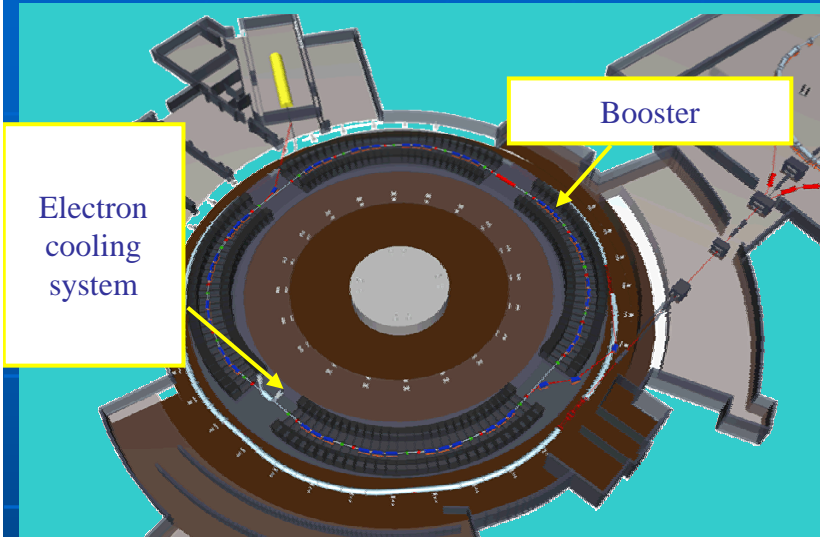
## Preliminary topics:

- *MMT-DY processes with L&T polarized p & D beams: extraction of unknown (poor known) PDF*
- *PDFs from J/y production processes*
- *Spin effects in baryon, meson and photon productions*
- *Spin effects in various exclusive reactions*
- *Diffraction processes*
- *Cross sections, helicity amplitudes & double spin asymmetries (Krisch effect) in elastic reactions*
- *Spectroscopy of quarkoniums with any available decay modes*
- *Polarimetry*



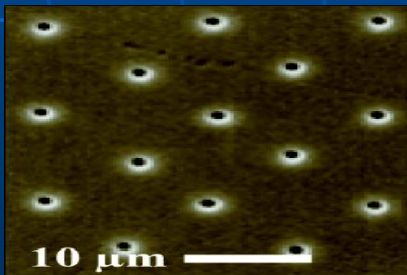
# Applied research at NICA

## Booster-synchrotron application to nanostructures creations:

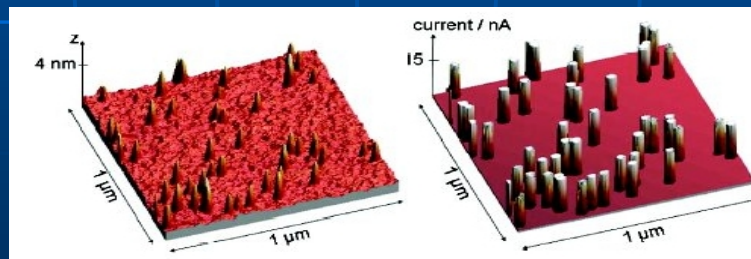


Design and parameters of booster, including wide accessible energy range, possibility of the electron cooling, allow to form dense and sharp ion beams. System of slow extraction provides slow, prolonged in time ion extraction to the target with space scanning of ions on the target surface and guaranty **high controllability** of experimental conditions.

## Ion-track technologies:



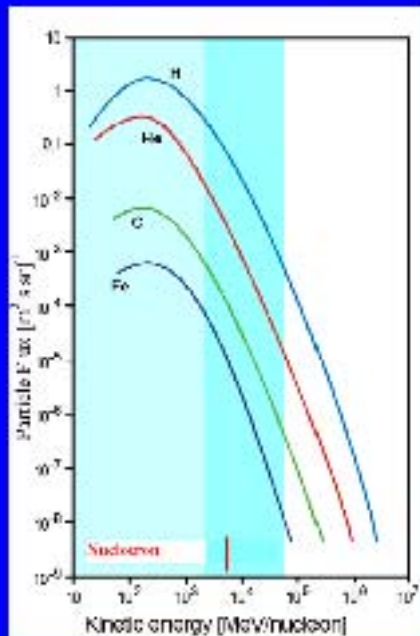
Ion tracks in a polymer matrix (GSI, Darmstadt)



Topography and current of a diamond-like carbon (DLC) film. The 50 nm thick DLC film was irradiated with 1 GeV Uranium ions.

Production of nanowires, filters, nanotransistors, ...

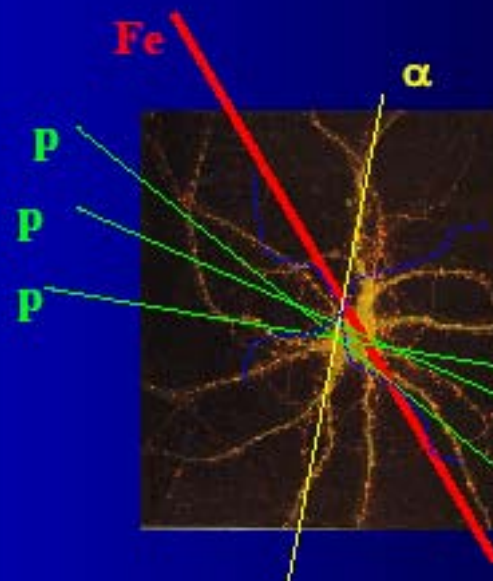
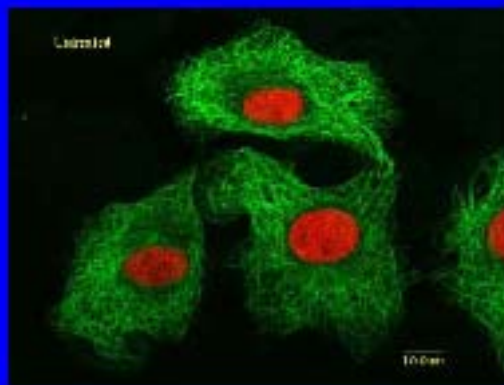
# NICA and Space Radiobiology



**Energetic spectrum of Galactic heavy ions**

## *Consequences of action of Galactic heavy ions for Mars mission:*

- ❖ Induction of cancer;
- ❖ Formation of gene and structural mutations;
- ❖ Violation of visual functions:
  - ❖ lesions of retina;
  - ❖ cataract induction;
- ❖ Violation of nervous system function.



# Concluding remarks

## Round Table Discussion I

Searching for the mixed phase of strongly interacting matter at the JINR Nuclotron

*July 7 - 9, 2005*

<http://theor.jinr.ru/meetings/2005/roundtable/>



## Round Table Discussion II

Searching for the mixed phase of strongly interacting matter at the JINR Nuclotron: Nuclotron facility development

JINR, Dubna, October 6 - 7, 2006

<http://theor.jinr.ru/meetings/2006/roundtable/>

## Round Table Discussion III

*Searching for the mixed phase of strongly interacting QCD matter at the NICA: Physics at NICA*

JINR (Dubna), November 5 - 6, 2008

<http://theor.jinr.ru/meetings/2008/roundtable/>



## Round Table Discussion IV

*Searching for the mixed phase of strongly interacting QCD matter at the NICA: Physics at NICA (White Paper)*

JINR (Dubna), September 9 - 12, 2009

<http://theor.jinr.ru/meetings/2009/roundtable/>



Draft v 1.01  
June 04, 2009

**SEARCHING for a QCD MIXED PHASE at the  
NUCLOTRON-BASED ION COLLIDER FACILITY  
(NICA White Paper)**

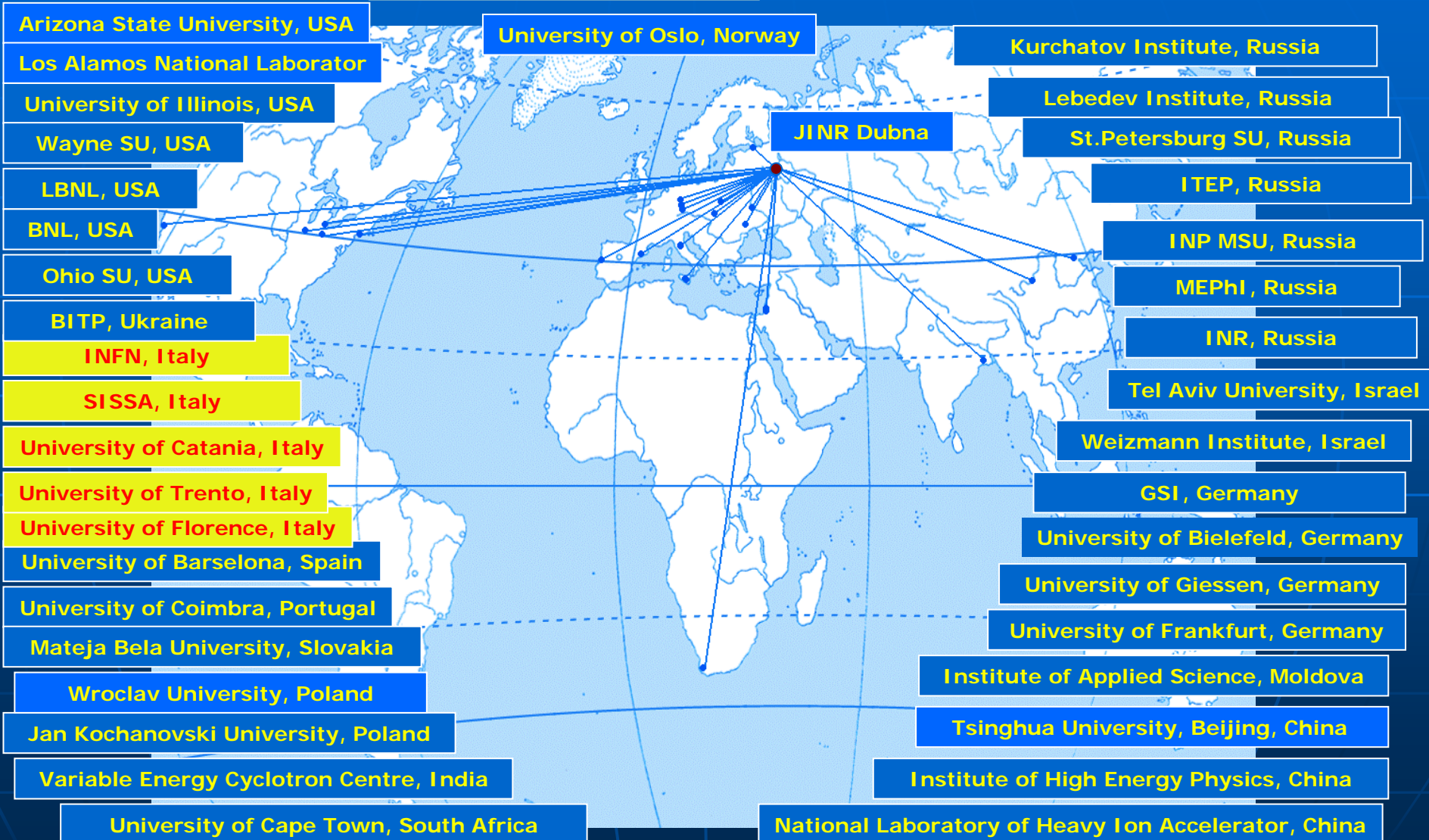
**Editorial board:**

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**D. Kharzeev**  
**A. Sissakian**  
**A. Sorin**  
**O. Teryaev**  
**V. Toneev**  
**I. Tserruya**



# Round Table IV and the NICA White Paper

85 authors from 39 scientific centers in 16 Countries (8 JINR members)



<http://theor.jinr.ru/twiki-cgi/view/NICA/WebHome>

# International Coordinating Committee meeting on the NICA Project



# Nuclotron-M Machine Advisory Committee and Honorary guests



# Visit of the GSI director Prof. Stoecker to JINR





# EDUCATIONAL PROGRAMS IN HEAVY ION PHYSICS



DIAS-TH: Dubna International Advanced School of Theoretical Physics  
Helmholtz International Summer School

## Dense Matter in Heavy Ion Collisions and Astrophysics

Bogoliubov Laboratory of Theoretical Physics  
JINR, Dubna, Russia, July 14-26, 2008

### TOPICS:

- Hadrons in the Medium
- Equation of state and Phase Transitions
- Hadron Production and Heavy Ion Collisions

### ORGANIZERS:

- J. Wambach (GSI, TU Darmstadt)
- V. Voronov (JINR)
- D. Blaschke (JINR, U Wroclaw)

### LOCAL ORGANIZERS:

- A. Sorin (JINR)
- J. Schmelzer (U Rostock, JINR)
- V. Zhuravlev (JINR)
- V. Skokov (sc. secretary, JINR)
- A. Dolya (secretary, JINR)

### SUPPORTED BY:

- Helmholtz Association
- Helmholtz Centers DESY and GSI
- Joint Institute for Nuclear Research
- Russian Foundation for Basic Research

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WWW: [www.jinr.ru](http://www.jinr.ru)

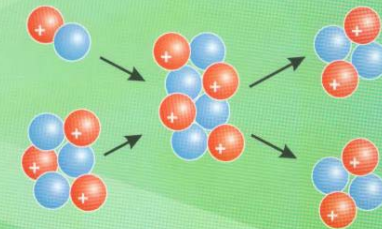
Dubna International Advanced  
School of Theoretical Physics



МОСКОВСКИЙ  
ИНЖЕНЕРНО-ФИЗИЧЕСКИЙ ИНСТИТУТ  
(ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ)

## Введение в физику тяжелых ионов

БИБЛИОТЕКА ЯДЕРНОГО УНИВЕРСИТЕТА



# Prospect: Students and NICA



**School**

**“Dense matter in HIC”, August 16 -22, 2010**

**and**

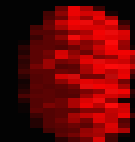
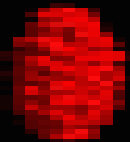
**Conference**

**“Critical Point and Onset of Deconfinement”**

**August 23 – 29, 2010**

**JINR, Dubna**

**<http://theor.jinr.ru/meetings/2010/>**



# Welcome to the collaboration!

