Joint Institute for Nuclear Research
International Intergovernmental Organization

NICA Project at JINR

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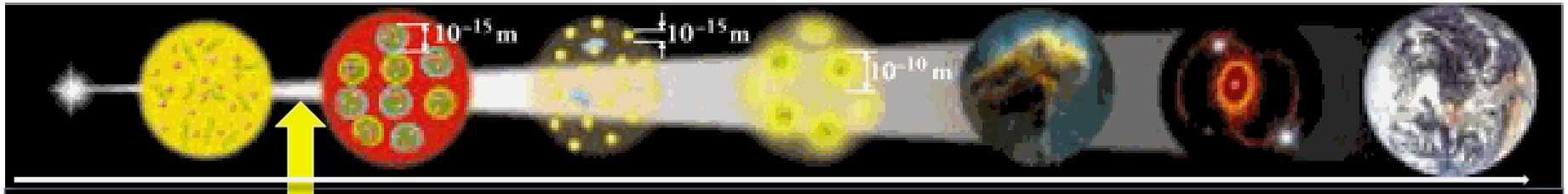
I. Meshkov, A. Sorin, G. Trubnikov
(for the NICA collaboration)

NICA

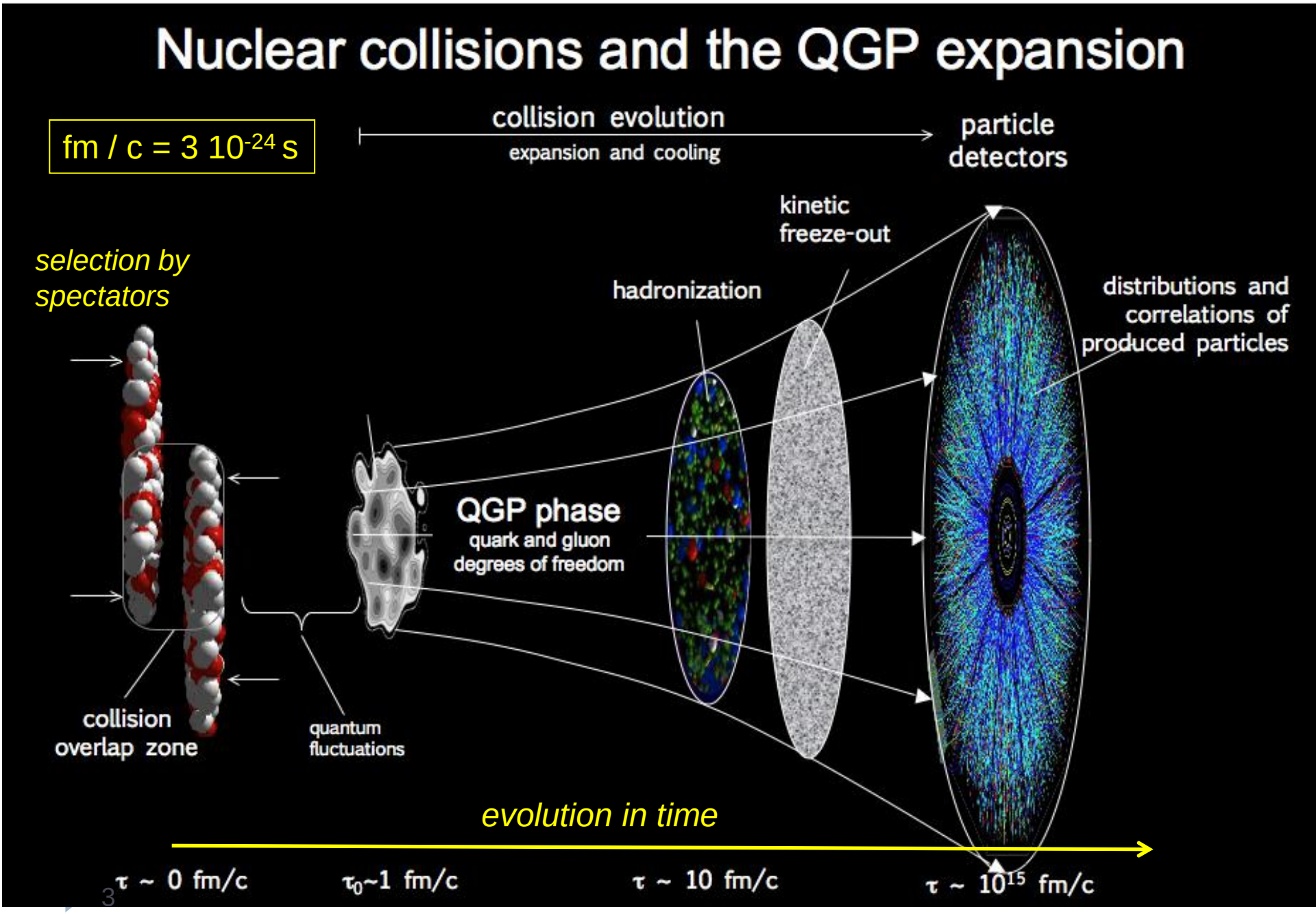
XIIIth DIAS-TH Winter School "Heavy Ion Physics: From LHC to NICA"
JINR, Dubna, February 3, 2017

Mini “Big Bang” in Laboratory

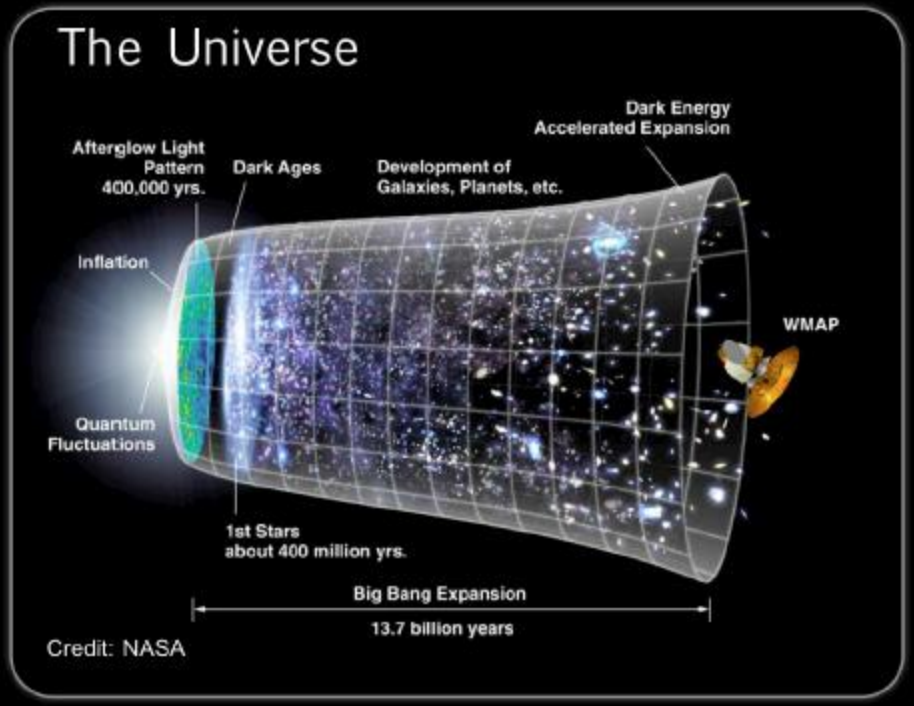


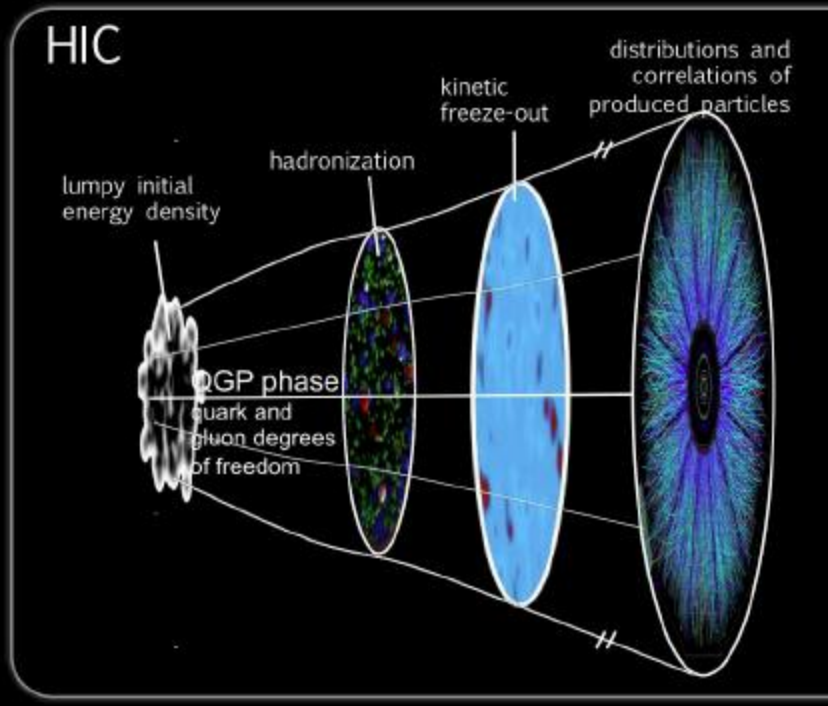
Big Bang	Q-G plasma	p & n formation	low mass nuclei formation	neutral atom formation	star formation	dispersion of massive elements	Today
T	$>10^{12}$ K	10^{12} K	10^{9} K	4000 K	20 - 3 K	< 20 K	3 K
time	10^{-6} s	10^{-4} s	3 min	400 k yr	10^{9} yr	$> 10^{9}$ yr	15 10^{9} yr

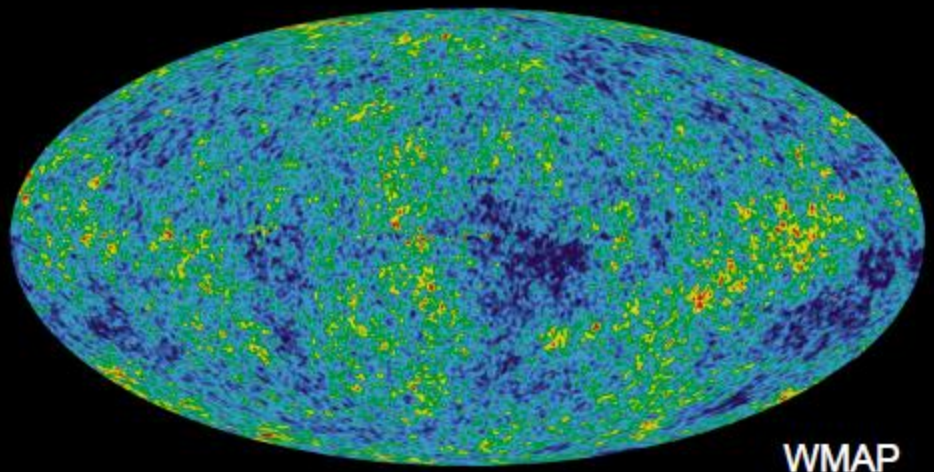
Nuclear collisions and the QGP expansion



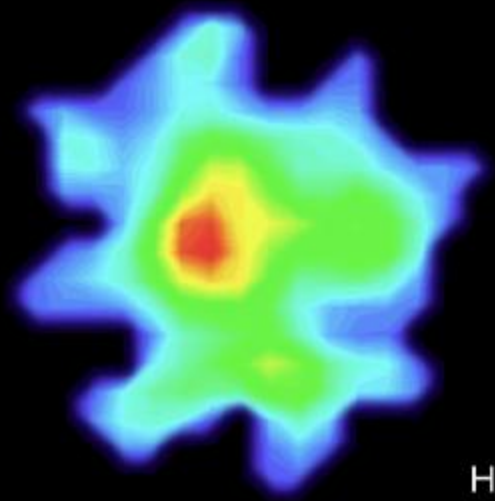
The Big Bang vs the Little Bangs





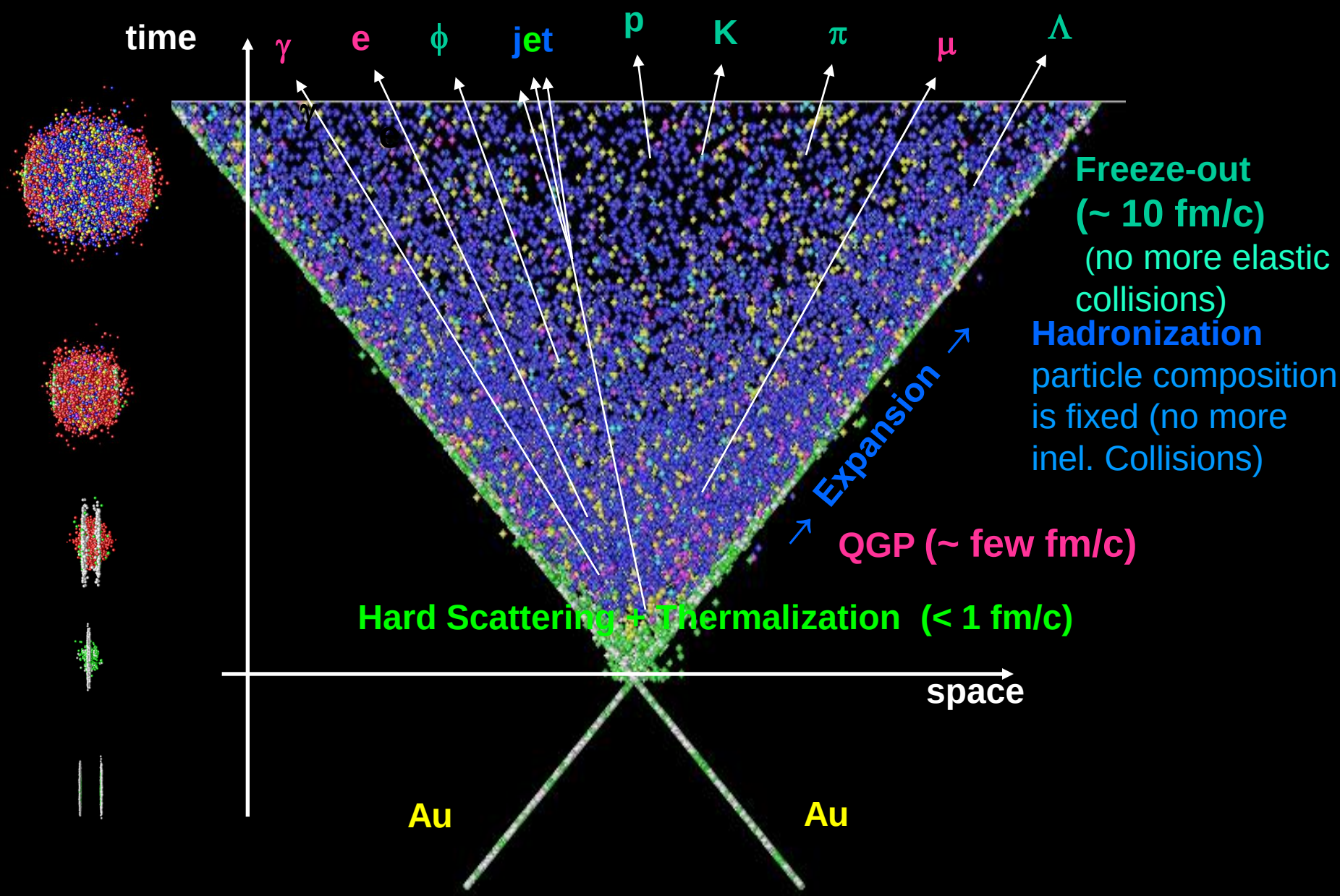


WMAP

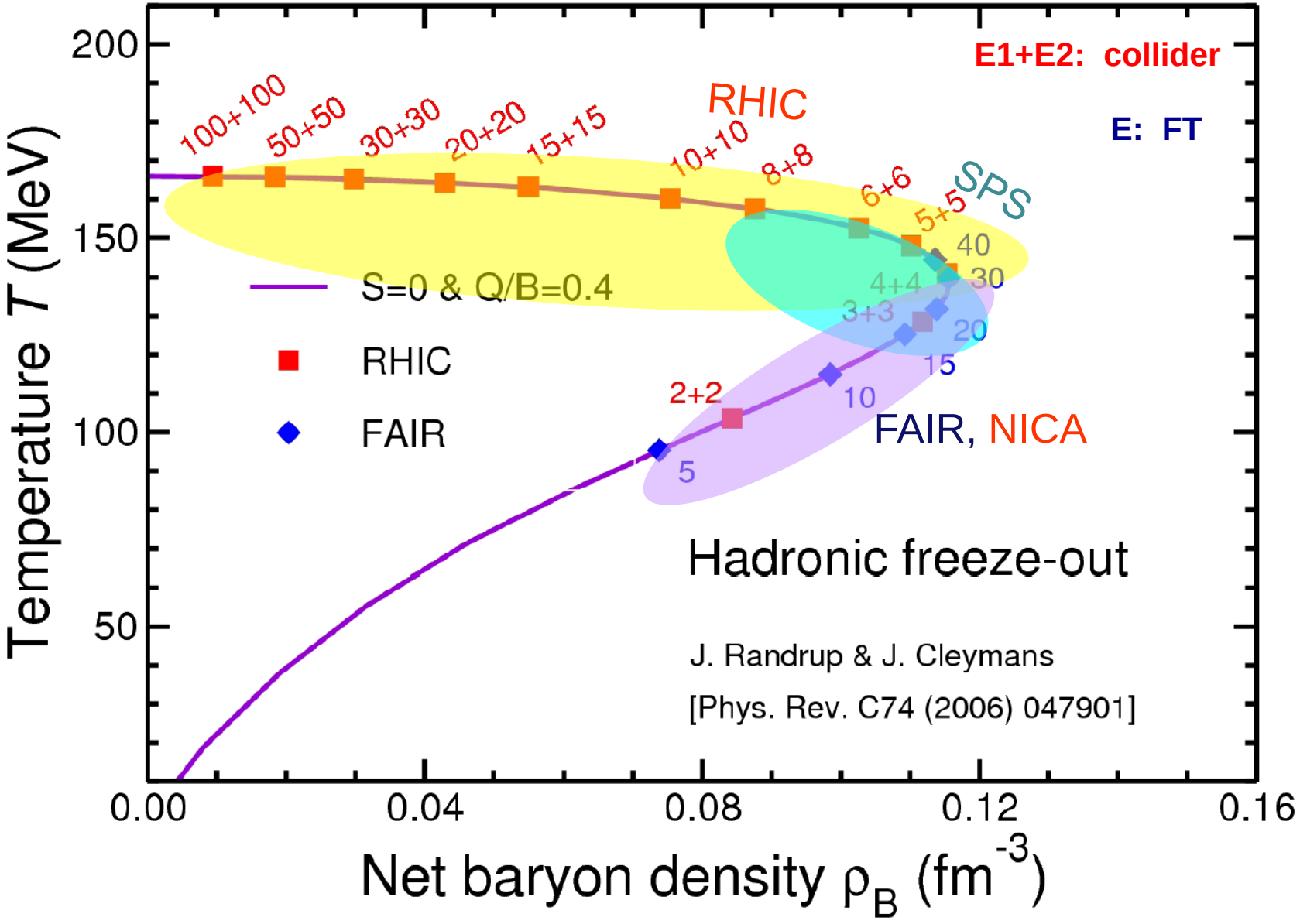


HIC

Space-time Evolution of the Collisions



Freeze-out conditions

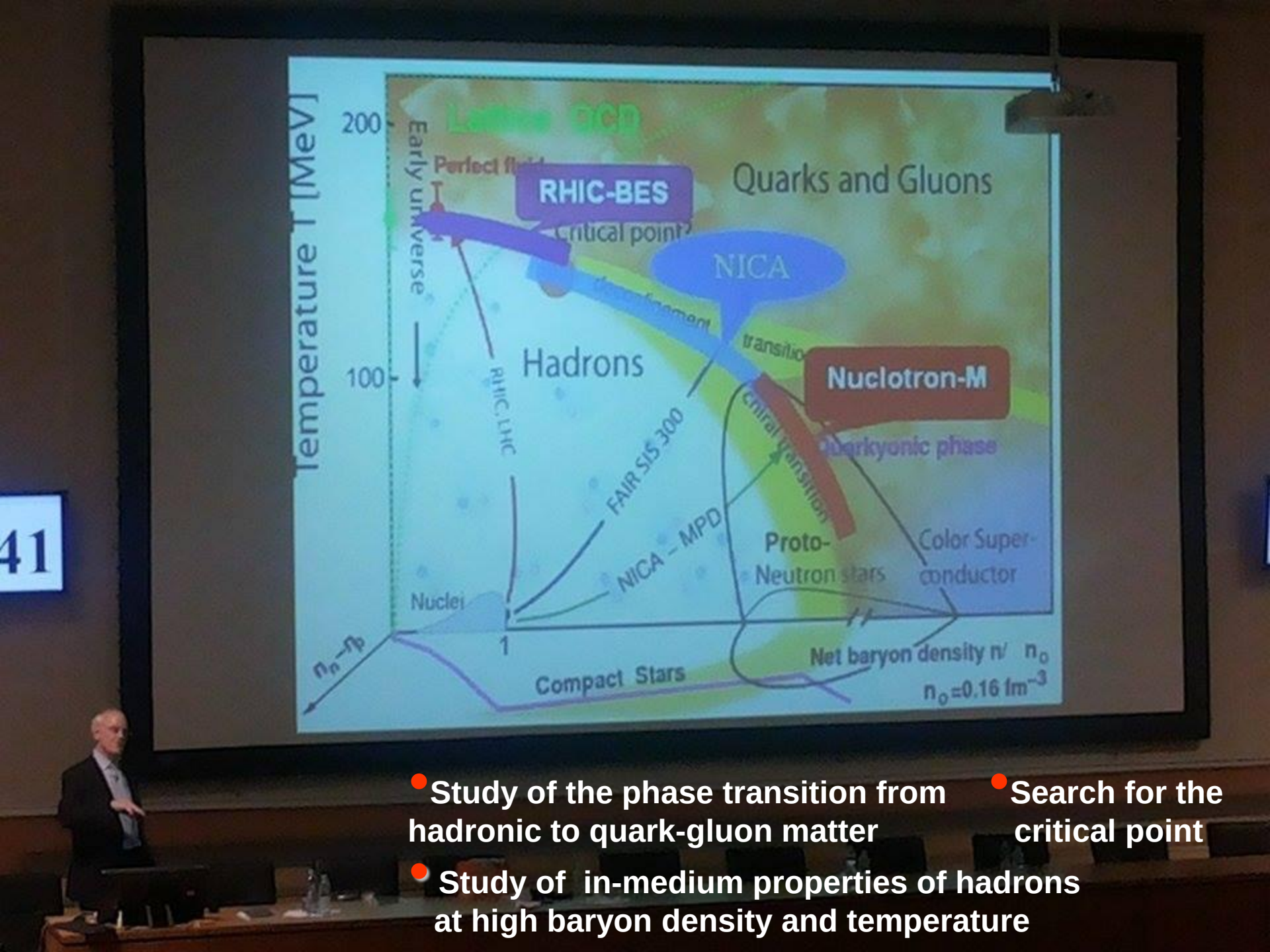


“Hilbert Problems” of Dense Matter Physics:

- Which phases?
- Which degrees of freedom?
- Nature of the (spin) nucleon?
- How hadronization proceeds?
- ...

Challenging questions:

- Character of phase transitions (if any)?
- Signals for 1st order phase transition?
- Critical Point?
- When does the perfect fluid turn on?
- Duality of dynamical and thermal descriptions?
- Global polarization in HIC?
- ...



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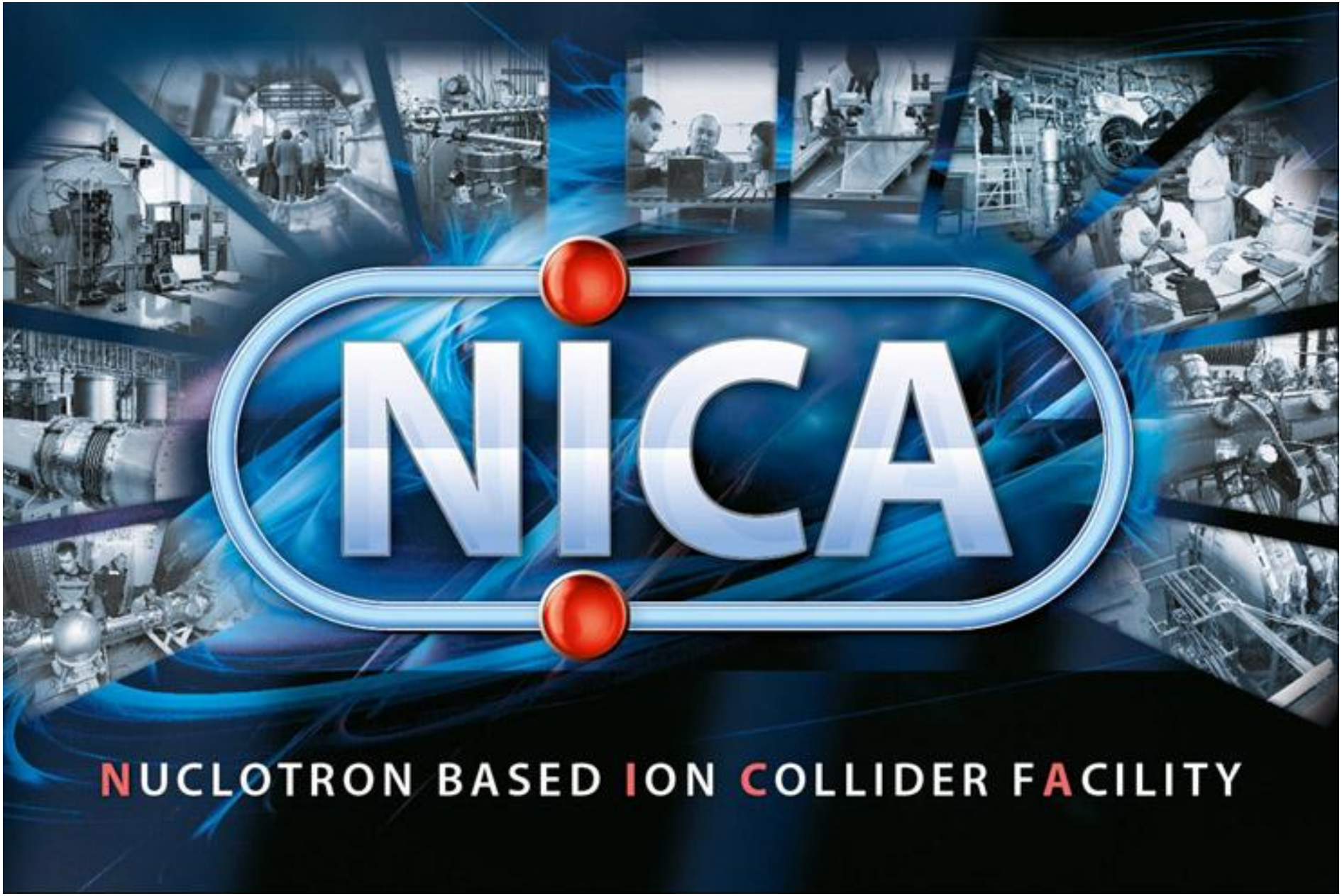
- Study of the phase transition from hadronic to quark-gluon matter
- Search for the critical point
- Study of in-medium properties of hadrons at high baryon density and temperature

Dense QCD Matter Physics

- **Nuclear equation-of-state, new forms of matter at high densities?**
  What are the properties and the degrees of freedom of QCD matter at neutron star core densities?
- **Hadrons in dense matter:**
  What are the in-medium properties of hadrons?
  Is chiral symmetry restored at very high baryon densities?
- **Production of single and double hypernuclei**
  How far can we extend the third (strange) dimension of the nuclear chart?
- **Strange matter:**
  Does strange matter exist in the form of heavy multi-strange objects?



http://nica.jinr.ru/


NICA

NICA (Nuclotron based Ion Colider fAcility)

– the flagship project in HEP

of Joint Institute for Nuclear Research (JINR)

Main targets of "NICA Complex":

- ***study of hot and dense baryonic matter***
- *investigation of nucleon spin structure, polarization phenomena*
- *development of accelerator facility for HEP @ JINR providing intensive beams of relativistic ions from p to Au*

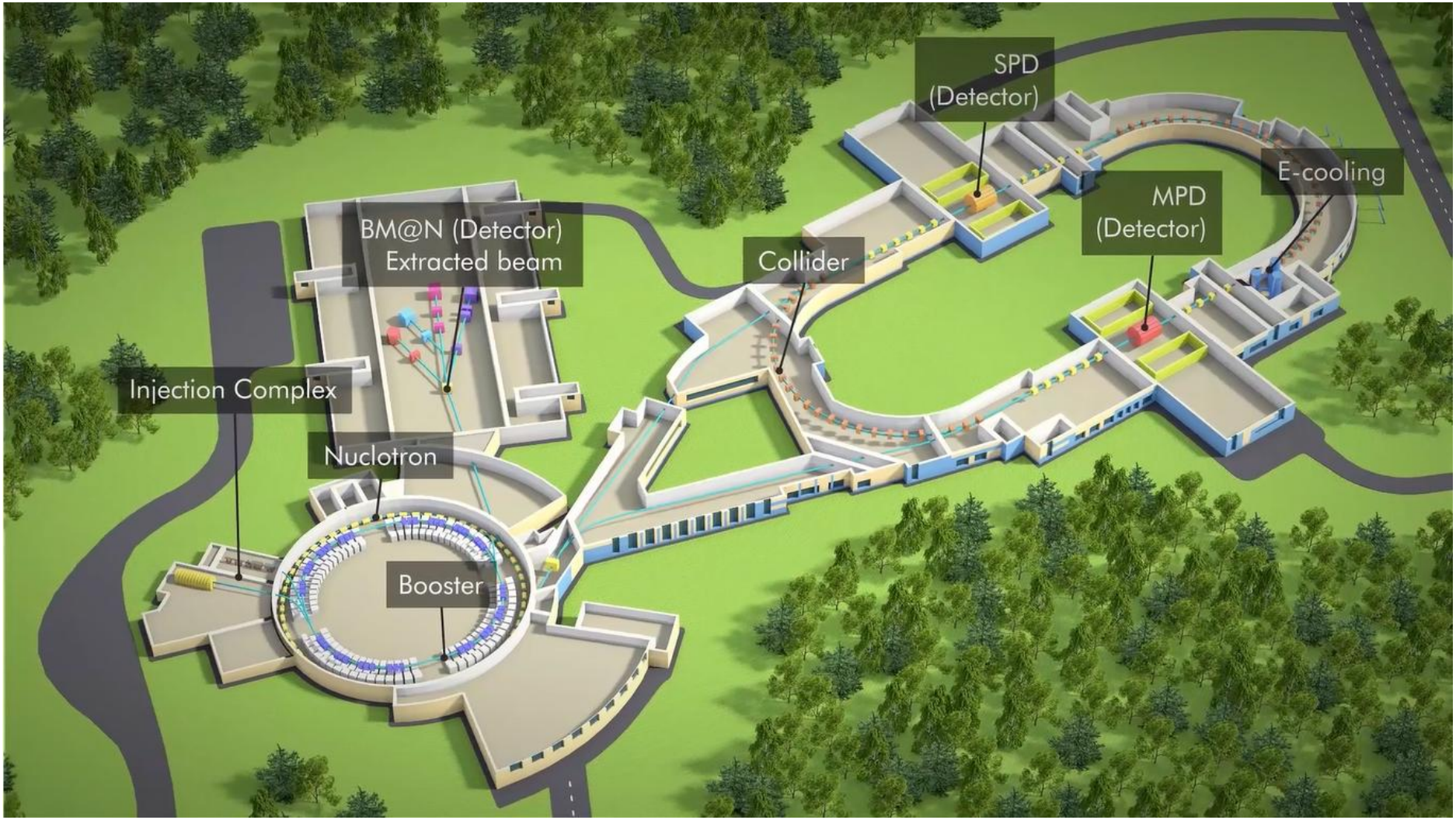
polarized protons and deuterons

with energy up to

$\sqrt{s_{NN}}$ = *11 GeV (*Au^{79+} **, L ~** 10^{27} cm^{-2} c^{-1}*)*

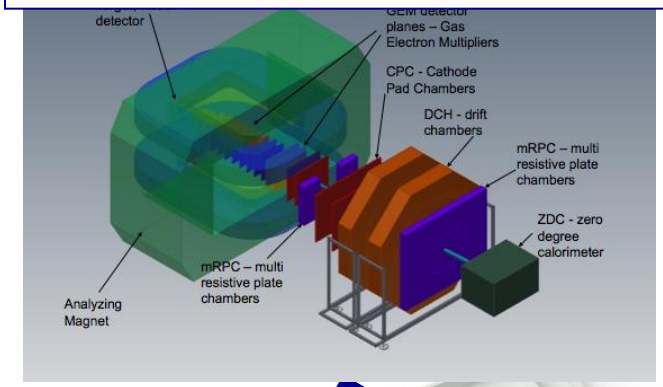
$\sqrt{s}$ =*27 GeV (p,* L ~ 10^{32} cm^{-2} c^{-1})

NICA


SPD
(Detector)
E-cooling
MPD
(Detector)
BM@N (Detector)
Extracted beam
Collider
Injection Complex
Nuclotron
Booster

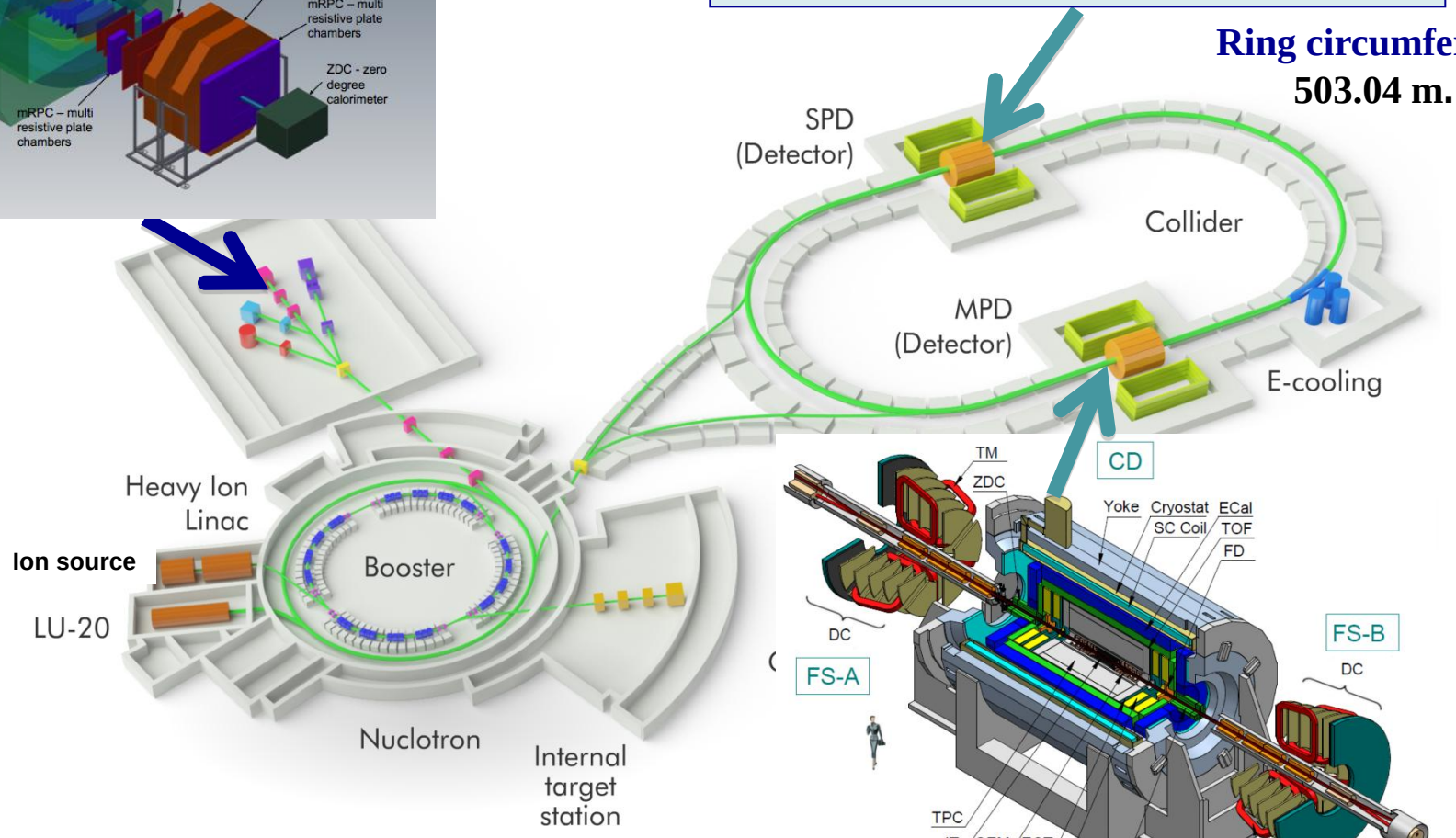
NICA Complex

Baryonic Matter at Nuclotron (BM@N)



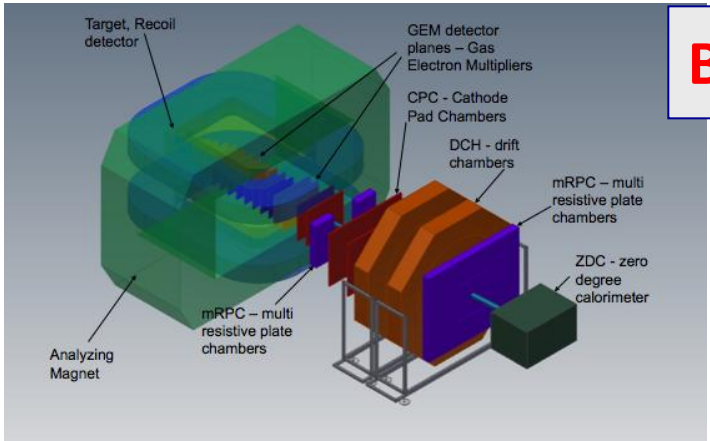
SPD (Spin Physics Detector)

Ring circumference
503.04 m.



MultiPurpose Detector (MPD)

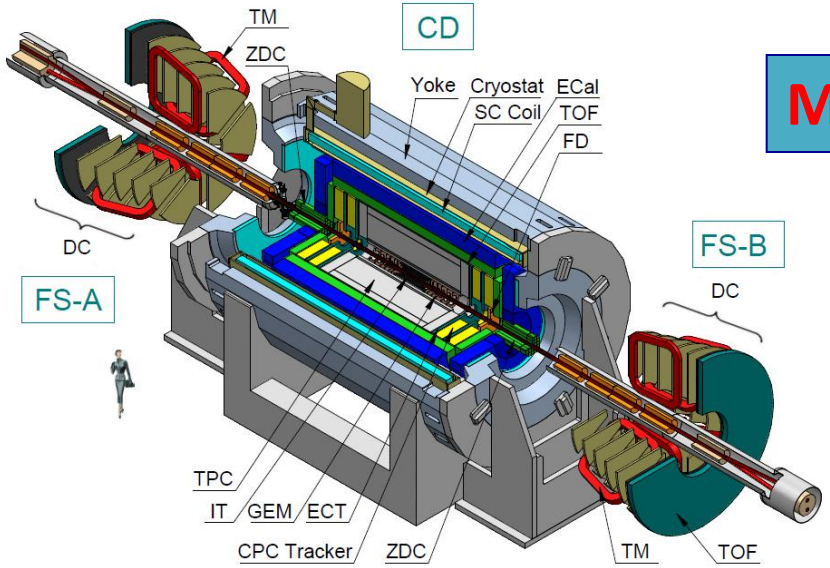
3 detectors



Baryonic **M**atter at **N**uclotron (**BM@N**)

The fixed target experiment at the Nuclotron

Stage I: end 2017



MultiPurpose Detector (MPD)

Collider experiment at NICA

Stage I: 2020

SPD (Spin Physics Detector) *at the NICA Collider*

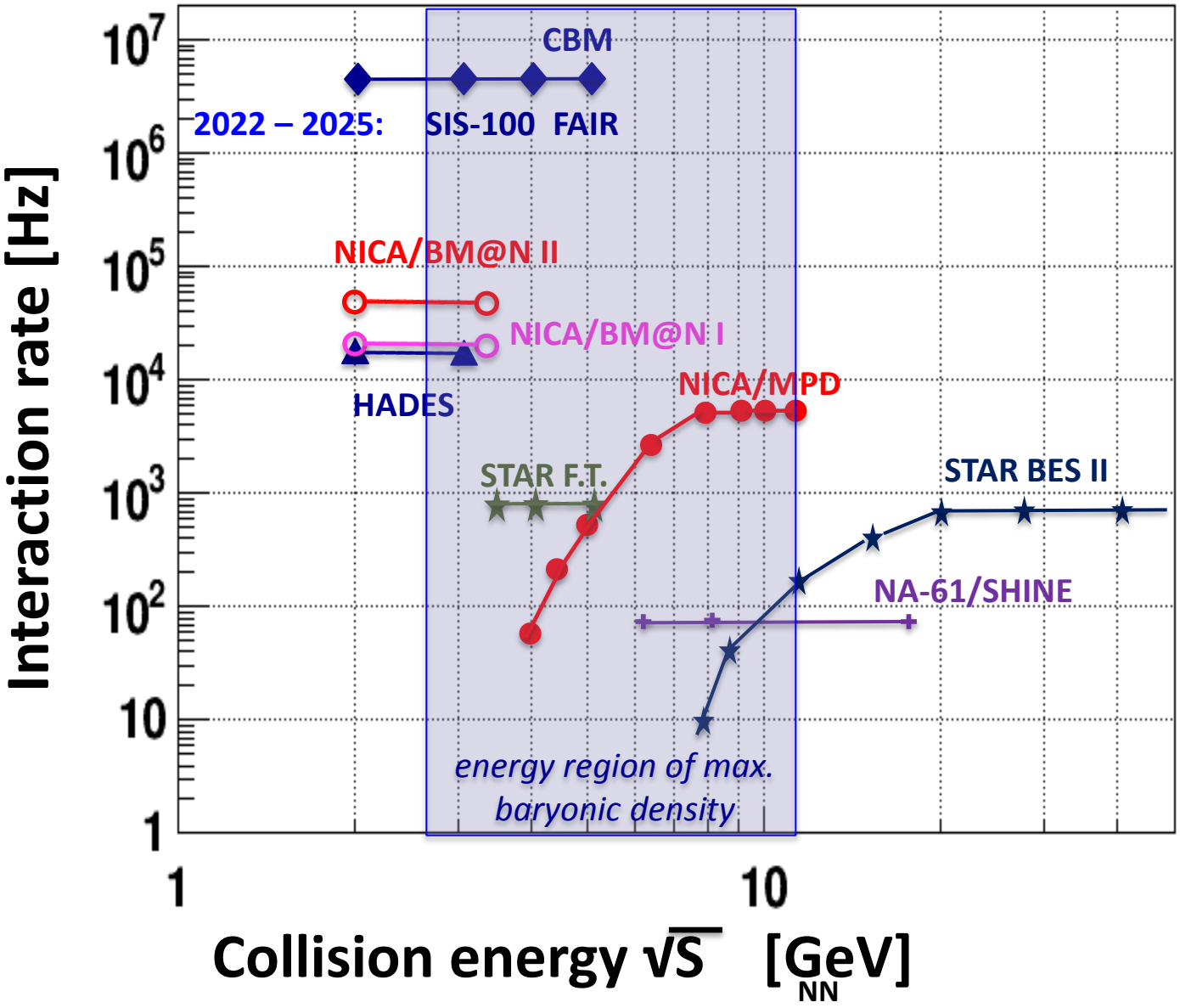
project is under preparation

All basic parts of the **NICA complex**
are at the stages of fabrication or **TDR** approval.

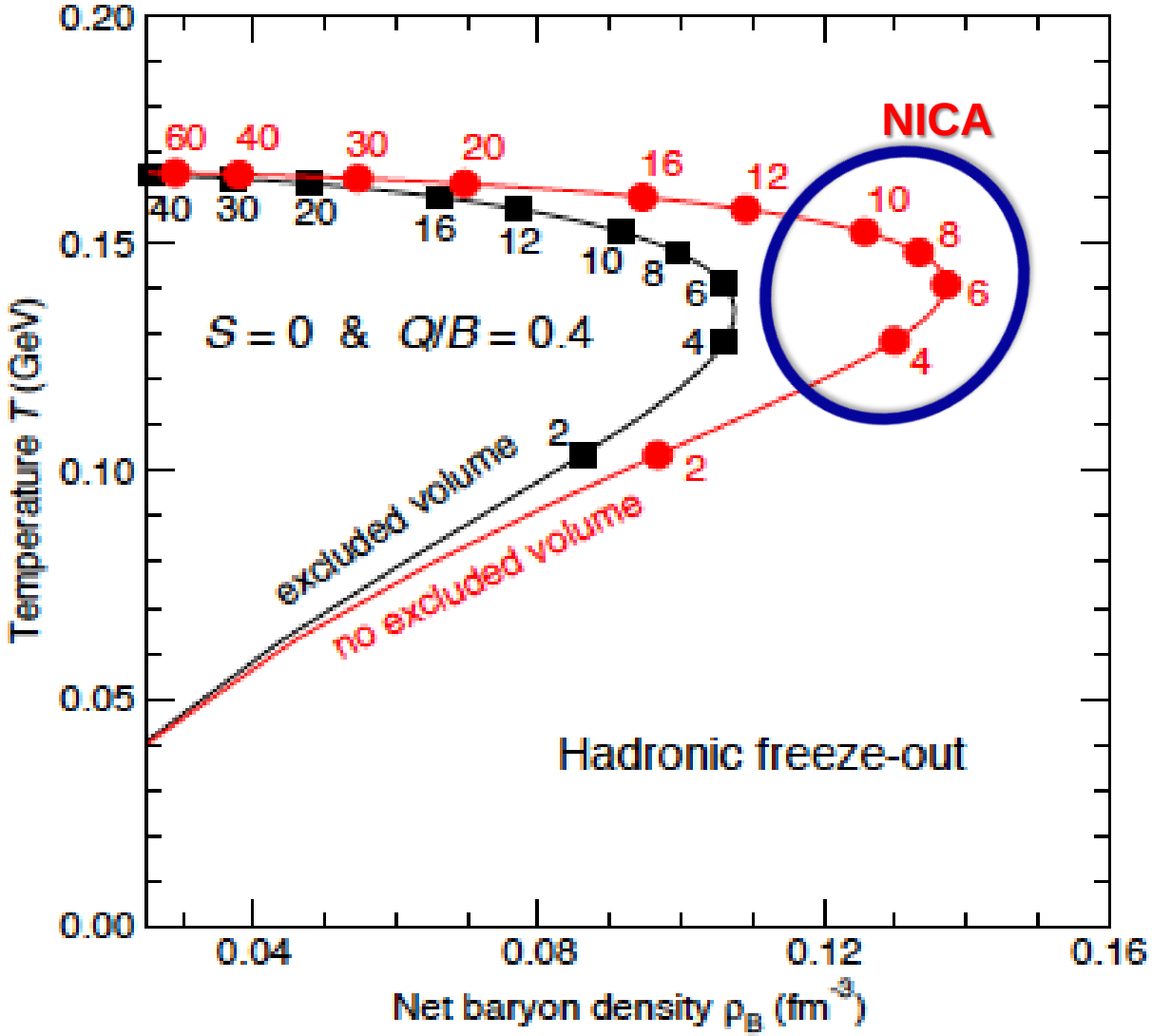
The major milestones for the commissioning:

accelerator complex		
	start-up configuration	**– 2020**
	the design configuration	**– 2023**
BM@N		
	the I stage	**– 2017**
	the II stage	**– 2019**
MPD		
	the I stage	**– 2020**
	upgraded (IT + end-cups)	**– 2023**
SPD	*project is under preparation*	

Present and future HIC experiments



Maximal freeze-out baryon density



J.Randrup, J.Cleymans (NICA White Paper)

Experimental modes

Collider mode

Fixed target mode

Advantages:

- ***coverage of max. phase space***
- *minimum biased acceptance*
- *free of target parasitic effects*
- *NICA energy range: energy independent homogenous acceptance*
- *….*

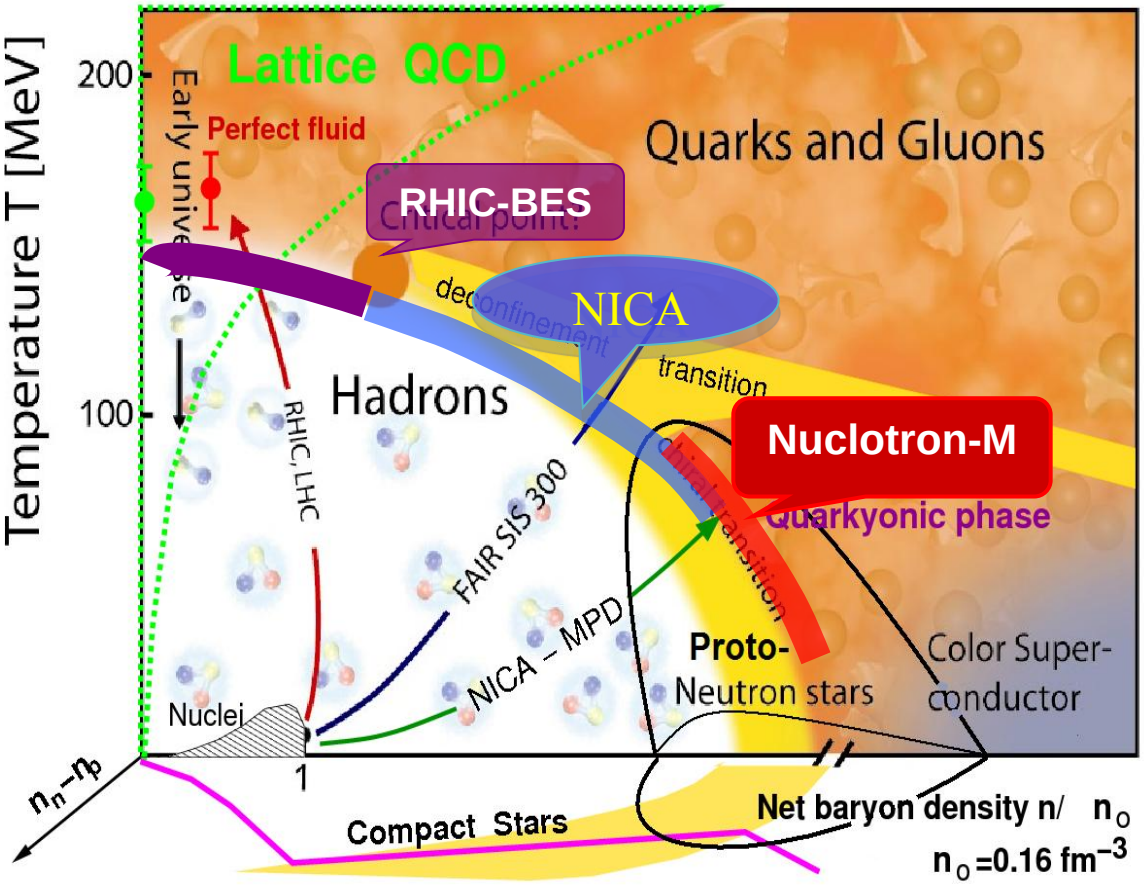
- *rate is limited just by detector capability*
- *easy upgradable*
- *….*

Disadvantages:

- *rate is limited by luminosity*
- *limited combinations "beam"/"target"*
- *…..*

- *a limited phase space*
- *momentum dependent corrections*
- *target influenced corrections*

QCD phase diagram: prospects for NICA



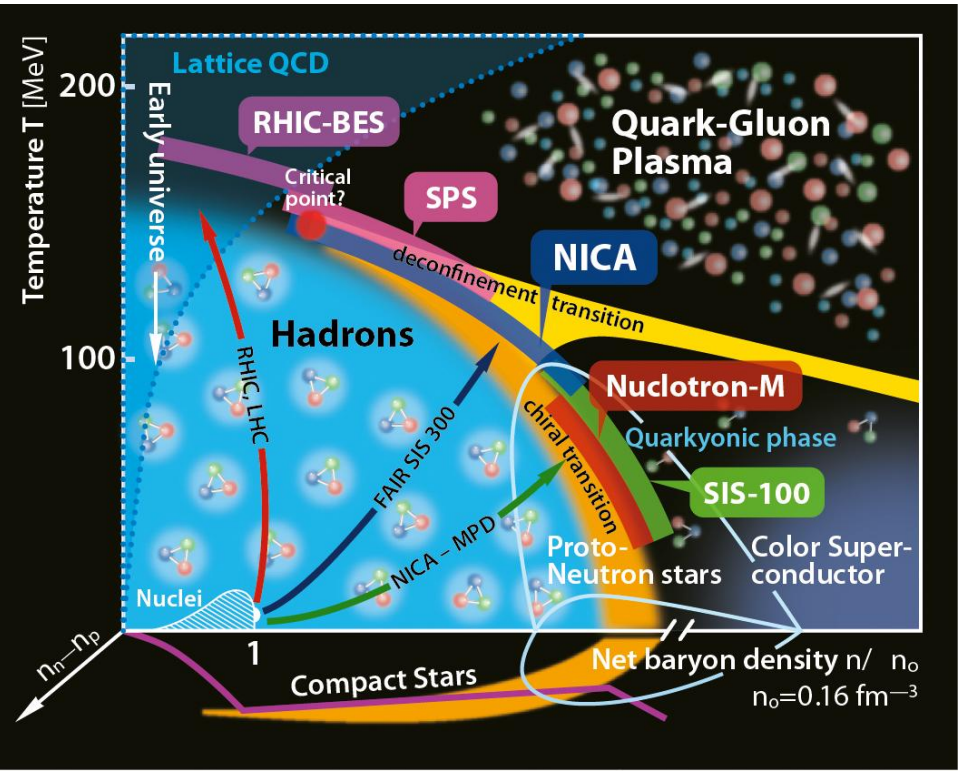
Energy Range of NICA

unexplored region of the QCD phase diagram:

- **Highest net baryon density**
- **Onset of deconfinement phase transition**
- **Discovery potential:**
  a) Critical End Point
  b) Chiral Symmetry Restoration
  c) Hypothetic (e.g. quarkyonic) phases
- **Complementary to RHIC/BES, NA61/CERN, CBM/FAIR**

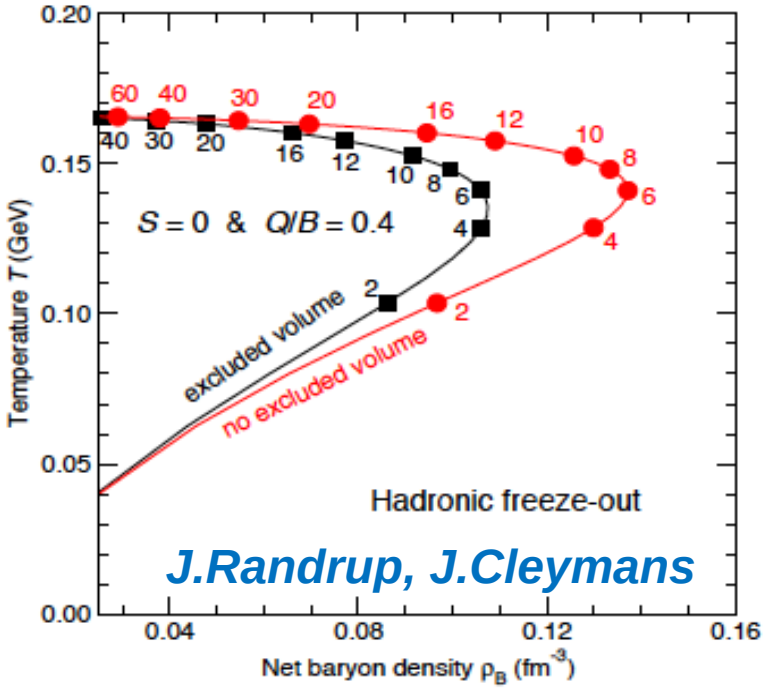
Comprehensive experimental program requires scan over the QCD phase diagram by varying collision parameters: system size, beam energy and collision centrality
NICA provides capabilities for studying a variety of phenomena in a large region of the phase diagram

MPD@NICA Physics



QCD matter at MPD@NICA :

- *Highest net baryon density*
- *Energy range covers onset of deconfinement*
- *Complementary to the RHIC/BES, FAIR , J-PARC-HI and CERN experimental programs*



- **Bulk properties, EOS** - *particle yields & spectra, ratios, femtoscopy, flow*
- **In-Medium modification of hadron properties**
- **Deconfinement (chiral), phase transition at high r_B** - *enhanced strangeness production*
- **QCD Critical Point** - *event-by-event fluctuations & correlations*
- **Strangeness in nuclear matter** - *hypernuclei*

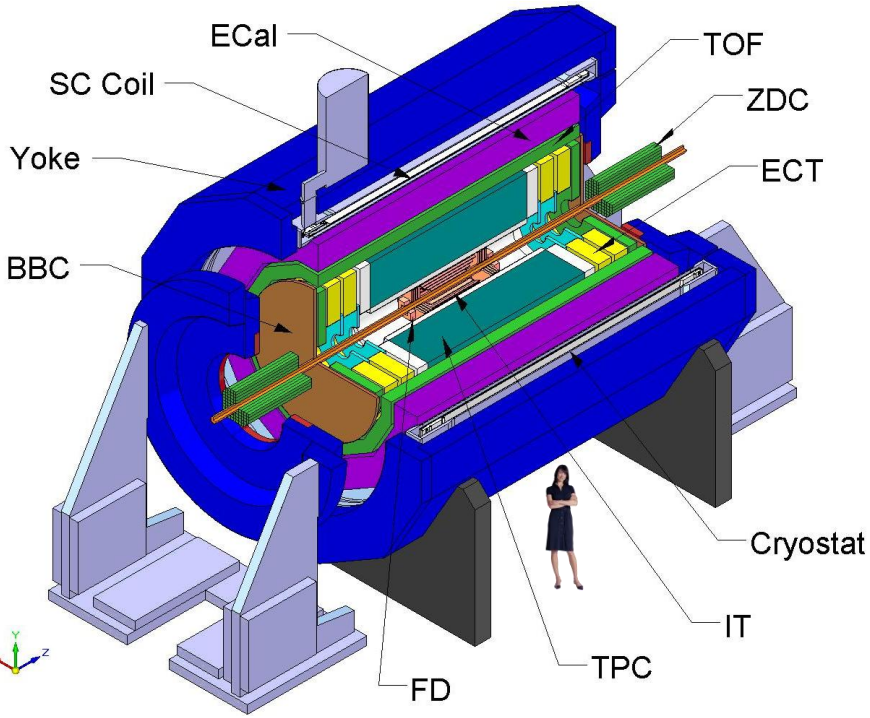
***The observables in AA, pA and pp collisions:* multiplicity of produced hadrons (π, K, p, Λ, Ξ, Ω), electromagnetic probes: electrons, gammas, vector meson decays , event-by-event fluctuations, femtoscopy of π, K, p, Λ**

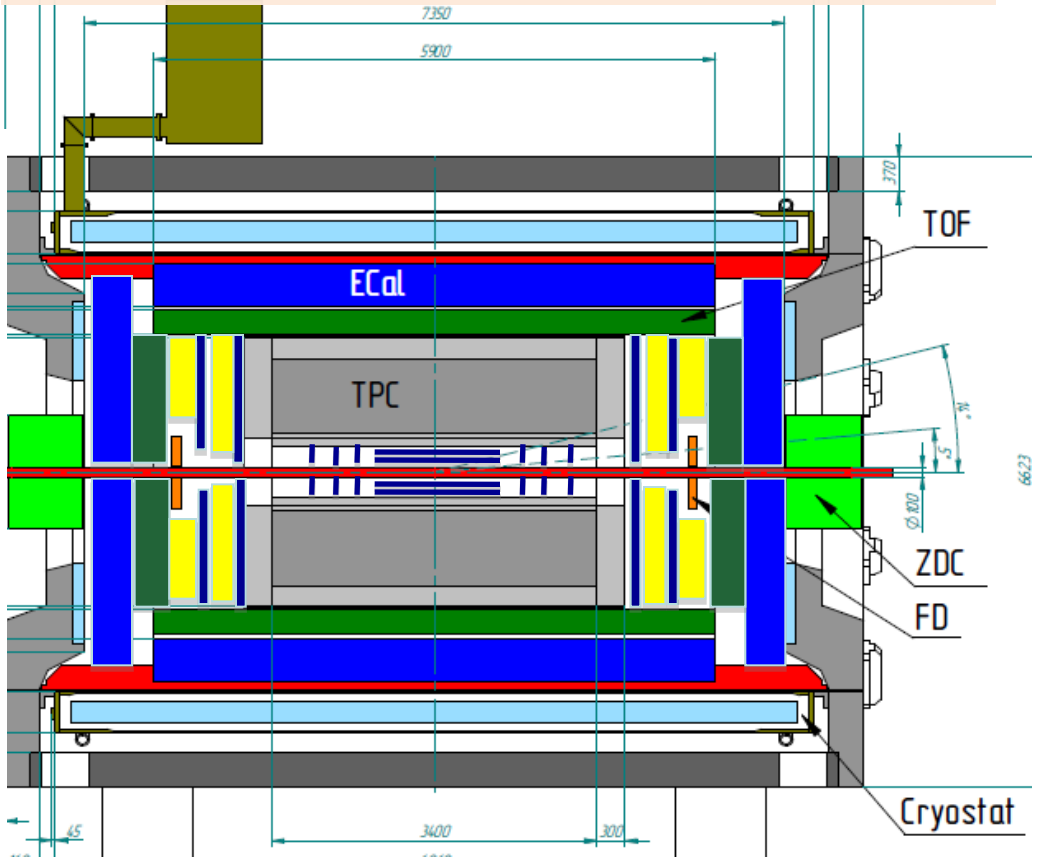
MPD detector for Heavy-Ion Collisions @ NICA

Tracking: up to |η|<2 (TPC)
PID: hadrons, e, γ (TOF, TPC, ECAL)
Event characterization:
centrality & event plane (ZDC)

Stage 1: TPC, TOF, ECAL, ZDC, FD

Stage 2: IT + Endcaps (tracker, TOF, ECAL)





MPD required features:

- *hermetic and homogenous acceptance (2π in azimuth), low material budget*
- *good tracking performance and powerful PID (hadrons, e, γ)*
- *high event rate capability and detailed event characterization*

MultiPurpose Detector (MPD): Observables Staging

I stage: Barrel (*TPC, TOF, ECAL*), *ZDC, FD*

mid rapidity region (good performance)

- *Particle yields and spectra*
- *Event-by-event fluctuations*
- *Femtoscopy involving π, K, p, Λ*
- *Collective flow for identified hadron species*
- *Electromagnetic probes (electrons, gammas), vector mesons*

II stage: *extended rapidity + Vertex Tracker*

- *Total particle multiplicities*
- *Asymmetries study (better reaction plane determination)*
- *Di-Lepton precise study (ECal extension?)*
- *Exotics (soft photons, hypernuclei)*

MPD physics cases (2020-2023)

Observable	Set-up	Coverage	New insights
Hadron yields & ratios	TPC, TOF, FHCAL,ECAL	$\|\eta\| < 1.5$ pT < 4 GeV/c	Data for $4<\sqrt{s}<7$ GeV, critical assessment of y-spectra and K/π-ratio
Hyperons: yields, flow, Polarization	TPC, TOF FHCAL	$\|\eta\| < 1.5$ pT < 4 GeV/c	New data on yields, flow and polarization at $\sqrt{s} < 7$ GeV.
Dileptons	TPC, TOF ECAL, FHCAL	$\|\eta\| <$ **1.2** pT < 3 GeV/c	**low statistics data for comparison**
Fluctuations & Correlations	TPC, TOF ECAL, FHCAL	$\|\eta\| < 1.5$	New data on Ev-by-Ev fluct. for $\sqrt{s} > 4$ GeV
Chiral Magnetic & vortical effects	TPC, TOF FHCAL	$\|\eta\| < 1.5$ pT < 3 GeV/c	Data @ $\sqrt{s} < 7$GeV (CME) Vortical @ $4 < \sqrt{s} < 11$ GeV
(Hyper)Nuclei	TPC, TOF ZDC	$\|\eta\| < 1.5$ pT< 5 GeV/c	**low statistics data for comparison**

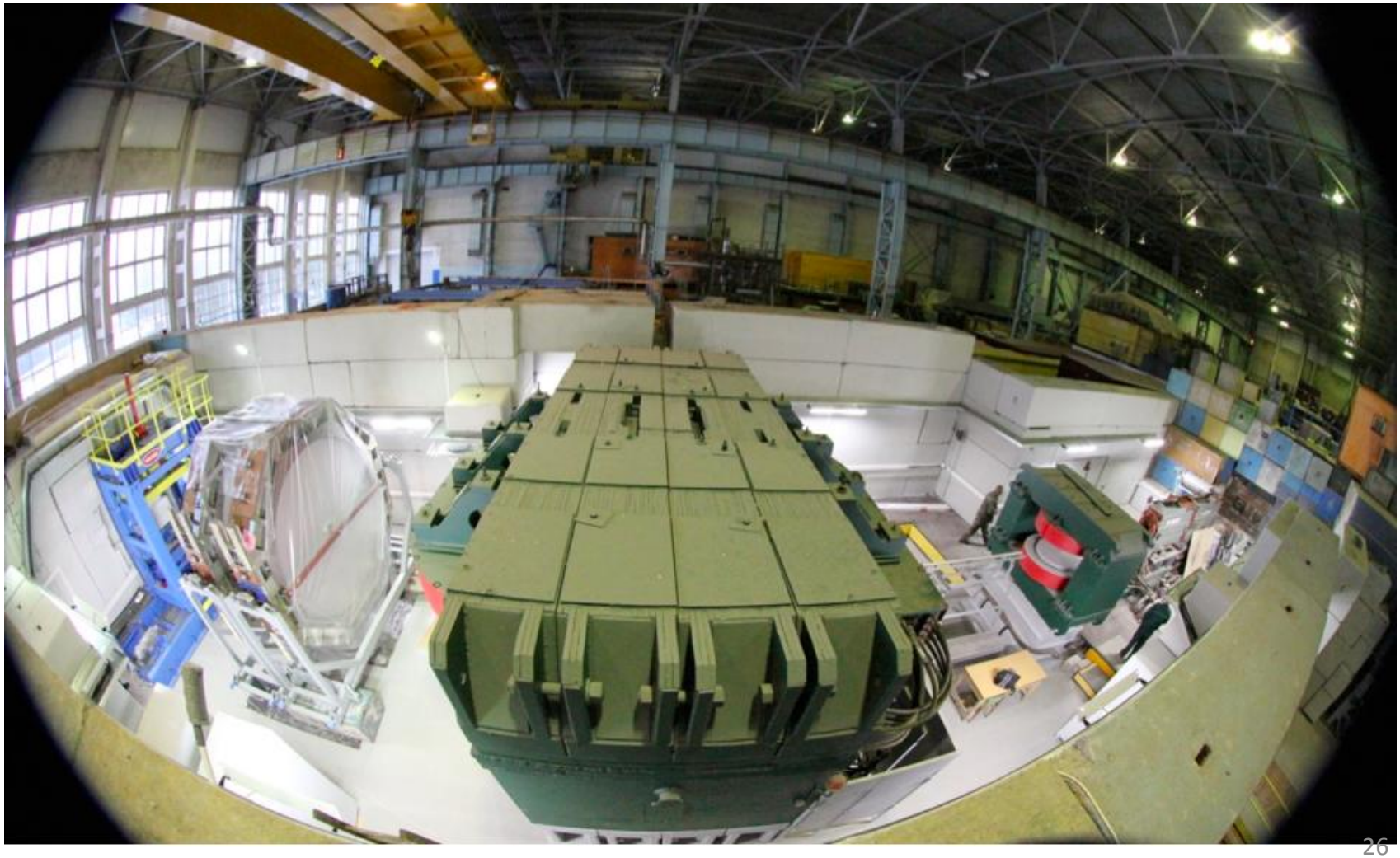
- **In stage-II one should consider efficient measurements of open-charm hadrons, di-leptons, and direct photons.**

Strange matter production in heavy ion collisions at the Nuclotron extracted beam: Baryonic Matter at Nuclotron(BM@N)

- **The goal of the experiment is the systematic measurements of the observables for multistrange objects (Ξ^-, Ω^-, exotics) in Au-Au collisions in energy range of Nuclotron extracted beams (up to 5.5 A GeV)**

Baryonic Matter at Nuclotron (BM@N)

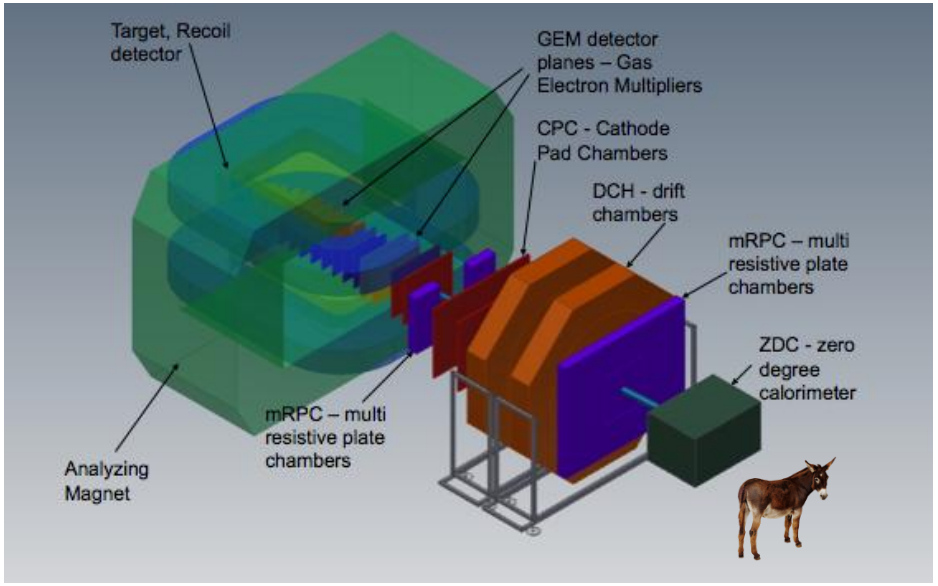
at Nuclotron extracted beams



BM@N: *the 1st stage*

Participants from:

Russia: *INR, MEPhi, SINP, MSU, IHEP, S-Ptr Radium Inst.*
Bulgaria: *Plovdiv University;*
China: *Tsinghua University, Beijin;*
Poland: *Warsaw Tech.Uni.*
Israel: *Tel Aviv Uni.*
Germany: *Frankfurt Uni.*
+ expression of interest from CBM



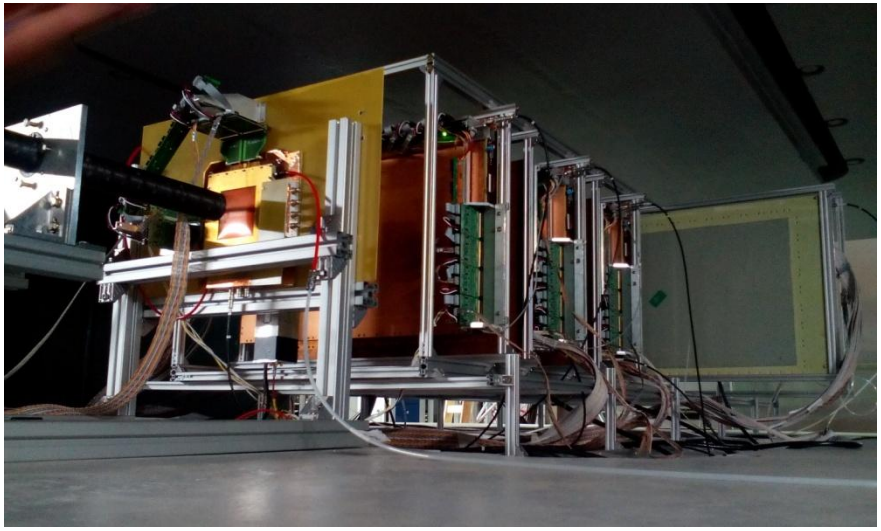
Physics:

- ✓ *strange / multi-strange hyperon and hypernuclei production at the threshold*
- ✓ *hadron femtoscopy*
- ✓ *in-medium modifications of strange & vector mesons in dense nuclear matter*
- ✓ *electromagnetic probes, states decaying into γ, e (with ECAL)*

BM@N Run 52 (June 2016): *tests & commissioning of GEM CT located inside analyzing magnet*

d beam (~5·10^5 /cycle) with 2.94 GeV/n

*5 GEM detectors 66 x 41cm^2 + 1 detector **163 x 45** cm^2*



BM@N status and milestones

BM@N plan

*technical runs with **d, Li, C** beams*: **2016 – 2017;**

physics run **BM@N** *(I stage) with **Kr** int rate 20 kHz:* **IV q., 2017;**

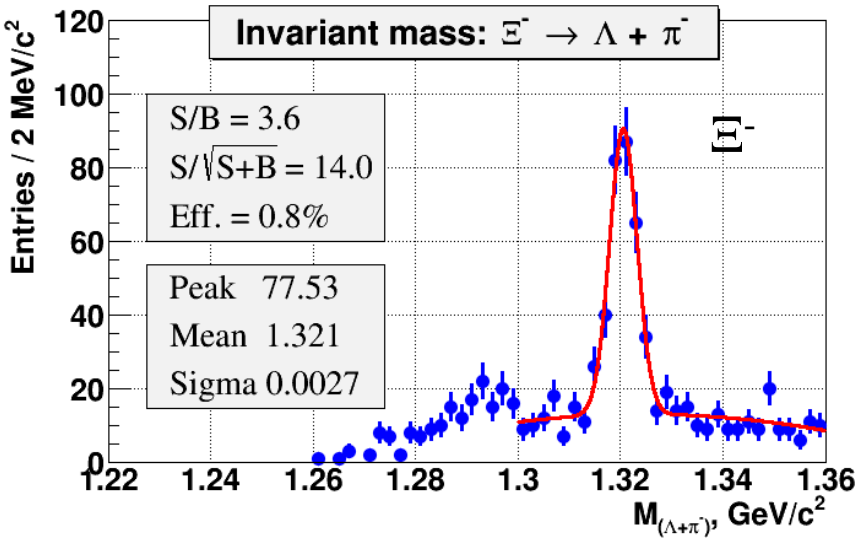
physics run **BM@N** *(II stage) with **Au** int rate 50 kHz:* **2019.**

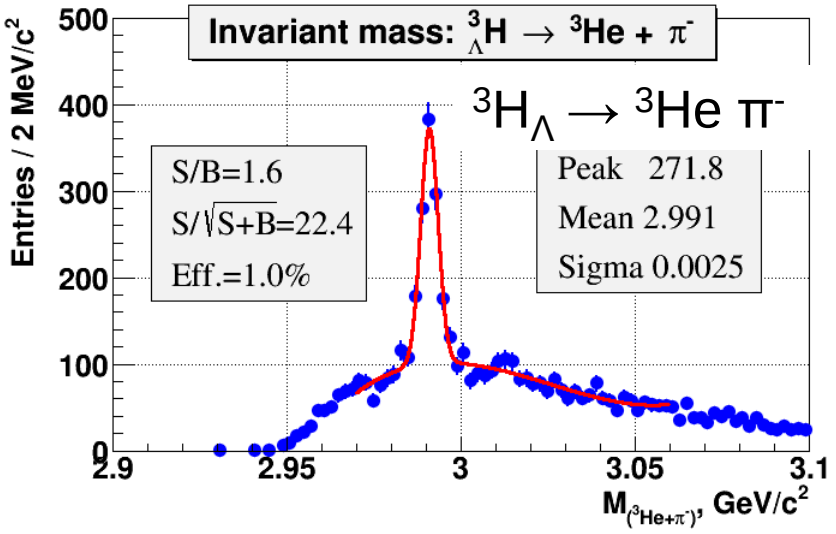
next technical run in 2016: *commissioning of GEM & Si inside magnet*

Simulation

A.Zinchenko, V.Vasendina

UrQMD & DCM-QGSM, Au+Au, $E_{kin.}$ = 4.5A GeV, 2×10^6 events;



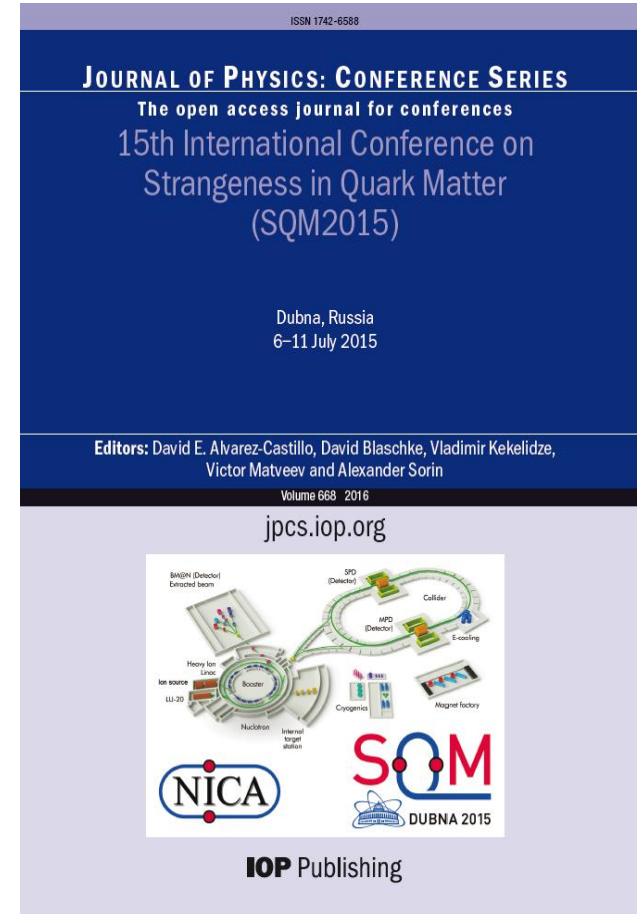


BM@N plans

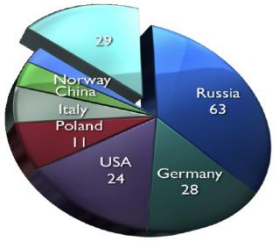
year	2016	2017 Feb.-Mar.	2017 Nov.-Dec.	2019	2020 + ..
beam	d (⇑)	C, Ar	Kr	Au	Au, p
maximum intensity, Hz	1M	1M	1M	1M	10M
trig. rate, Hz	10k	10k	20k	20k	50k
central tracker	6 GEM half pl.	8 GEM half pl.	10 GEM half pl.	8 GEM full pl.	12 GEM or 8+2Si
expiment status	techn. run	techn. run	physics run	physics stage 1	physics stage 2

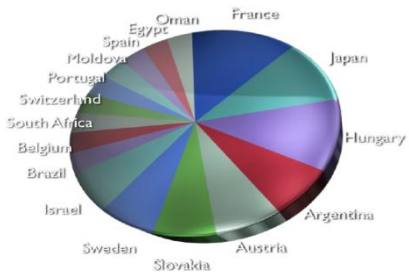
beam: E_{kin} = 3.5, 4.0, 4.5 AGeV

SQM2015 in Dubna

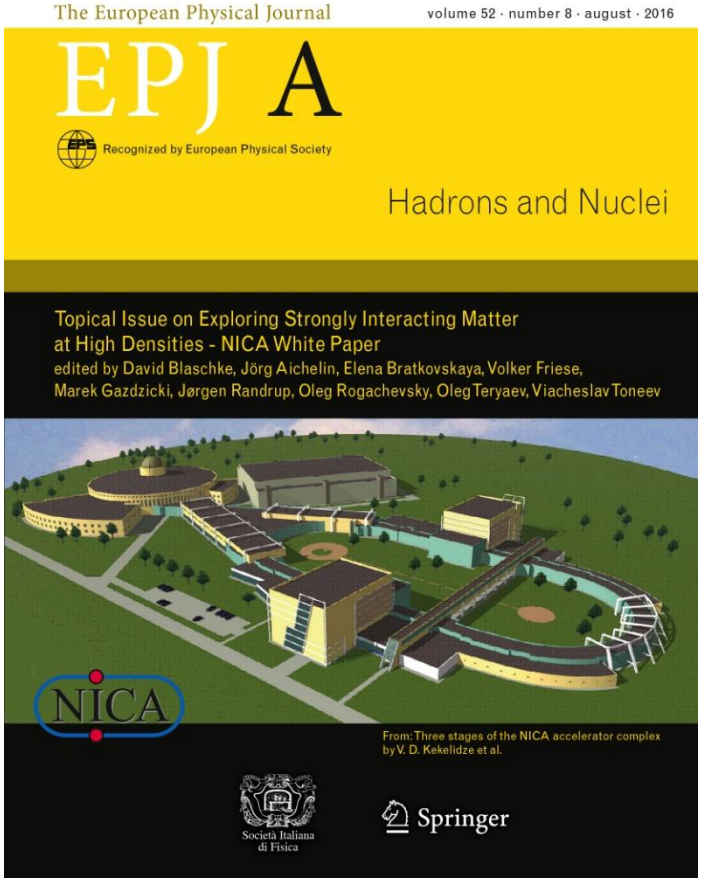


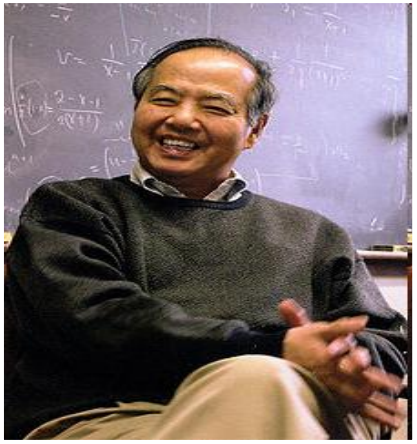
NICA White Paper





111 *contributions,*
188 *authors*
from **24** *countries*





T. D. Lee:
"*The NICA heavy ion collider will be a very major step towards the formation of a new phase of quark-gluon matter."*

http://theor0.jinr.ru/twiki-cgi/view/NICA/WebHome

Fixed Target Experiments at the Nuclotron

→ Ideally suited for exploration of reaction mechanisms & in-medium properties
→ Energy range formerly not accessible or of limited experimental information
→ Expectation of a rich structure of the QCD phase diagram @ high densities

TOOL:
→ Subthreshold production of (multi-)strange hadrons: Φ, K*, K*, Λ, Σ, Ξ, Ω^-
→ Extend studies at SIS18, observe Ω^- as result of multi-step production here
→ Extract information about densities reached in the collision → EoS

Important:
→ Systematic study of production mechanisms by measurement of excitation functions for hadron production in p+p, d+p
→ High enough statistics for multi-dimensional analysis (centrality, y, p_T)

Production of hypernuclei: → study recommended!

→ Two mechanisms: (1) Absorption of produce Λ by spectator nuclei
(2) Coalescence of Λ nucleons at midrapidity
→ Important for hypernuclei spectroscopy: extract Y-N, Y-Y interactions

Collider Experiments at MPD

First round of MPD/NICA experiments:

→ diagnostic observables of beam energy scan programs at SPS, RHIC
→ MPD detector to be optimized to study fluctuations an correlations
→ excitation functions of fluct./corr., dependence on centrality & system size

Observables:

→ EBE fluctuations of multiplicty and p_T of charged and identified part. (p,K,π)
→ long-range angular correlations like v_1, v_2 of (p,K,π,Λ) and light clusters
→ three-body correlations (for CME) and short-range two-particle corr. (size)
→ coverage in rapidity and p_T shall be large, low p_T extremely important!
→ measurements as function of collison energy for following systems:
– p+p collisions
– d+d collisions with possibility of off-line event selection of reactions with (p,p), (p,n), (n,n) spectators
– d+Pb collisions
– collisions of identical heavy nuclei, such as Pb+Pb (later also smaller A)
→ second stage: open-charm hadrons, di-leptons, di-photons at NICA

Spin Physics in Heavy-Ion Collisions

- Spin-dependent observables might also be manifested in HIC
- No beam polarization but plenty of effects in final state
- Especially interesting is the polarization of hyperons
- Self-analyzing: revealed in weak P-violating decay
- Related to P-odd effects in QCD medium: Vorticity and Hydrodynamic helicity
- Detailed study at MPD planned
- Extensive theoretical investigations and simulations performed at JINR:

O.Rogachevsky, A.S., O.Teryaev, Phys. Rev. C (2010);

M.Baznat, K.Gudima, A.S., O.Teryaev, Phys. Rev. C (2013), Phys. Rev C (2015);

A.S., O.Teryaev, arXiv:1606.08398

Spin effects in heavy ion collisions might be used as a complementary probe.

Spin physics program involving all the NICA detectors (MPD, SPD, BM@N) is possible.

Vorticity & Polarization effects in HI collisions

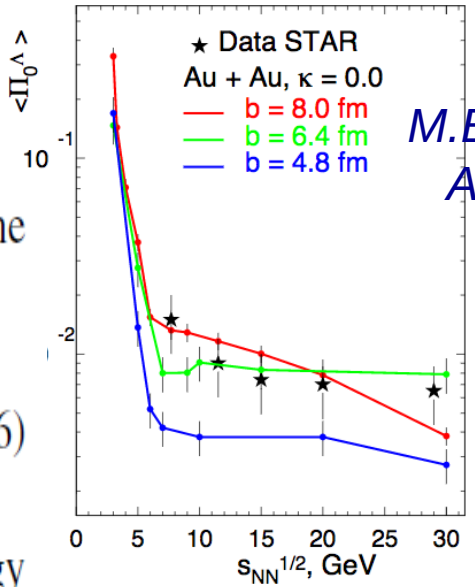
O. Rogachevsky, A. Sorin, O. Teryaev, Phys. Rev. C 82, 054910, 2010.

One would expect that polarization is proportional to the anomalously induced axial current [7]

$$j_A^\mu \sim \mu^2 \left(1 - \frac{2\mu n}{3(\epsilon + P)}\right) \epsilon^{\mu\nu\lambda\rho} V_\nu \partial_\lambda V_\rho, \qquad (6)$$

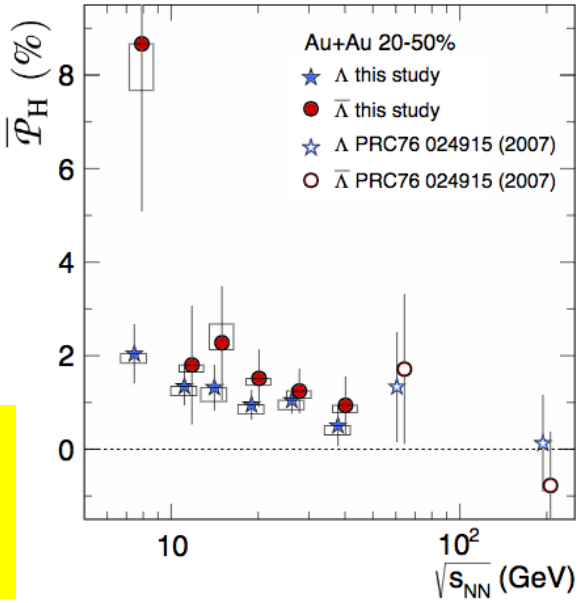
where n and ϵ are the corresponding charge and energy densities and P is the pressure. Therefore, the μ dependence of polarization must be stronger than that of the CVE, leading to the effect's increasing rapidly with decreasing energy.

This option may be explored in the framework of the program of polarization studies at the NICA [17] performed at collision points as well as within the low-energy scan program at the RHIC.



M.Baznat, K.Gudima A.Sorin, O.Teryaev arXiv:1701.00923

STAR Coll.,arXiv:1701.06657



***M.Baznat, K.Gudima, A.S., O.Teryaev Phys. Rev. C (2013); Phys. Rev C (2015); A.S., O.Teryaev* Phys.Rev. C95 (2017) 011902**

SPD (Spin Physics Detector) at NICA

Collider provides both:
transversally & longitudinally
polarized ***p*** & ***d***
*with energy up to √S = **27 GeV***

The issues to be studied:

- *MMT-DY processes*
- *J/Ψ production processes*
- *Spin effects in inclusive high-p_T reactions*
- *Spin effects in one and two hadron production processes*
- *Polarization effects in heavy ion collisions*

The Collaboration is forming
Project is under preparation

SPD@NICA will provide unique opportunity to study all PDFs in one experiment and obtain the comprehensive information on nucleon spin structure at high statistical level with min. systematic uncertainties

Current and future experiments towards exploration of nucleon spin structure

experiment	CERN, COMPASS-II	FAIR, PANDA	FNAL, E-906	RHIC, STAR	RHIC-PHENIX	NICA, SPD
mode	F.T.	F.T.	F.T.	collider	collider	collider
Beam/target	π- , p	anti-p, p	π- , p	pp	pp	pp, pd,dd
Polarization:b/t	0; 0.8	0; 0	0; 0	0.5	0.5	0.7
Luminosity	$2\cdot10^{33}$	$2\cdot10^{32}$	$3.5\cdot10^{35}$	$5\cdot10^{32}$	$5\cdot10^{32}$	10^{32}
$\sqrt{s}$, *GeV*	14	6	16	200, 500	200, 500	10 - 26
$x_{1(beam)}$ *range*	0.1-0.9	0.1-0.6	0.1-0.5	0.03-1.0	0.03-1.0	0.1-0.8
q_T, *GeV*	0.5 -4.0	0.5 -1.5	0.5 -3.0	1.0 -10.0	1.0 -10.0	0.5 -6.0
Lepton pairs,	μ-μ+	μ-μ+	μ-μ+	μ-μ+	μ-μ+	μ-μ+, e+e-
Data taking	2015	>2025	2013	>2016	>2016	>2020
Transversity	NO	NO	NO	YES	YES	YES
Boer-Mulders	YES	YES	YES	YES	YES	YES
Sivers	YES	YES	YES	YES	YES	YES
Pretzelosity	NO	NO	NO	NO	YES	YES
Worm Gear	NO	NO	NO	NO	NO	YES
Direct γ	NO	NO	NO	YES	YES	YES

NICA International collaboration

Belarus
NC PHEP BSU (Minsk)
GSU (Gomel)
…
…

Germany
GSI (Darmstadt)
JLU (Giessen)
UR (Regensburk)
Frankfurt/Main Univ.
FIAS
FZJ (Julich)
FAU(Erlangen)

Bulgaria
INRNE BAS (Sofia)
TU-Sofia
SU
ISSP BAS
LTD BAS
SWU
PU (Plovdiv)
TUL (Blagoevgrad)

Ukraine
BITP NASU, KSU (Kiev)
KhNU, KFTI NASU (Kharkiv)

Russia
INR RAS (Moscow)
NRC KI (Moscow)
BINP RAS (Novosibirsk)
MSU (Mscow)
LPI RAS (Moscow)
St.Pet. Univ ersity
RI (St.Petersburg)
…
…

Poland
Tech.University (Warsaw)
Warsaw University
Fracoterm (Krakow)
Wroclaw University
INP (Krakow)

Czech Republic
TUL (Liberec)
CU (Prague)
Rzezh, …

RSA
UCT (Cape Town)
UJ (Johannesburg)
iThemba Labs

Australia
Azerbaijan
CERN
China
France
Georgia
Greece
India

Italy
Japan
Moldova
Mongolia
Romania
Serbia
Slovakia
USA

CERN-JINR cooperation

JINR –BMBF Agreement

JINR-France (IN2P3) MoU

Workshop on NICA Megaproject

NICA–FAIR Agreement

NICA “corner stone” ceremony, JINR, March 25, 2016

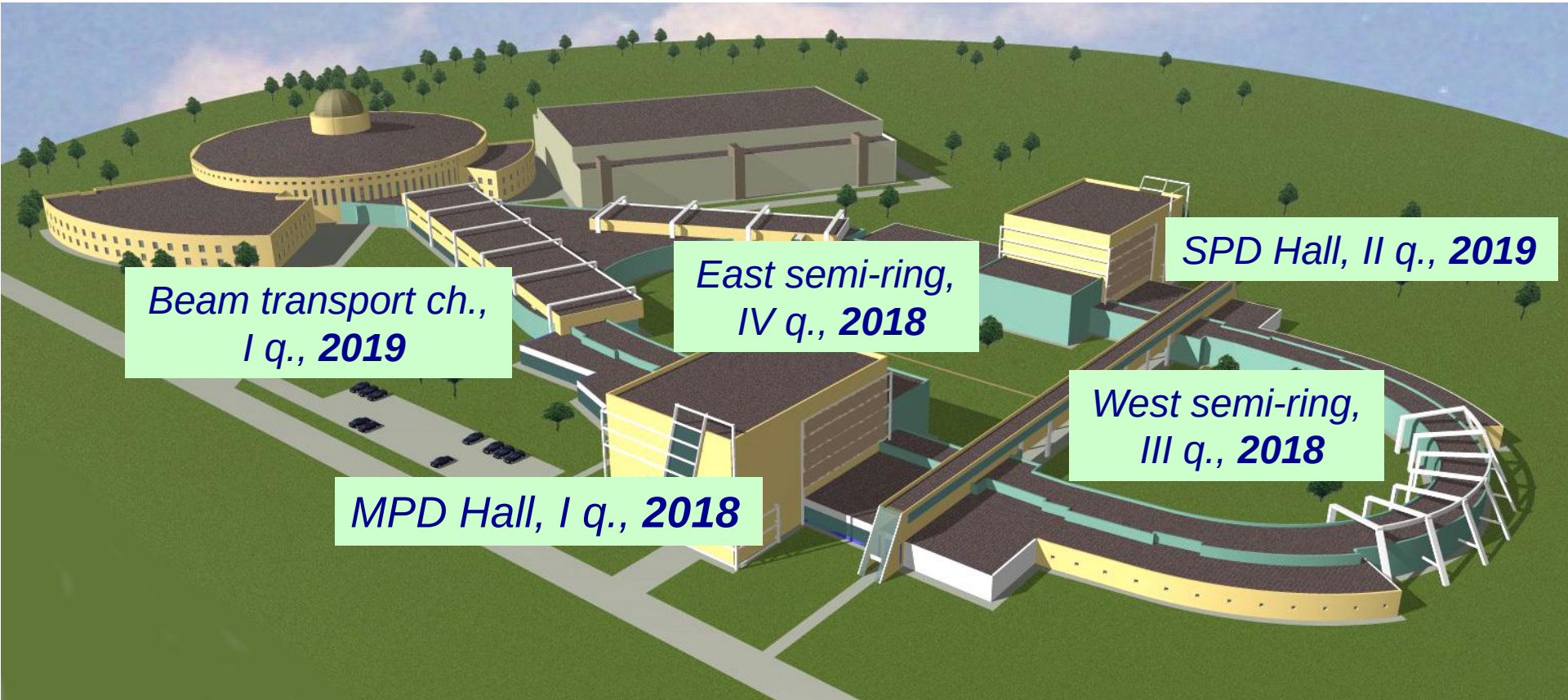
The NICA Civil engineering

General Contract *(duration 43 months)*

STRABAG – *main contractor;* **Комета** – *main designer*

The works are in progress: piling, subcontractor for iron/concrete works

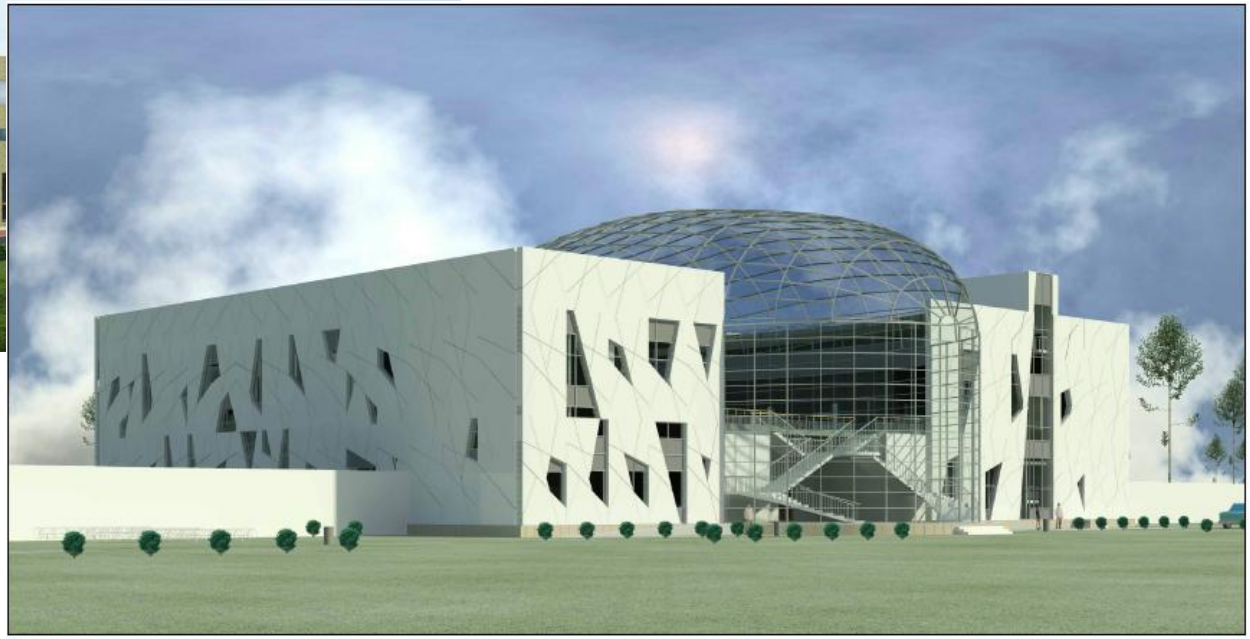
The whole Complex comprises several Objects to be commissioned



The construction is in progress

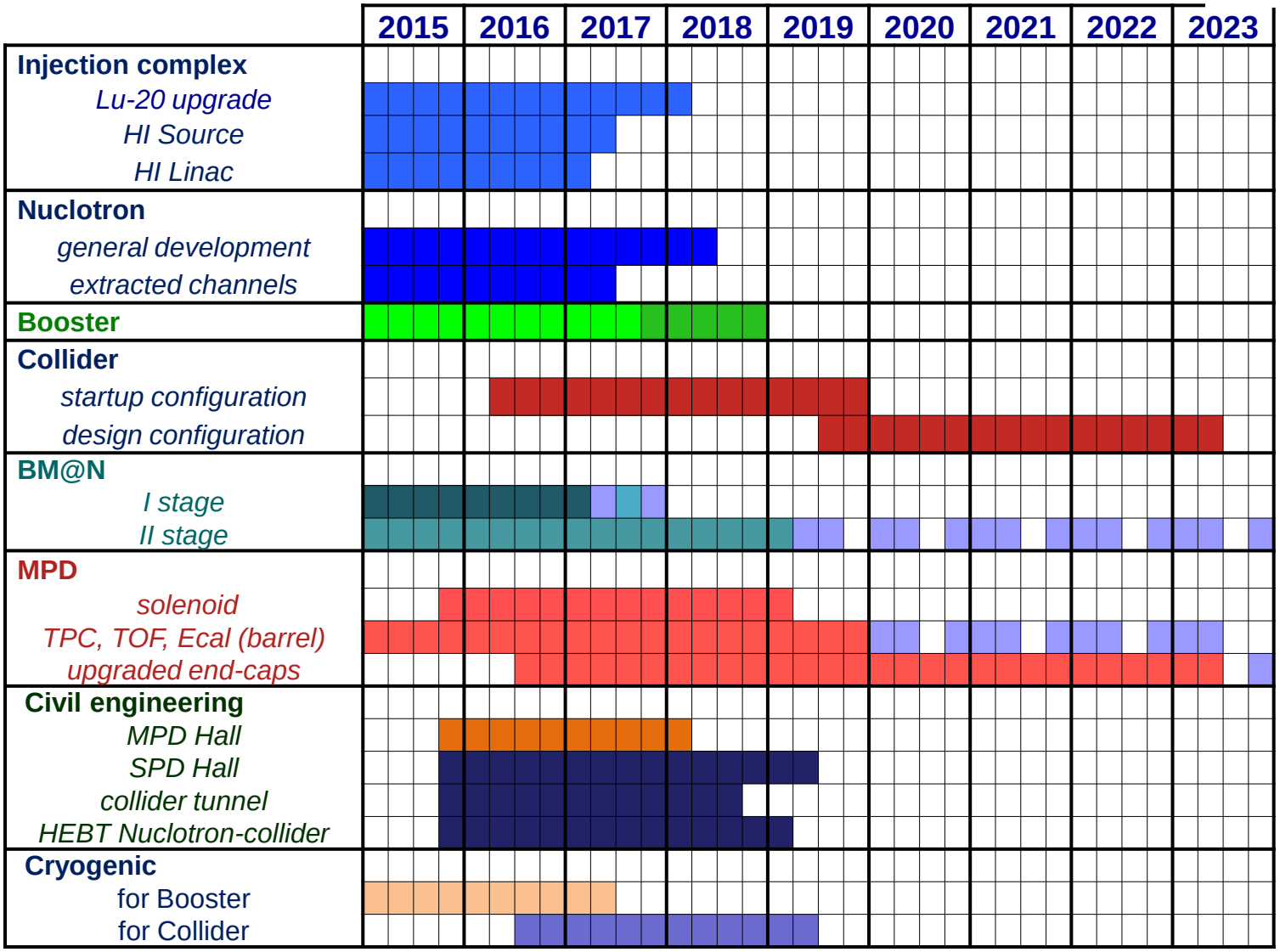
Innovation center of NICA

Examples of architectural solutions



At this time, several architectural solutions proposed by different project organizations are actively discussed. Here are two examples of such solutions.

NICA schedule



Accelerator elements

Machine Advisory Committee

- *Boris Sharkov, ITEP, chairman*
- *Pavel Beloshitsky, CERN*
- *Sergei Ivanov, IHEP*
- *Thomas Roser, BNL*
- *Alexei Fedotov , BNL*
- *Markus Steck, GSI*
- *Nicholas Walker, Desy*
- *Sergei Nagaitsev, FNAL*
- *Alexander Zlobin, FNAL*
- *Takeshi Katayama, Tokyo Univ.*
- *Valeri Lebedev, FNAL*
- *Rolf Stassen, FZJ*
- *Yuri Senichev, FZJ*
- *Evgeny Levichev, BINP*
- *Victor Yarba, FNAL*
- *Pavel Zenkevich, ITEP*

MultiPurpose Detector (MPD)

Detector Advisory Committee:

Hans Gutbrod, GSI - chairman

Itzhak Tserruya, Weizmann Institute

Hans Rudolf Scmidt, Tubingen Uni.

Jean Cleymans, Cape Town Uni.

Nu Xu, BNL

Baryonic Matter at Nuclotron (BM@N)

Detector Advisory Committee:

Hans Rudolf Schmidt, Tubingen Uni. - chairman

Hans Gutbrod, GSI

Itzhak Tserruya, Weitzmann Istitute

Peter Hristov, CERN

Karlheinz Hiller, DESY

Agreement between Government of Russian Federation and JINR on the NICA realization

ПРАВИТЕЛЬСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ

РАСПОРЯЖЕНИЕ

от 27 апреля 2016 г. № 783-р

МОСКВА

О подписании Соглашения между Правительством Российской Федерации и международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований о создании и эксплуатации комплекса сверхпроводящих колец на встречных пучках тяжелых ионов NICA

1. В соответствии с пунктом 1 статьи 11 Федерального закона "О международных договорах Российской Федерации" одобрить представленный Минобрнауки России согласованный с МИДом России, Минфином России, Минэкономразвития России и международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований проект Соглашения между Правительством Российской Федерации и международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований о создании и эксплуатации комплекса сверхпроводящих колец на встречных пучках тяжелых ионов NICA (прилагается).

2. Поручить Минобрнауки России провести переговоры с международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований и по достижении договоренности подписать от имени Правительства Российской Федерации указанное в пункте 1 настоящего распоряжения Соглашение, разрешив вносить в прилагаемый проект изменения, не имеющие принципиального характера.

2947103

СОГЛАШЕНИЕ

между Правительством Российской Федерации и международной межправительственной научно-исследовательской организацией Объединенным институтом ядерных исследований о создании и эксплуатации комплекса сверхпроводящих колец на встречных пучках тяжелых ионов NICA

Правительство Российской Федерации и международная межправительственная научно-исследовательская организация Объединенный институт ядерных исследований (далее - Объединенный институт ядерных исследований), в дальнейшем именуемые Сторонами,

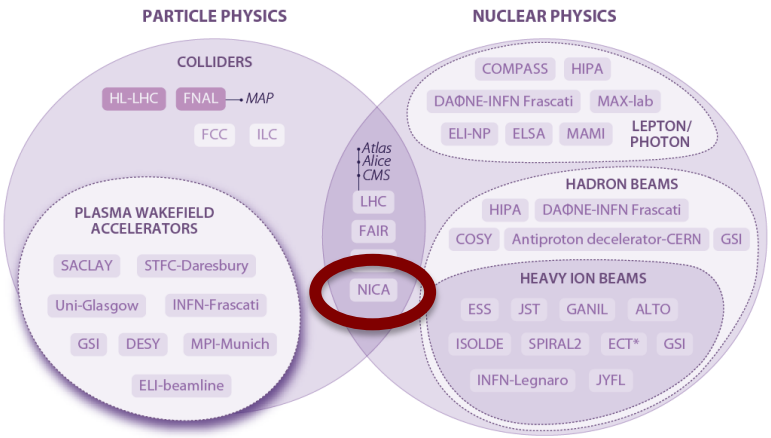
выражая общее желание содействовать укреплению потенциала Российской Федерации и Объединенного института ядерных исследований в области проводимых научно-технических и инновационных исследований в соответствии со статьей 30 Соглашения между Правительством Российской Федерации и Объединенным институтом ядерных исследований о местопребывании и об условиях деятельности Объединенного института ядерных исследований в Российской Федерации от 23 октября 1995 года,

стремясь создать комплекс сверхпроводящих колец на встречных пучках тяжелых ионов NICA (Nuclotron-based Ion Collider fAcility), обладающий беспрецедентными параметрами в области исследования физики частиц и ядер высоких энергий и обеспечивающий возможность его применения для инновационных разработок в приоритетных областях научных знаний, техники и технологий,

согласились о нижеследующем:

Статья 1

NICA in ESFRI road map update 2016



Concluding remarks

- **NICA can provide a competitive research *of dense baryonic matter and spin physics***
- **Construction of the *accelerator complex is in progress***
- **Constructions of both BM@N and MPD *are well progressing***
- **The SPD project is in preparation**
- **The NICA collaboration is growing**
- **New NICA partners are welcome**


NICA
The cooperation makes us stronger!
FAIR
CERN
Thank you!

Round Table Discussions on NICA/MPD@JINR

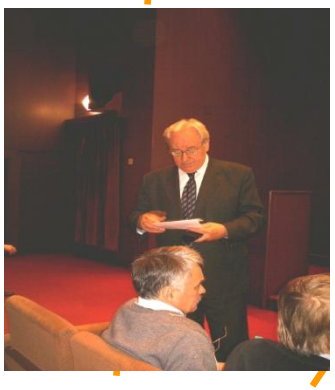
Round Table Discussion I: Searching for the mixed phase of strongly interacting matter at the JINR Nuclotron, *July 7 - 9, 2005*
http://theor.jinr.ru/meetings/2005/roundtable/

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/

Round Table Discussion V: *Searching for the mixed phase of strongly interacting QCD matter at the NICA: Physics at NICA (White Paper)* JINR (Dubna), August 28, 2010
http://theor.jinr.ru/~cpod/Dubna_2010_program2.htm



IHEP-JINR seminar at Protvino, 14.02.08

MEMORANDUM

МЕМОРАНДУМ
Совместного семинара ИТЭФ-ОИЯИ
Институт теоретической и экспериментальной физики
27 мая 2009 года, г. Москва

Участники семинара заслушали доклады:
А.Н. Сисакян "Ускорительный комплекс NICA: статус и перспективы".
Б.Ю. Шарков "Новые возможности ускорителей для исследования вещества экстремальных условиях".
И.Н. Мешков "Коллайдеры тяжёлых ионов RHIC и NICA: статус и перспективы".
В.Д. Тонеев "Физика тяжёлых ионов на ускорительном комплексе NICA".

Отмечены:
1) актуальность и возрастающая привлекательность исследований тяжелоионных столкновений в диапазоне энергий $\sqrt{s}NN \sim 4 - 11$ ГэВ для фундаментальных проблем поиска новых состояний ядерной материи и изучения процессов экстремально высоких плотностей;
2) прогресс в развитии проекта NICA, получившего широкую международную известность и высокую оценку авторитетных экспертов мирового уровня;
3) заинтересованность специалистов ИТЭФ в активном участии в совместных с ОИЯИ работах по проекту NICA;
4) необходимость более тесной кооперации в решении проблем, представляющих взаимный интерес, включая организацию ассоциации (консорциума, сообщества) по исследованию экстремальных состояний вещества и фазовых превращений в ионных столкновениях.

Соруководители семинара:
А.Н.Сисакян, академик РАН; В.И.Захаров, профессор
Участники семинара:
Б.Ю.Шарков, член-корреспондент РАН; И.Н.Мешков, член-корреспондент РАН; А.Б.Кайдалов, член-корреспондент РАН
А.С.Сорин, профессор; В.Д.Тонеев, профессор; А.Д.Коваленко, профессор; Г.В.Трубников, кфмн

Round Table Discussions I, II, III, IV, V…
JINR, Dubna, 2005, 2006, 2008, 2009,2010…

ITEP-JINR seminar at ITEP, 27.05.09

Решение
Общемосковского семинара по релятивистской ядерной физике

27 марта 2008 года
Институт Ядерных Исследований РАН

Участники семинара "Проект NICA (тяжелоионный коллайдер: концепции, планы реализации и перспективы совместных работ)" заслушав доклады, представленные разработчиками Проекта NICA/MPD (ОИЯИ):
1. А.Н. Сисакян "Статус проекта NICA/MPD".
2. А.Н. Сисакян, А.С. Сорин "Программа физических исследований на ускорительном комплексе NICA".
3. И.Н. Мешков "Концептуальный проект ускорительного комплекса NICA".
4. В.Д. Кекелидзе "Концептуальный проект многопелевого детектора MPD".

и обсудив цели и содержание проекта, а также перспективы его осуществления, пришли к следующему заключению.

1. Физическая проблема, инициировавшая разработку Проекта, является одной из наиболее важных среди фундаментальных проблем физики микромира и начальных этапов эволюции Вселенной.

2. Представленные на семинаре концептуальные проекты NICA и MPD выполнены на современном уровне с привлечением передовых технологий и использованием оригинальных идей, предложенных и развитых в России.

3. Осуществление Проекта на базе лабораторий ОИЯИ представляется вполне реальным, а представленные планы работ - выполнимыми.

4. Для успешного и быстрого выполнения Проекта целесообразно создание широкой Всероссийской и международной коллаборации.

5. Институты России располагают необходимым научным и инженерно-техническим потенциалом.

6. Успешная реализация Проекта позволит всем участникам Проекта занять лидирующие позиции в физике высоких энергий и войти в число самых передовых исследовательских центров мира.

В.А.Матвеев, Директор ИЯИ РАН, академик РАН
А.Н.Тавхелидзе, академик РАН
Б.Ю.Шарков, Директор ИТЭФ, чл.-корр. РАН
А.Н.Лебедев, чл.-корр. РАН
В.А.Рубаков, академик РАН

All Moscow-JINR seminar at INR, 27.03.08

Critical point and onset of deconfinement - CPOD-2010

August 22-29 2010, Dubna

NICA/JINR-FAIR Bilateral Workshop

Matter at Highest Baryon Densities in the Laboratory and in Space

Frankfurt Institute for Advanced Studies, April 2 - 4, 2012

http://theor.jinr.ru/~nica_fair/

Topics:

- Phases of QCD at high baryon densities
- Effects signalling phase transitions
- Observables in heavy-ion collisions and in astrophysics
- Simulations of ion collisions and supernovae

Aims:

- identify discovery potential of Nuclotron-NICA and FAIR in the canon of current and future HIC experiments
- chiral symmetry restoration
- onset of deconfinement
- in-medium modification of hadron properties
- color superconductivity, multiquark states, etc.

Results:

- Most promising and feasible suggestions for experiments at Nuclotron-NICA and CBM/FAIR
- Priorities for detectors and formation of international collaborations

NICA White Paper prioritization meeting
JINR Dubna, November 5, 2013

THEORY

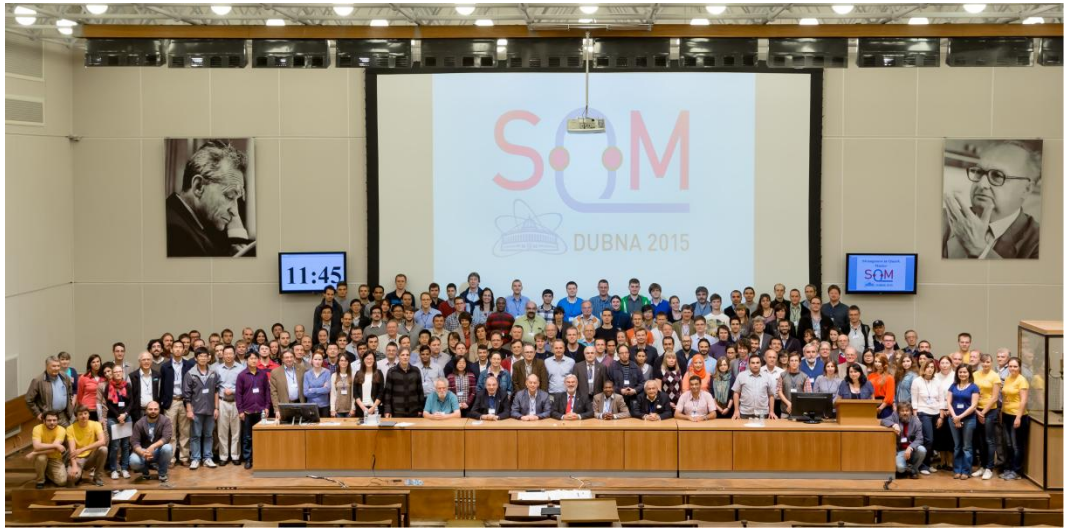
J. Aichelin (SUBATECH Nantes, France)
D. Blaschke (JINR & Univ. Wroclaw, Poland)
E. Bratkovskaya (Univ. Frankfurt, Germany)
J. Randrup (LBNL Berkeley, USA)
V. Toneev (JINR)
O. Teryaev (JINR)

EXPER.

V. Friese (GSI Darmstadt, Germany)
M. Gazdzicki (Univ. Frankfurt, Germany & Univ. Kielce, Poland)
O. Rogachevsky (JINR)

Strangeness in Quark Matter 2015

Dubna, 6.-11. July 2015



SQM DUBNA 2015

Satellite Meetings:

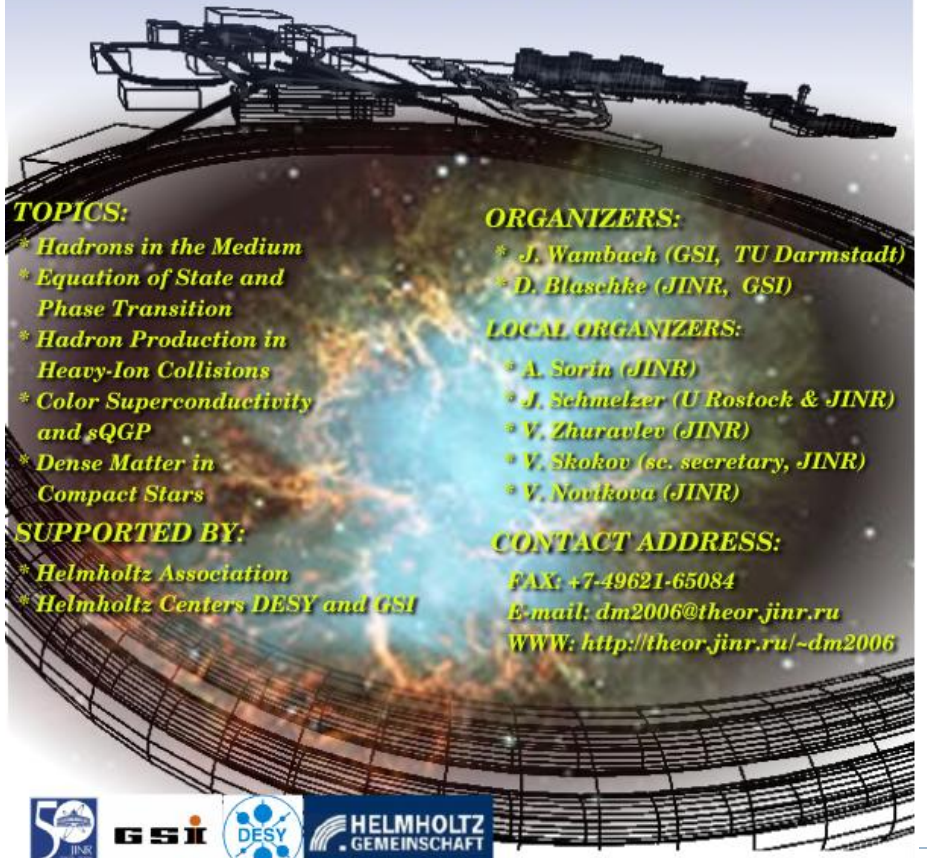
- Summer School “Dense Matter”, Dubna, June 29 – July 11, 2015
- Round Table “Physics at NICA”, Dubna, July 5, 2015

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, August 21 – September 1, 2006



TOPICS:
* *Hadrons in the Medium*
* *Equation of State and Phase Transition*
* *Hadron Production in Heavy-Ion Collisions*
* *Color Superconductivity and sQGP*
* *Dense Matter in Compact Stars*

SUPPORTED BY:
* *Helmholtz Association*
* *Helmholtz Centers DESY and GSI*

ORGANIZERS:
* *J. Wambach (GSI, TU Darmstadt)*
* *D. Blaschke (JINR, GSI)*

LOCAL ORGANIZERS:
* *A. Sorin (JINR)*
* *J. Schmelzer (U Rostock & JINR)*
* *V. Zhuravlev (JINR)*
* *V. Skokov (sc. secretary, JINR)*
* *V. Novikova (JINR)*

CONTACT ADDRESS:
FAX: +7-49621-65084
E-mail: dm2006@theor.jinr.ru
WWW: http://theor.jinr.ru/~dm2006

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
- Dense Matter in Compact Stars
- Future Experimental Facilities

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)
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- A. Dolya (secretary, JINR)

SUPPORTED BY:
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- Joint Institute for Nuclear Research
- Russian Foundation for Basic Research

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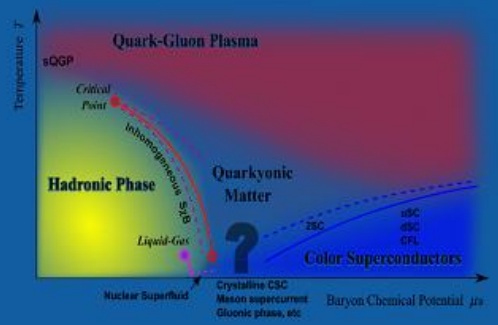
DIAS-TH Dubna International Advanced School for Theoretical Physics
HIC-for-FAIR School and Workshop

Dense QCD Phases in Heavy-Ion Collisions

August 21- September 4, 2010 @ Joint Institute for Nuclear Research



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HADRON PRODUCTION IN HEAVY-ION COLLISIONS

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Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research
Dubna International Advanced School of Theoretical Physics
Helmholtz International Summer School

Lattice QCD, Hadron Structure and Hadronic Matter

Dubna, Russia, September 5 - 17, 2011

Introduction to Lattice Gauge Theories
Hadron structure and spectroscopy
Nonzero temperature and baryon number density
Heavy quark physics
Beyond the Standard Model
Strong magnetic fields
Simulation algorithms and analysis techniques

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M. Goeckeler *(ITP, Regensburg U)*
M. Mueller-Preussker *(Humboldt U., Berlin)*
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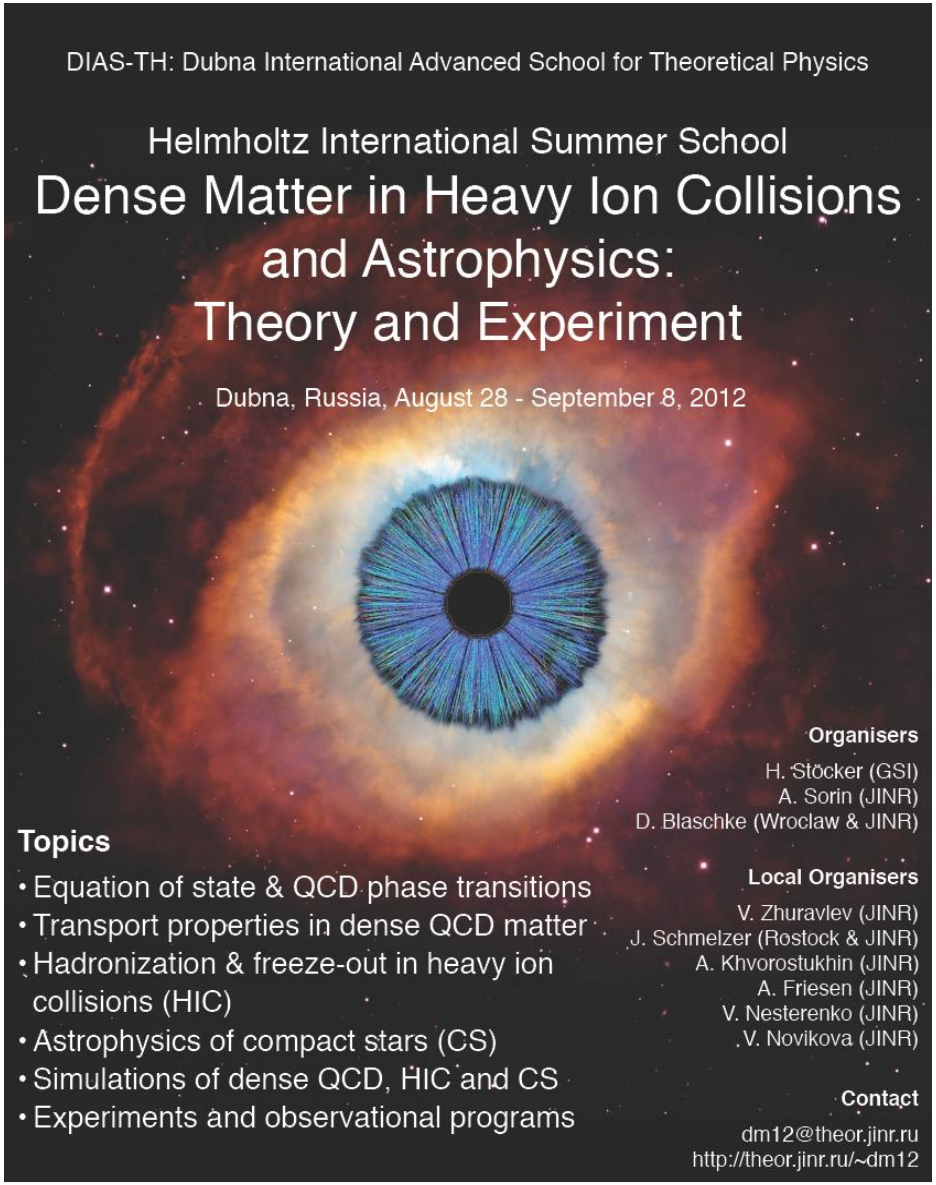
DIAS-TH: Dubna International Advanced School for Theoretical Physics
Helmholtz International Summer School
Dense Matter in Heavy Ion Collisions and Astrophysics: Theory and Experiment
Dubna, Russia, August 28 - September 8, 2012
Organisers
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Topics
• Equation of state & QCD phase transitions
• Transport properties in dense QCD matter
• Hadronization & freeze-out in heavy ion collisions (HIC)
• Astrophysics of compact stars (CS)
• Simulations of dense QCD, HIC and CS
• Experiments and observational programs

There's two possible outcomes: if the result confirms the hypothesis, then you've made a discovery. If the result is contrary to the hypothesis, then you've made a discovery.

(Enrico Fermi)

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