Joint Institute for Nuclear Research
International Intergovernmental Organization

Status of the NICA project

V. Kekelidze, A. Kovalenko, R. Lednicky, V. Matveev,
I. Meshkov, A. Sorin, G. Trubnikov
(for the NICA/MPD collaboration)

Секции ядерной физики ОФН РАН
«Физика фундаментальных взаимодействий»
ГНЦ ИФВЭ, Протвино, 5 - 8 Ноября 2013

Nuclotron Based Ion Collider fAcility - NICA

Main targets of "NICA Complex":

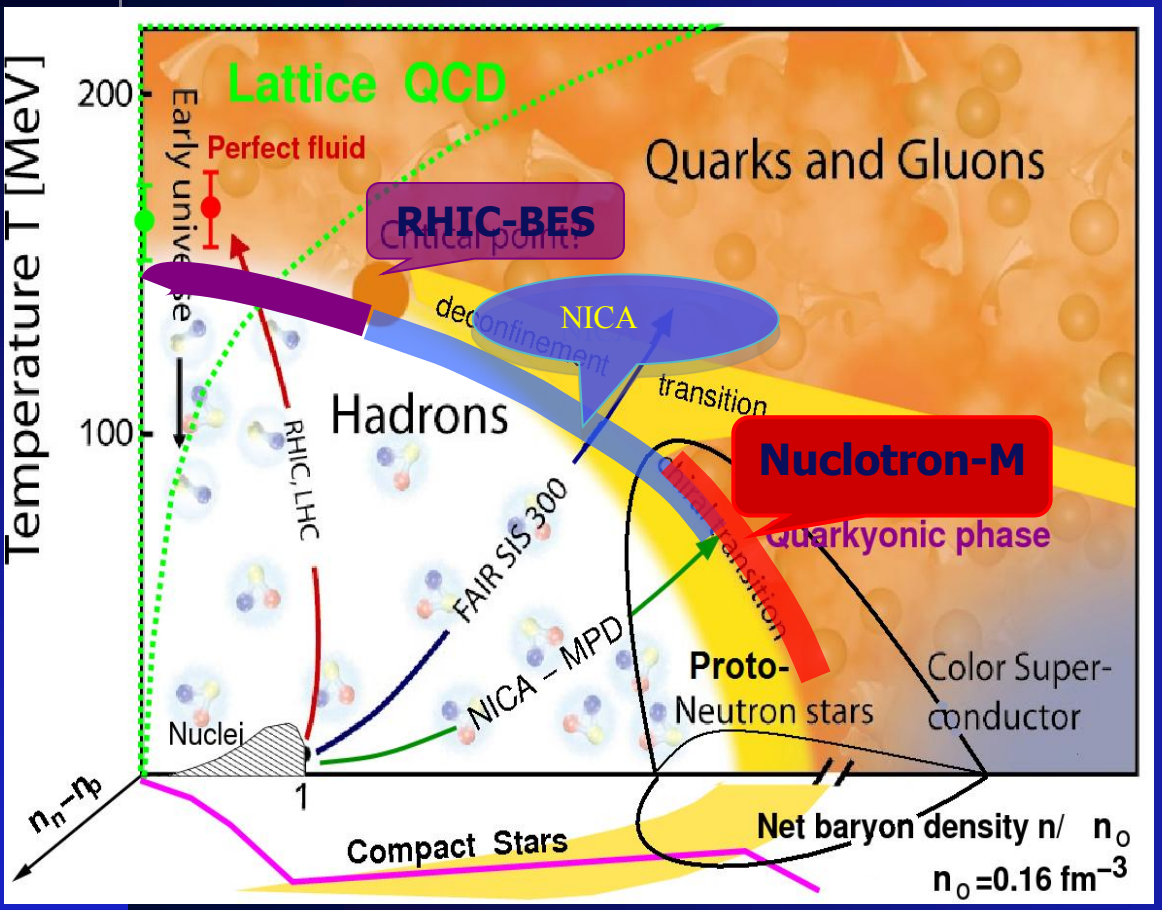
- study of hot and dense baryonic matter

- *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 max energy up to* $\sqrt{S_{NN}}$ = ***11 GeV (Au^{79+})*** *and =****26 GeV (p)***

- *development of infrastructure for applied research*

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 (CEP)
  b) Chiral Symmetry Restoration
  c) Hypothetic Quarkyonic phase
- **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

Editorial board:

D. Blaschke
E. Bratkovskaya
D. Kharzeev
V. Matveev
A. Sorin
A. Stöcker
O. Teryaev
I. Tserruya
N. Xu

Draft v 9.02
June 07, 2013

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

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

NICA White Paper

SEARCHING for a QCD MIXED PHASE at the NUCLOTRON-BASED ION COLLIDER FACILITY

The NICA White Paper addresses the following key topics:

- Phases of dense QCD matter and conditions for their possible realization
- Characteristic processes as indicators of phase transformations
- Estimates of various observables for events
- Comparison to other experiments

NICA White Paper - Contents

(104 contributions)

NICA White Paper – International Effort

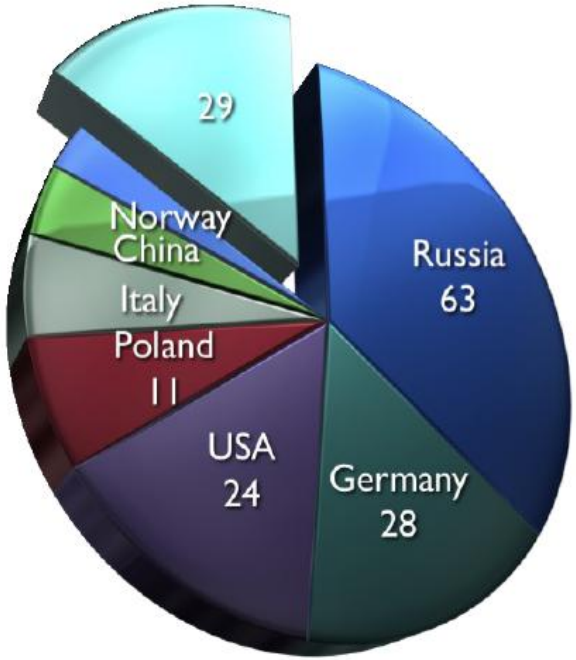
NICA

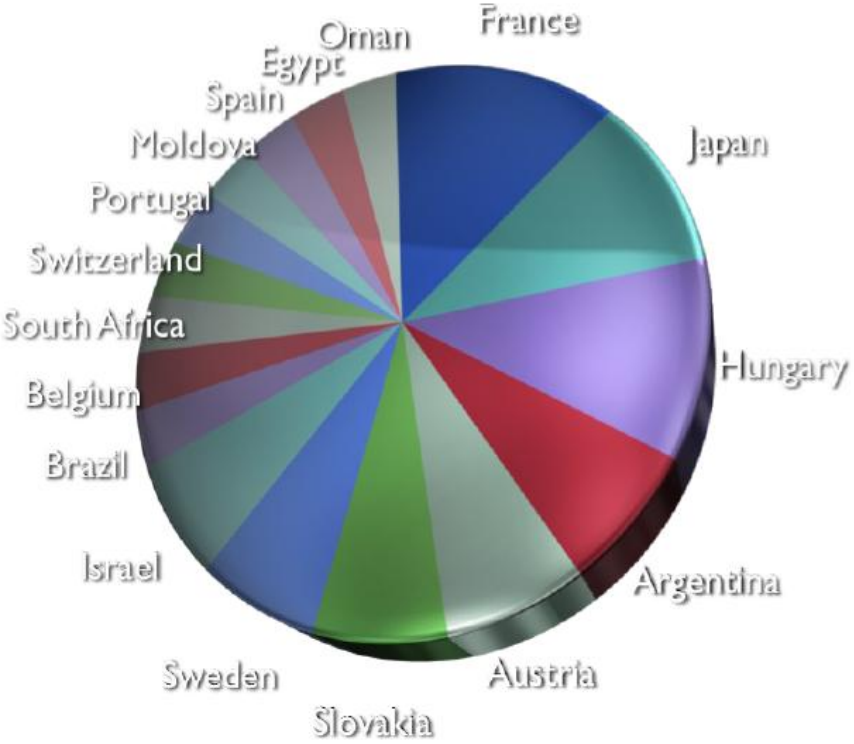
Draft v 9.02
June 07, 2013

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

Statistics of White Paper Contributions

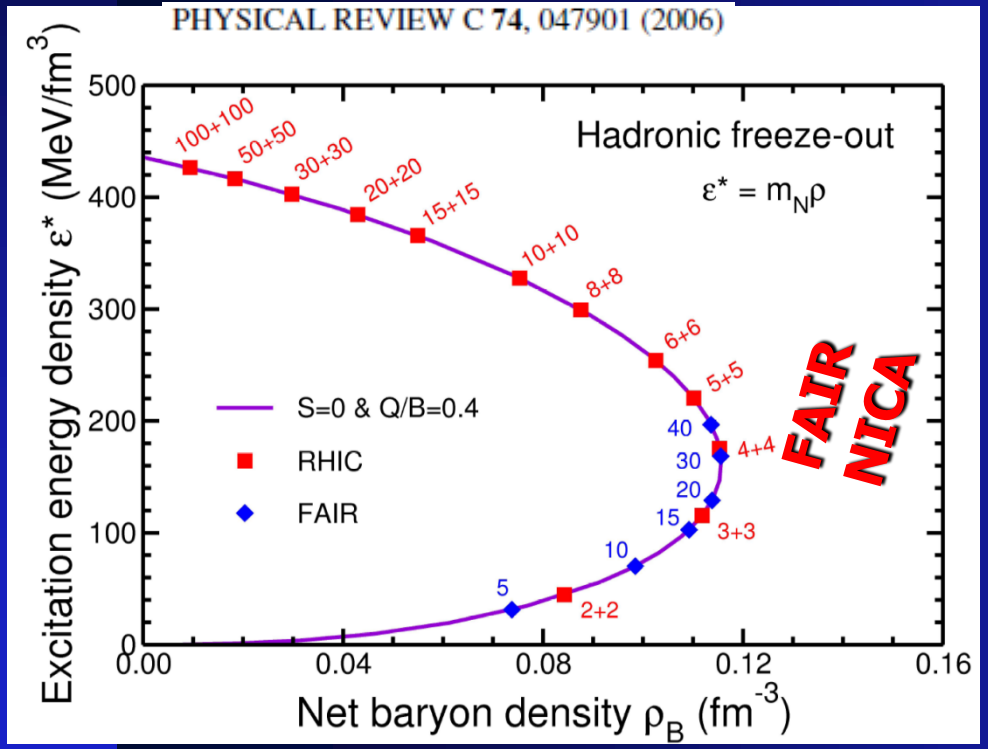
104 contributions:
188 authors from 70 centers in 24 countries

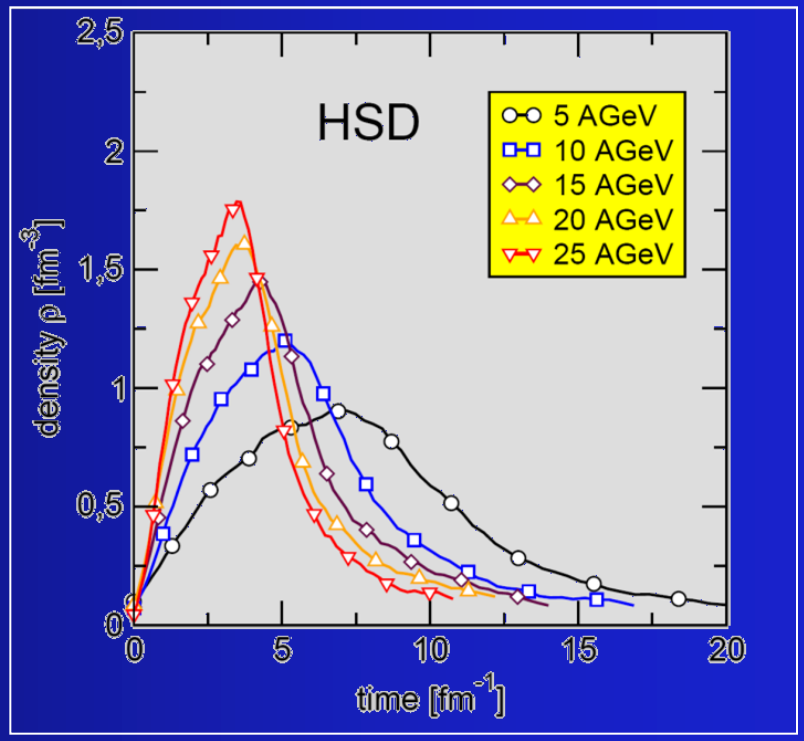




Highest baryon density at Lab

System of maximal net baryon (freeze-out) density is created in A+A collisions at NICA energies → optimum for the compressed baryon matter exploration

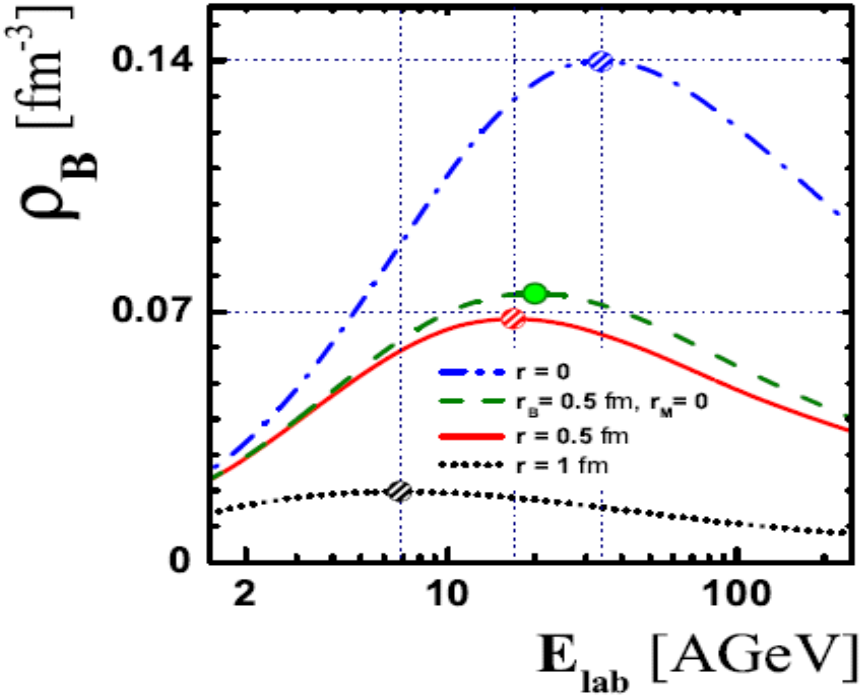


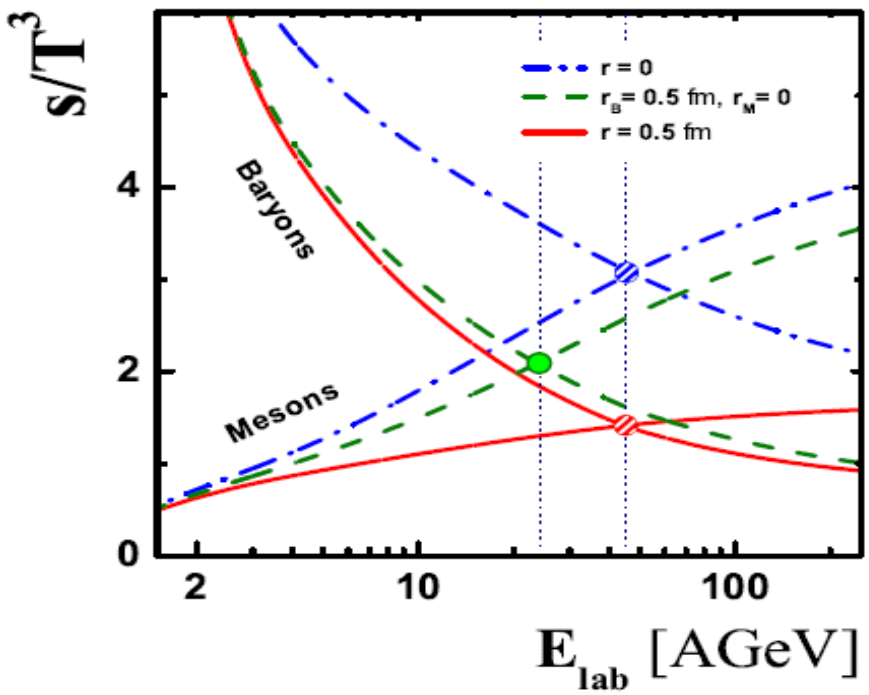


J.Randrup, J.Cleymans, 2006

Excluded volume effects on baryon density and transition from baryon to meson dominated matter

V. V. Begun, M. Gaździcki, M. I. Gorenstein (2013)





By varying the hadron radii in the range r = (0-1.0) fm the collision energy at which the baryon density is maximal changes between 7A and 34A GeV. This range is fully covered by the NICA collider. Thus experiments at NICA will allow to study in detail freeze-out conditions in heavy ion collisions in the domain of their rapid changes and the relation to the onset of deconfinement.

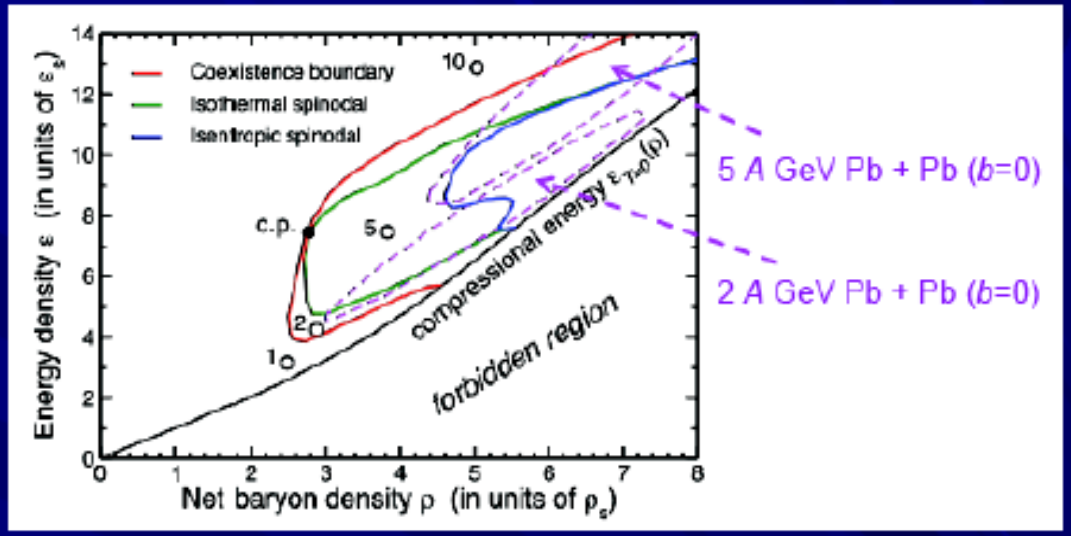
4.19 Spinodal amplification in nuclear collisions @ NICA nuclotron

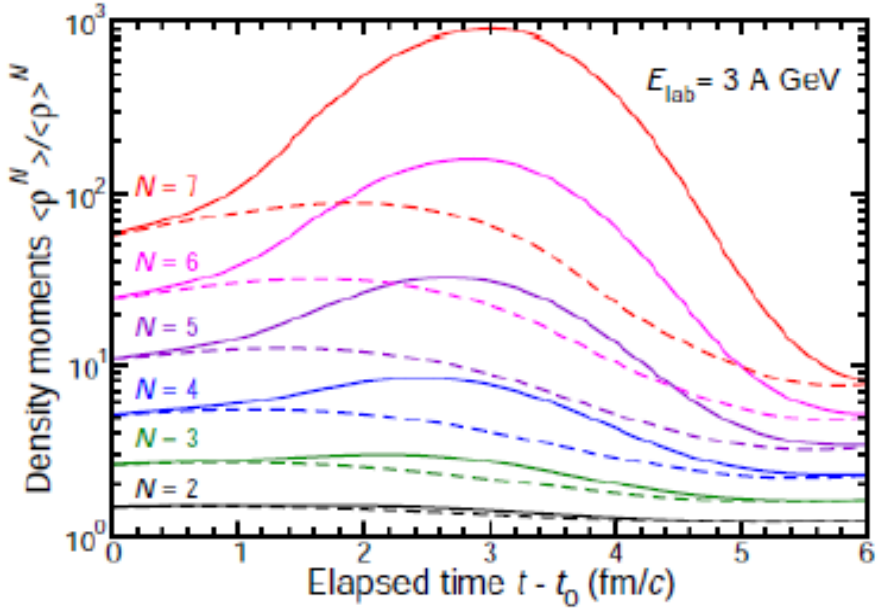
Jan Steinheimer and Jørgen Randrup
Nuclear Science Division, LBNL, Berkeley, California, USA

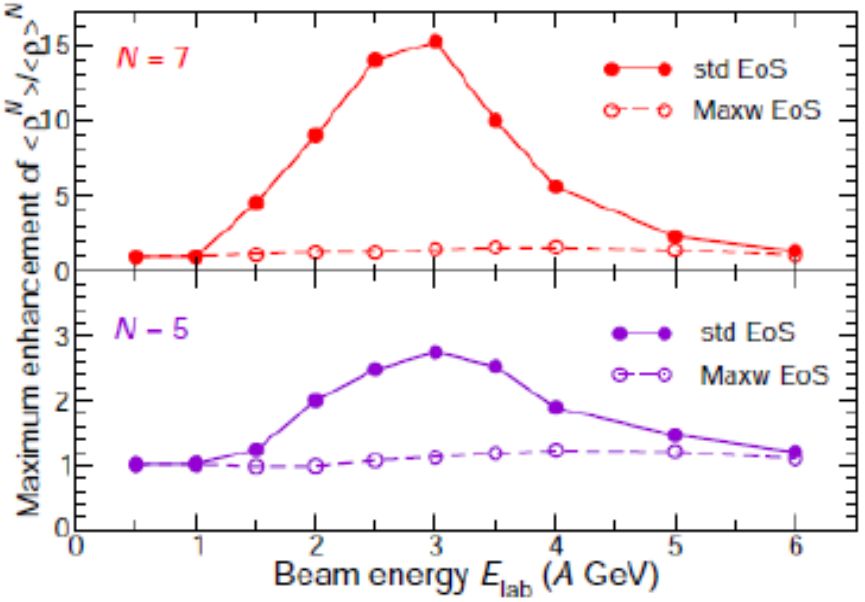
Quantitative measure for degree of clumping: moments of baryon density distribution ρ(r)

$$\langle \rho^N \rangle \equiv \frac{1}{A} \int \rho(\boldsymbol{r})^N \rho(\boldsymbol{r})\, d^3\boldsymbol{r}$$

Optimal energy range: Nuclotron
E_{Lab} ~ 2 – 4 A GeV

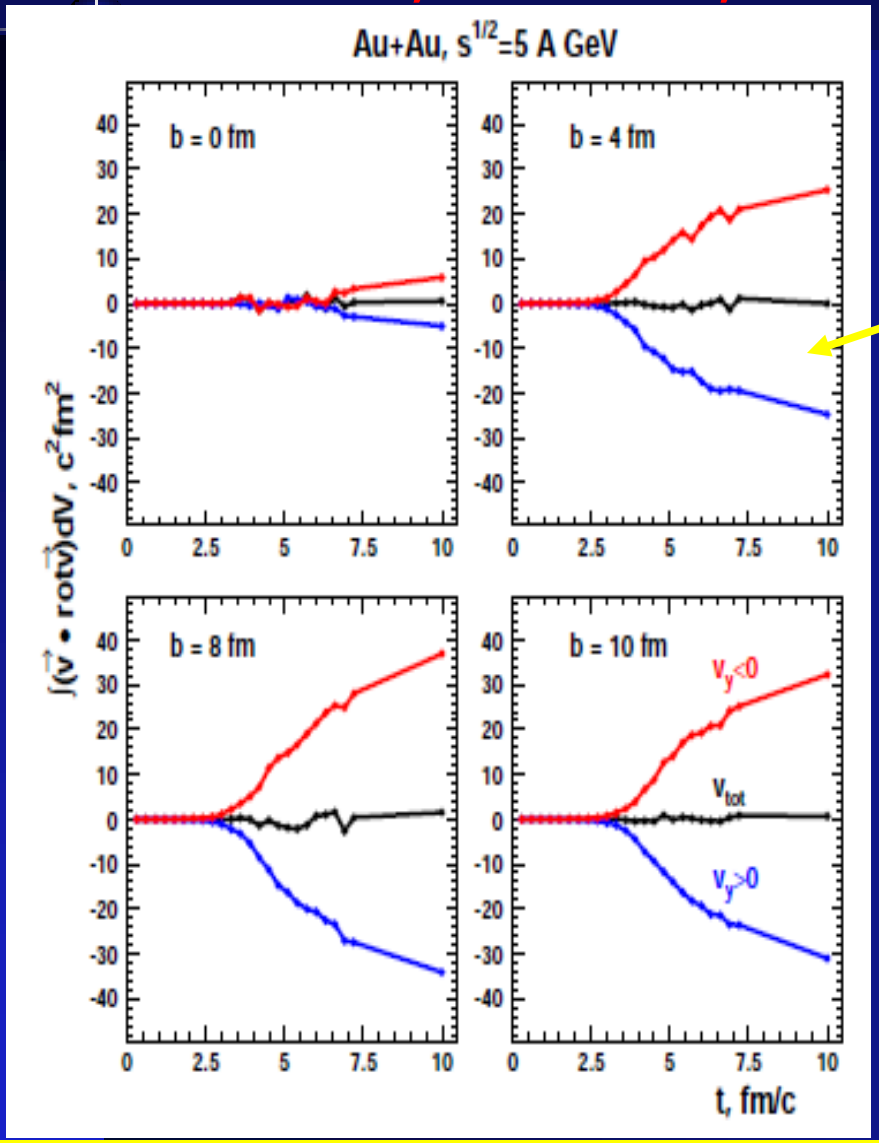






8.6 Vorticity and neutron asymmetries at NICA

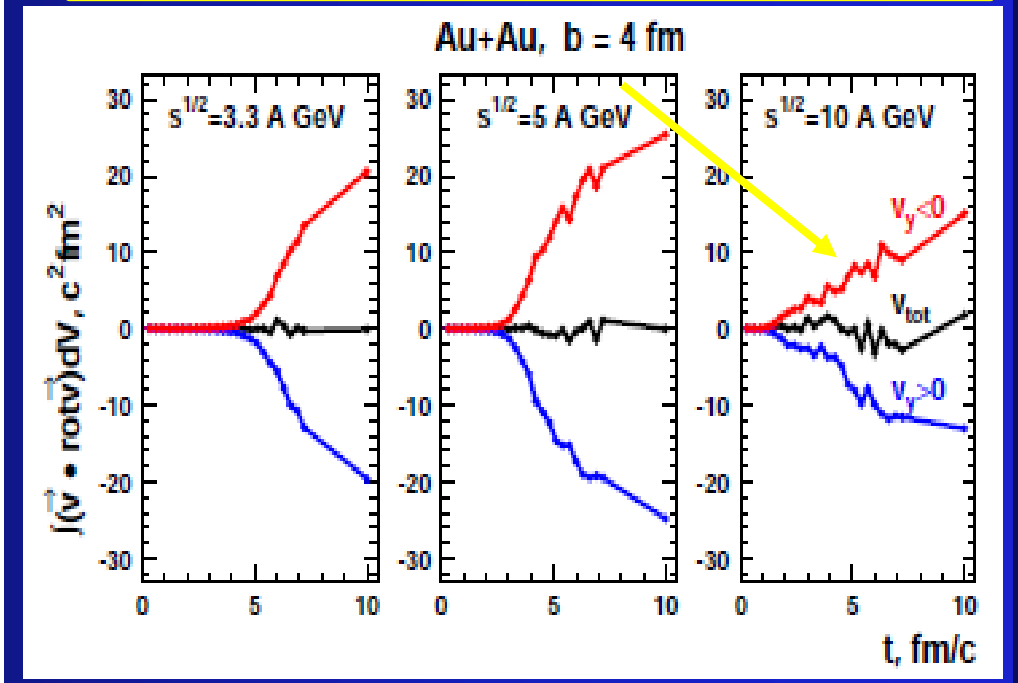
M. Baznat, K. Gudima, O. Rogachevsky, A. Sorin, O. Teryaev



Task for NICA:

- measure helicity for different centralities
- … for different energies

$$H \equiv \int dV (\vec{v} \cdot \vec{w})$$



→ **Max. effect at NICA energies !!**

CME@RHIC: 15 M events to establish the effect. CVE@NICA:1000 M events, which can be collected within a few months of the NICA run.

Observable: three-particle correlator

$$\langle cos(\phi_\alpha + \phi_\beta - 2\phi_c) \rangle$$

Towards the NICA White Paper prioritization

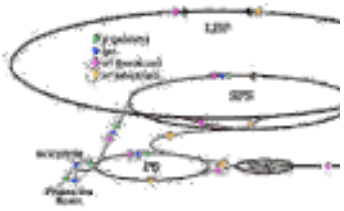
Meeting of the expert group

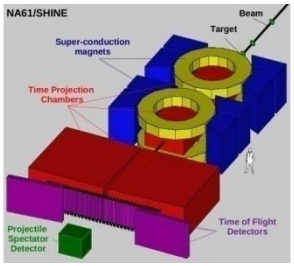
LHEP JINR, October 28 - November 1, 2013

1. **Aichelin Joerg** (Subatech, Université de Nantes, France)
2. **Blaschke David** (Wroclaw University, Poland and JINR, Dubna)
3. **Bratkovskaya Elena** (Frankfurt University and FIAS, Germany)
4. **Friese Volker** (GSI, Darmstadt, Germany)
5. **Gazdzicki Marek** (Frankfurt University, Germany)
6. **Rogachevsky Oleg** (JINR, Dubna)
7. **Randrup Jorgen (**Lawrence Berkeley National Laboratory, USA)
8. **Teryaev Oleg** (JINR, Dubna)
9. **Toneev Vyatcheslav** (JINR, Dubna)

2nd generation HI experiments

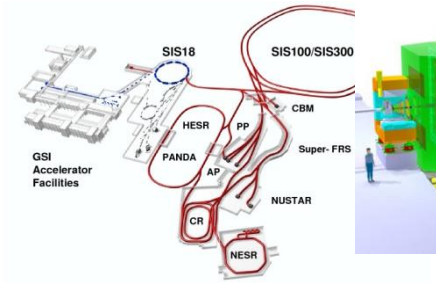
BES STAR/PHENIX@BNL/RHIC

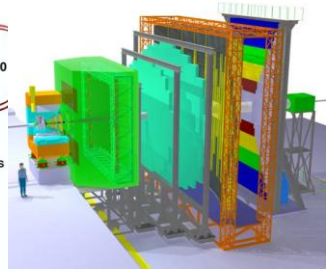




NA61@CERN/SPS

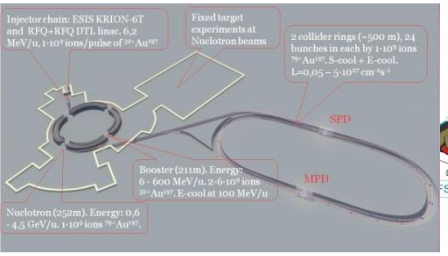
3nd generation HI experiments

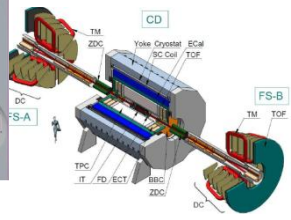




CBM@FAIR/SIS-100/300

Fixed target, E/A=10-40 GeV, highest intensity

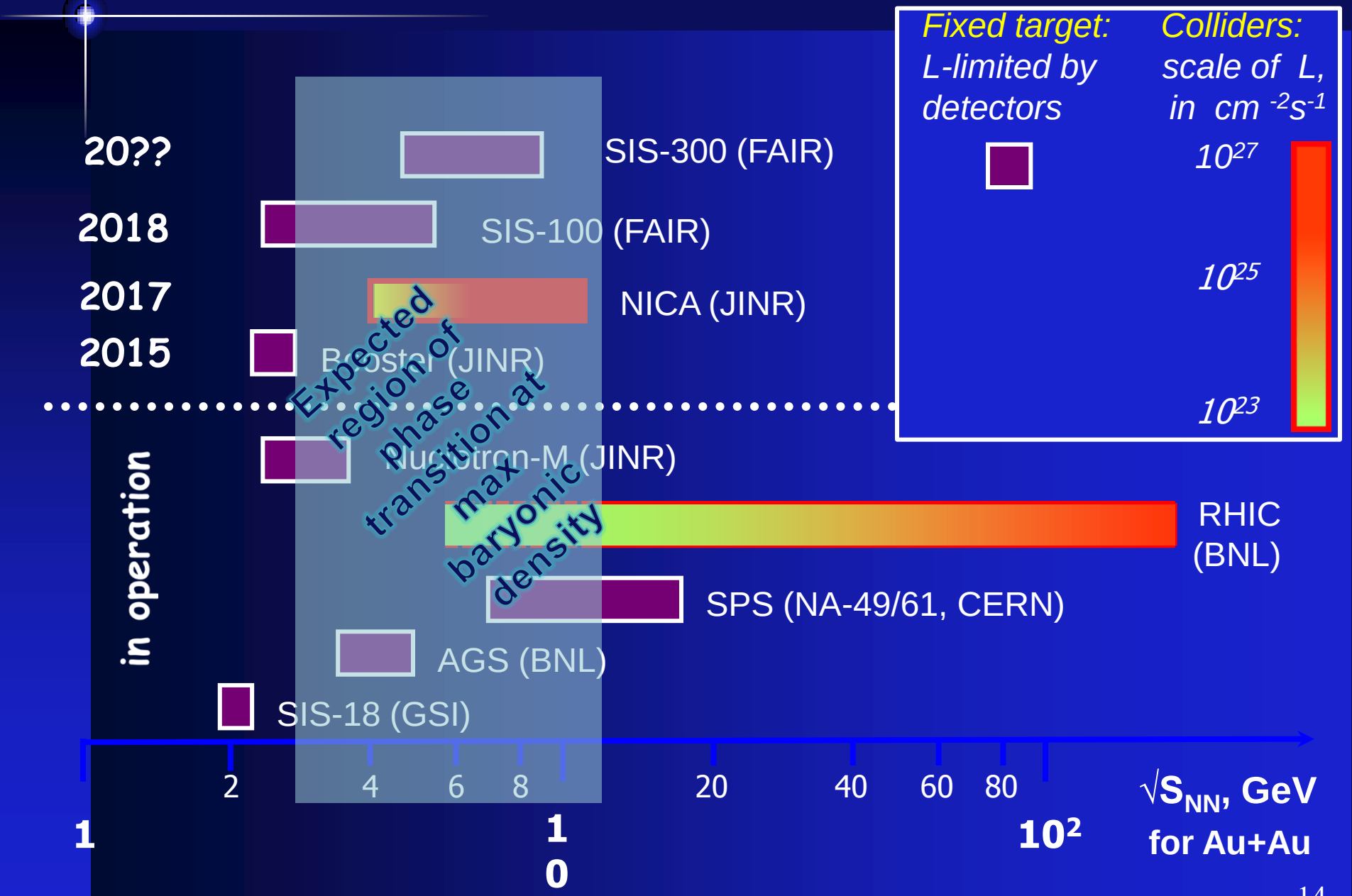




MPD@JINR/NICA

Collider, $\sqrt{s_{NN}}$ = 4-11 GeV, L~10^{27} cm^{-2}s^{-1} for Au^{79+}

Existing & Future HI Machines



NICA stages

- 7-years JINR plan approval (2010-2016) 2009

  ✓ *Project Nuclotron-M completed* *2010*

  (Nuclotron modernization I-stage)

in 2010-2013 7 runs were prepared and successfully carried out

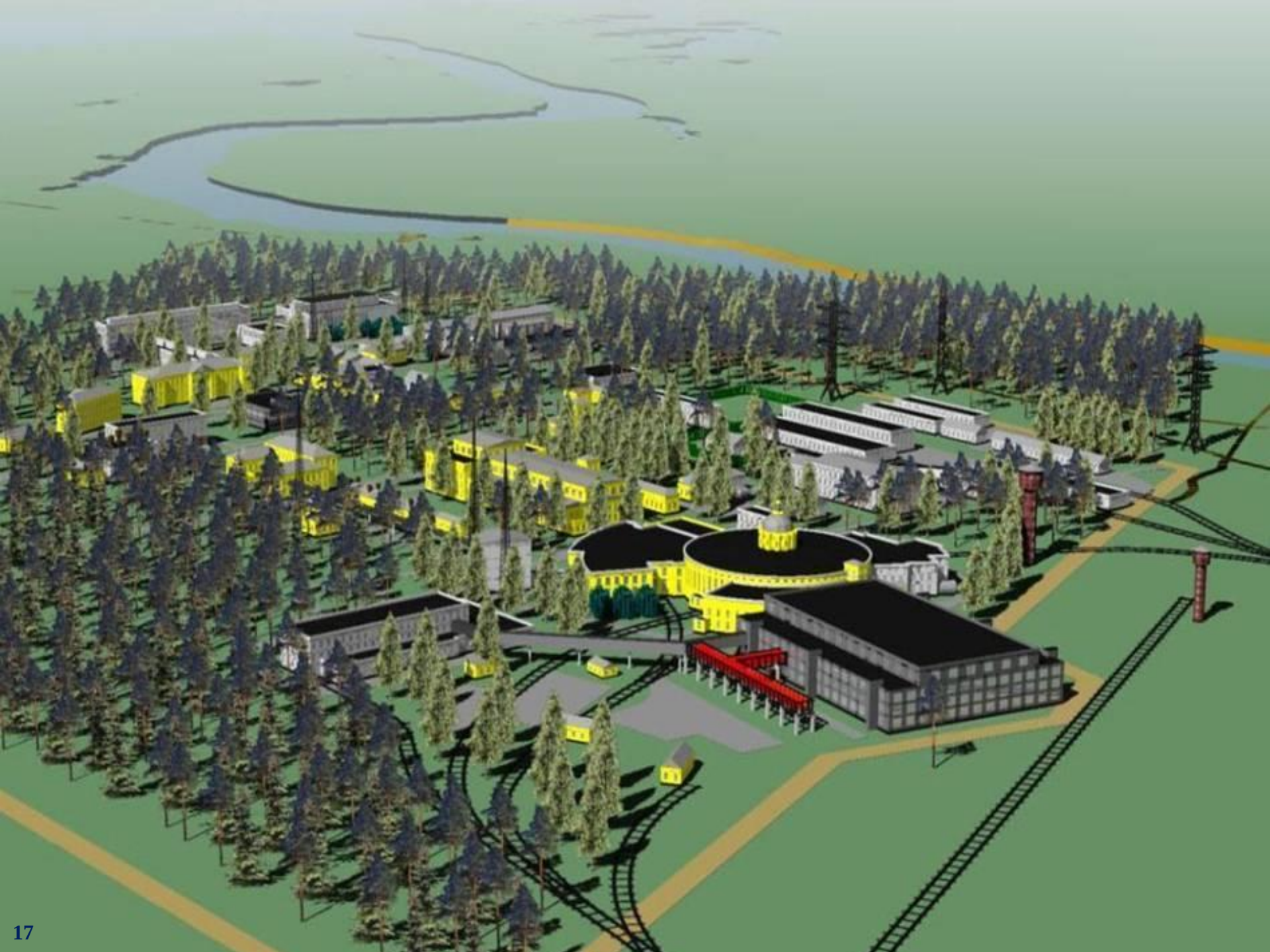
- Prepared and approved new projects:

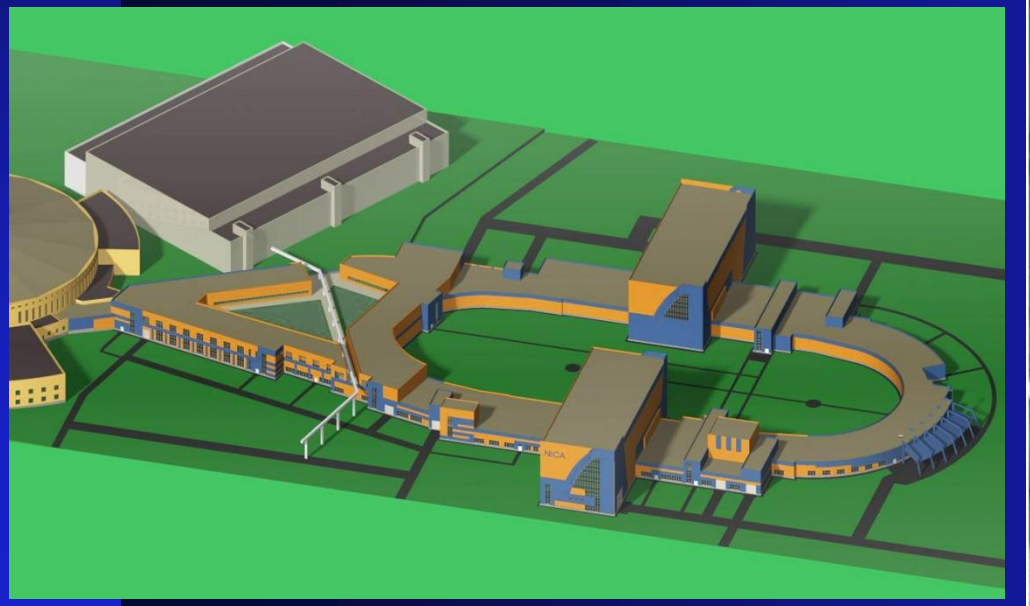
  ✓ *Nuclotron-NICA* *2010*

  ✓ *MPD (MultiPurpose Detector)* *2010*

  ✓ *BM@N (Barionic Matter at Nuclotron)* *2012*

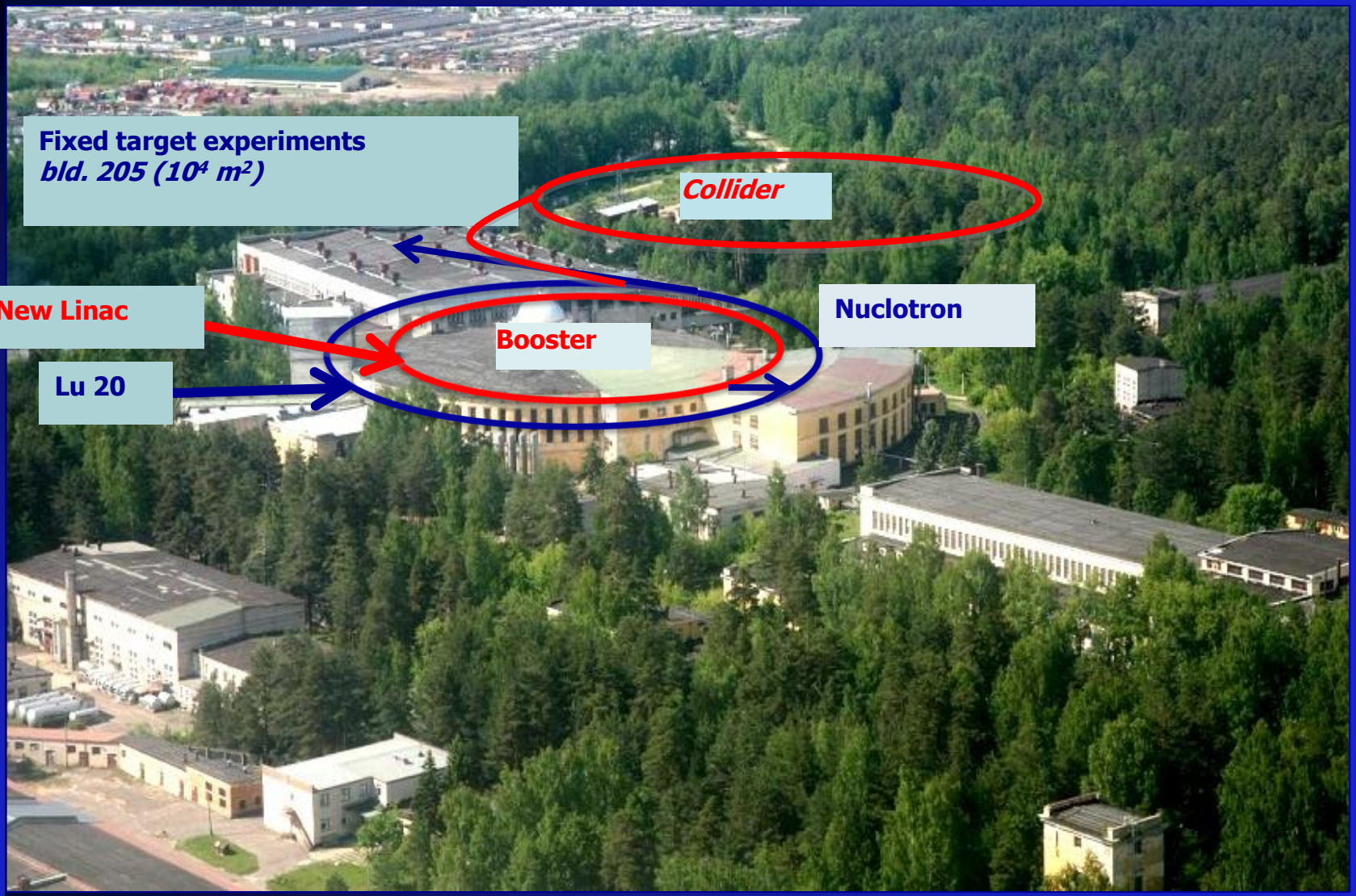
NICA site





Future NICA complex

Nuclotron-based Ion Collider fAcility (NICA)



1a) Heavy ion colliding beams $^{197}Au^{79+}$ x $^{197}Au^{79+}$ at
$\sqrt{s_{NN}}$ = 4 ÷ 11 GeV (1 ÷ 4.5 GeV/u ion kinetic energy)
at Laverage= 1E27 $cm^{-2}\cdot s^{-1}$ (at √sNN = 9 GeV)

1b) Light-Heavy ion colliding beams of the same energy range and luminosity

2) Polarized beams of protons and deuterons in collider mode:
p↑p↑ √spp = 12 ÷ 27 GeV (5 ÷ 12.6 GeV kinetic energy)
d↑d↑ √sNN = 4 ÷ 13.8 GeV (2 ÷ 5.9 GeV/u ion kinetic energy
Laverage > 1E31 $cm^{-2}\cdot s^{-1}$ (at √s_pp = 27 GeV)

3) The beams of light ions and polarized protons and deuterons for fixed target experiments:

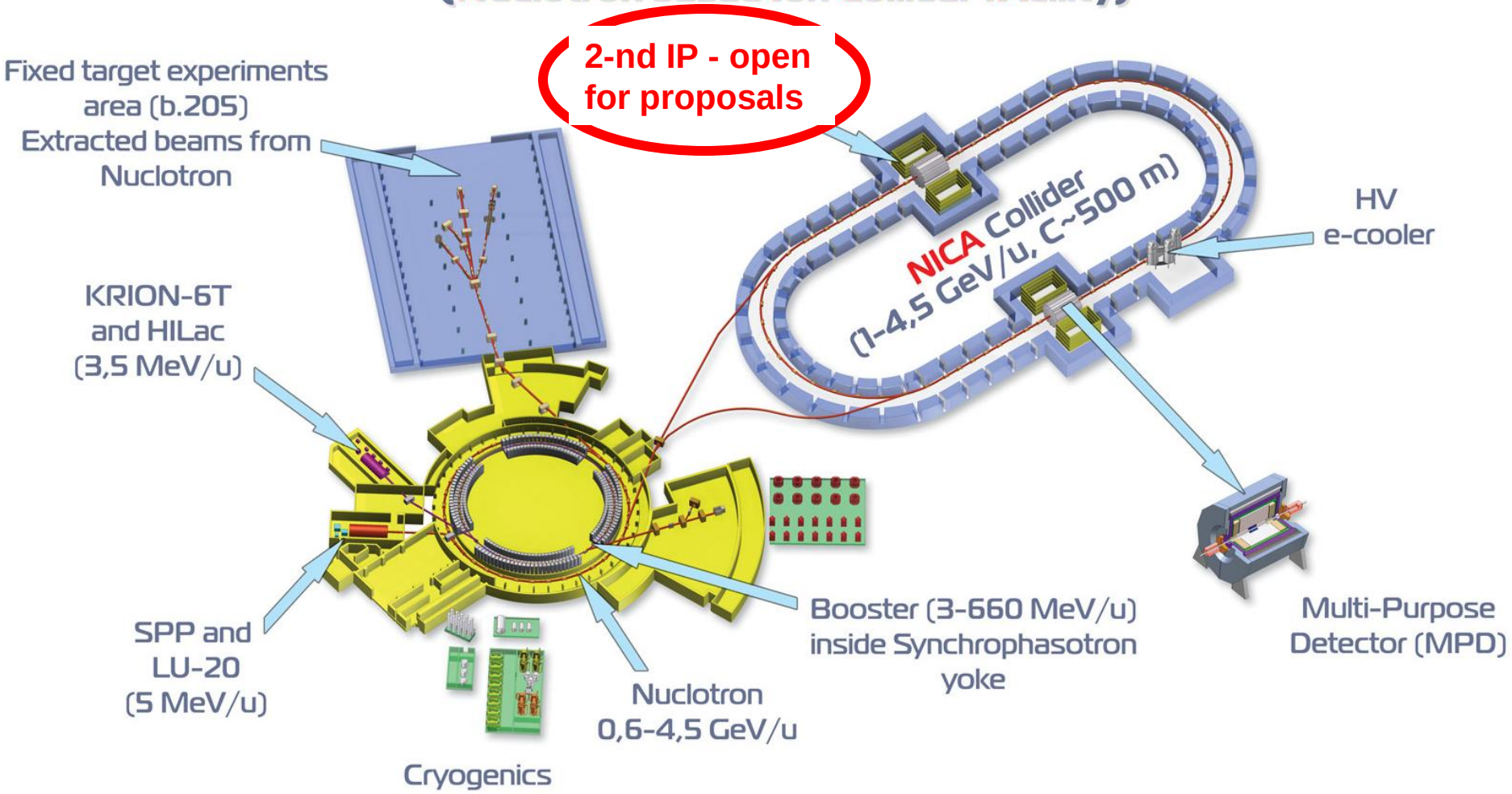
Li ÷ Au = 1 ÷ 4.5 GeV /u ion kinetic energy
p, p↑ = 5 ÷ 12.6 GeV kinetic energy
d, d↑ = 2 ÷ 5.9 GeV/u ion kinetic energy

4) Applied research with ion beams at kinetic energy from 0.5 GeV/u up to 12.6 GeV (p) and 4.5 GeV /u (Au)

Beam	Nuclotron beam intensity (particle per cycle)		
	Current	Ion source type	New ion source + booster
p	$3 \cdot 10^{10}$	Duoplasmotron	$5 \cdot 10^{12}$
d	$3 \cdot 10^{10}$	--- ,, ---	$5 \cdot 10^{12}$
^{4}He	$8 \cdot 10^{8}$	--- ,, ---	$1 \cdot 10^{12}$
d↑	$2 \cdot 10^{8}$	SPI	$1 \cdot 10^{10}$
^{7}Li	$8 \cdot 10^{8}$	Laser	$5 \cdot 10^{11}$
^{11,10}B	$1 \cdot 10^{9,8}$	--- ,, ---	
^{12}C	$1 \cdot 10^{9}$	--- ,, ---	$2 \cdot 10^{11}$
^{24}Mg	$2 \cdot 10^{7}$	--- ,, ---	
^{14}N	$1 \cdot 10^{7}$	ESIS (“Krion-6T”)	$5 \cdot 10^{10}$
^{24}Ar	$1 \cdot 10^{9}$	--- ,, ---	$2 \cdot 10^{11}$
^{56}Fe	$2 \cdot 10^{6}$	--- ,, ---	$5 \cdot 10^{10}$
^{84}Kr	$1 \cdot 10^{4}$	--- ,, ---	$1 \cdot 10^{9}$
^{124}Xe	$1 \cdot 10^{4}$	--- ,, ---	$1 \cdot 10^{9}$
^{197}Au	-	--- ,, ---	$1 \cdot 10^{9}$

Superconducting accelerator complex NICA

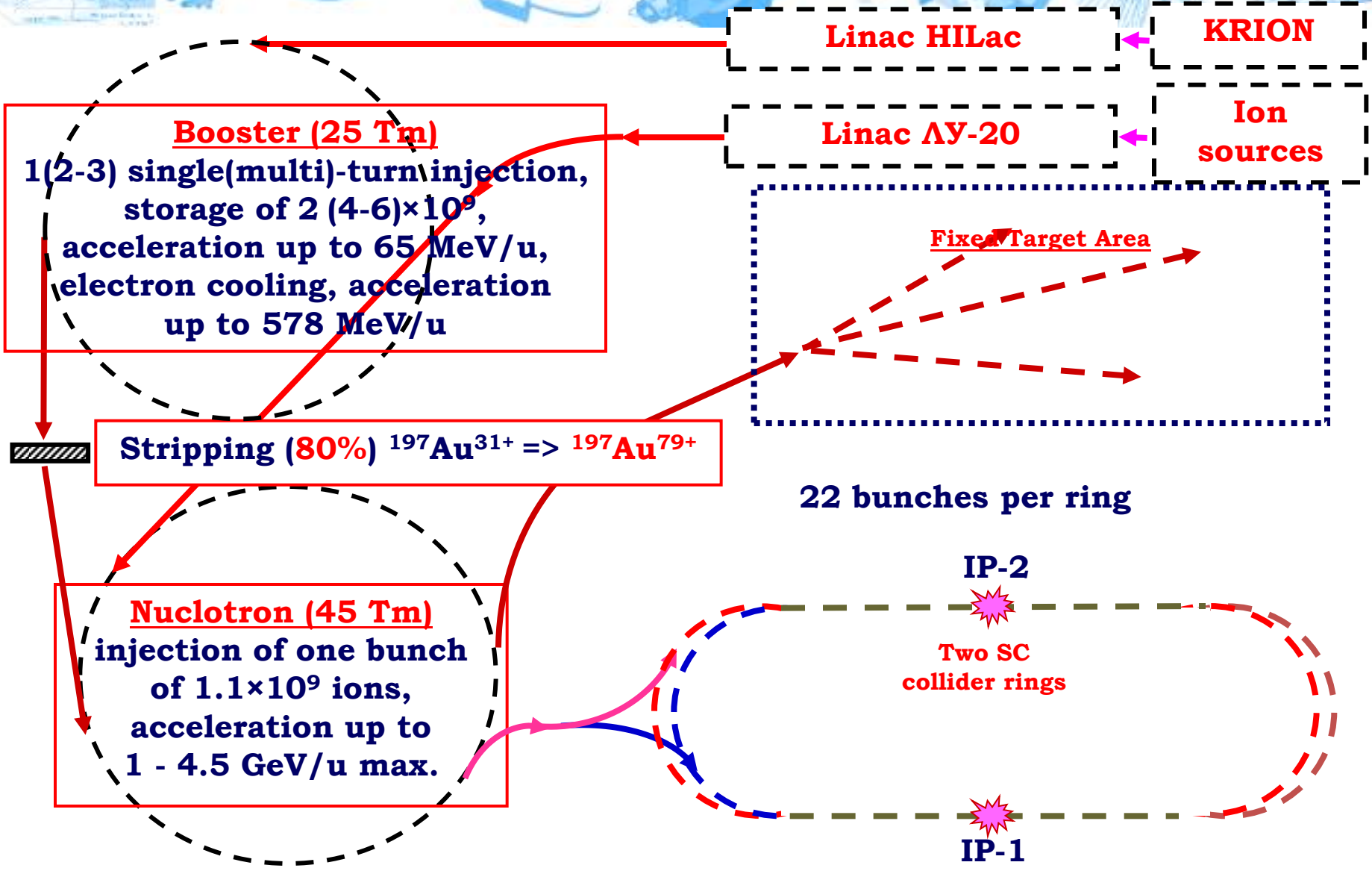
(Nuclotron based Ion Collider fAcility)



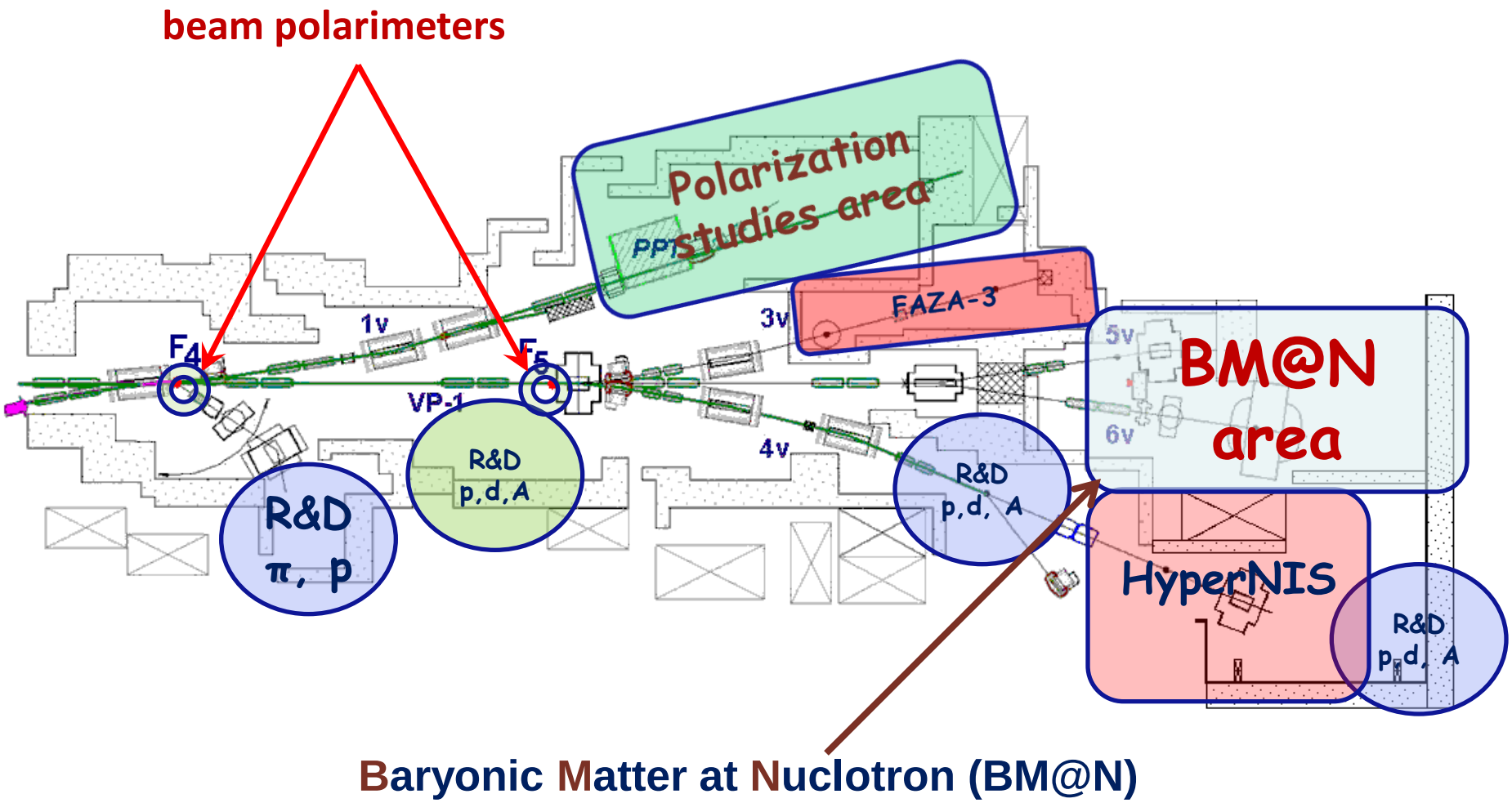
NICA Collider parameters:

- **Energy range: $\sqrt{s_{NN}}$ = 4-11 GeV**
- **Beams: from p to Au**
- **Luminosity: L~10^{27} (Au), 10^{32} (p)**
- **Detectors: MPD; 2-nd is waiting for Proposals**

NICA structure



Bld. 205 (*10 000 m²*): structure of research zones with extracted beams



The NICA beam users community

the Workshop "Prospect for experimental research on the Nuclotron beams"
held on 6-7 June at VBLHEP, JINR

The Workshop was organized in order to make the scientific community informed about:

- *status of the existing Nuclotron facility & the reached beam parameters;*
- *possibility of further development & usage of these beams for research;*
- *available supporting infrastructure & possibility of its development;*
- *agreed policy & rules of usage of the beams.*

07.06.2013

MINUTES
of the international workshop
"Prospect for experimental research on the Nuclotron beams"
6-7 June, 2013, Dubna

In accordance with the Seven-Year Plan for the JINR Development, approved by the Committee of Plenipotentiaries, the Nuclotron was successfully upgraded. It allows raising the capabilities for experiments at the Nuclotron beams to a new level.

There are several research programs being prepared and realized at the Nuclotron: Energy and transmutation, HyperNIS, ALPOM-2, DSS, FAZA-3 and BM@N. The other activities included in the JINR Topical Plan as well as new suggestions were also presented.

Draft of the updated Rules of planning and distribution of the beam time at the Nuclotron (User Access Policy) was announced. The document is available for discussion and suggestions (within two months) on the Workshop web-page http://nica.jinr.ru/files/Meeting6-7june/docs.html
The summary of the Round Table discussion and agenda of the workshop are available at the same site.

JINR Member-States representatives:

for Czech Republic — Dr. V.Wagner

for Bulgaria — Prof. Ch.Stoyanov

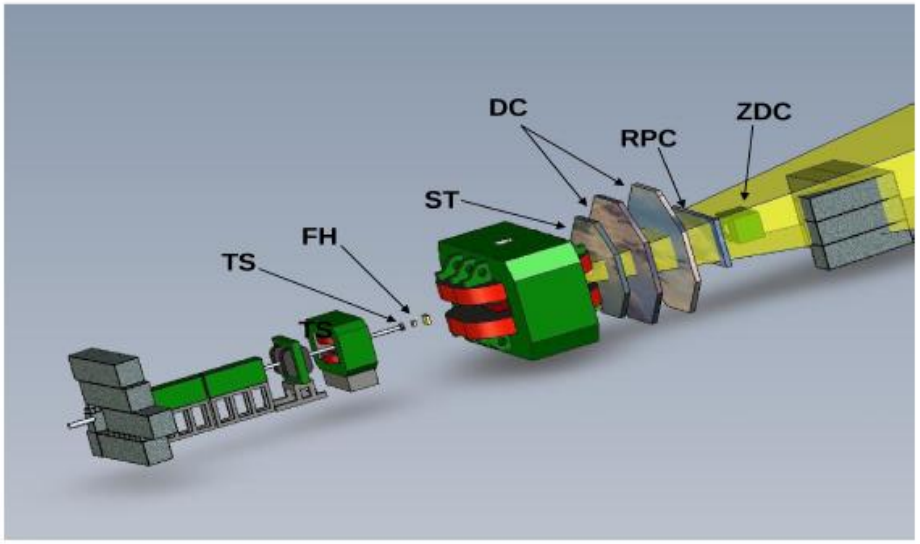
for Poland — Prof. M.Szuta

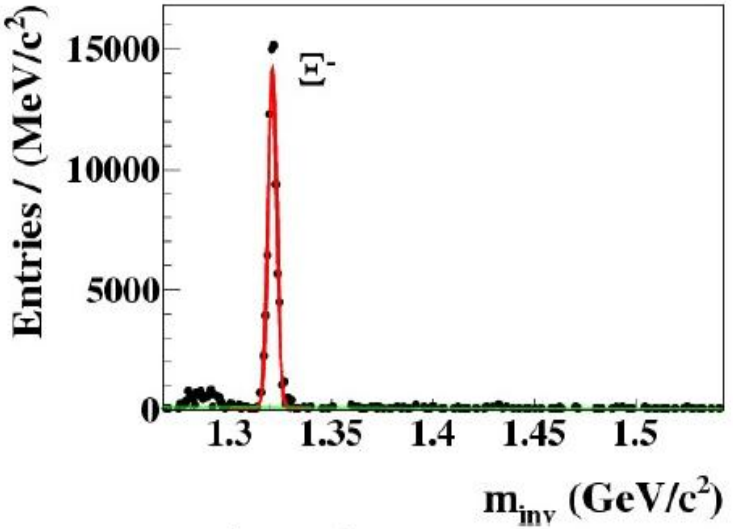
for Armenia — Prof. N.Demekhina

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

- Collaboration GSI-JINR (preparation of the joint experiment has started)
- 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 A GeV)

Physics at BM@N





Physics for the first stage of the BM@N spectrometer (2015):

-In-medium effects for strangeness and vector mesons decaying in hadron modes
-Flows, polarizations, vorticity and azhimuthal correlations of hadrons
-Femtoscopy for different hadrons (and photons)
-NN and NA interactions as the reference for AA collisions
-Electromagnetic probes (optionally)

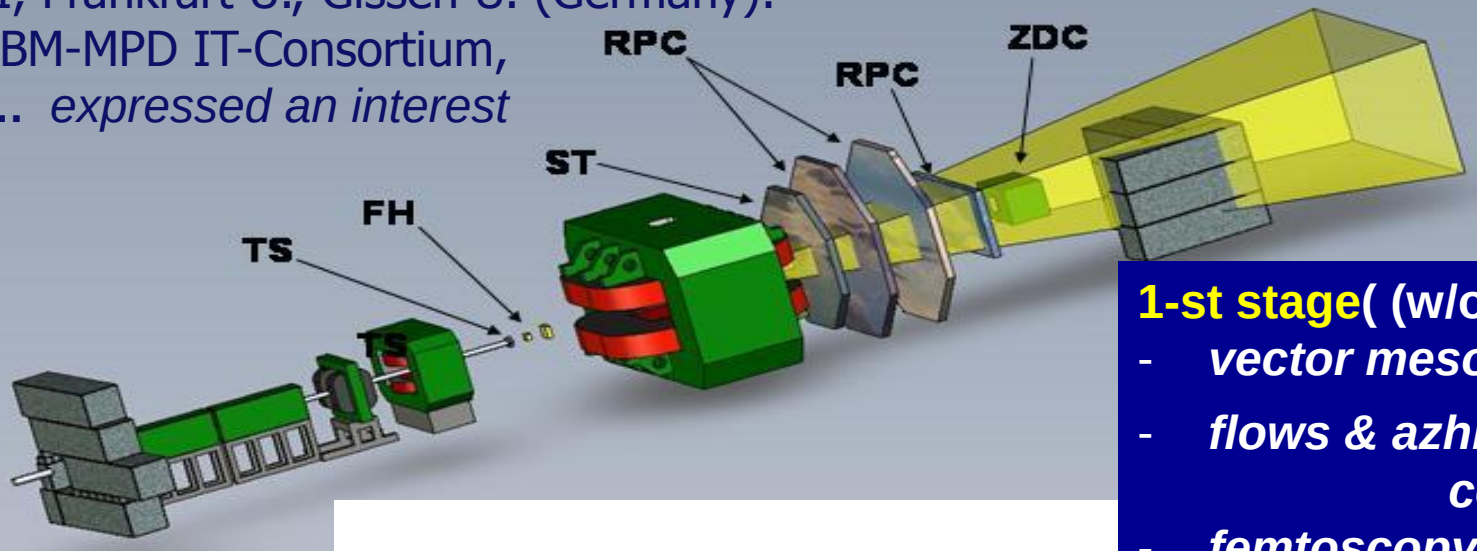
Physics for the BM@N spectrometer with inner tracker(2017):

-The measurements of the (sub)threshold cascade hyperons production in order to obtain the information on the nuclear matter EOS.

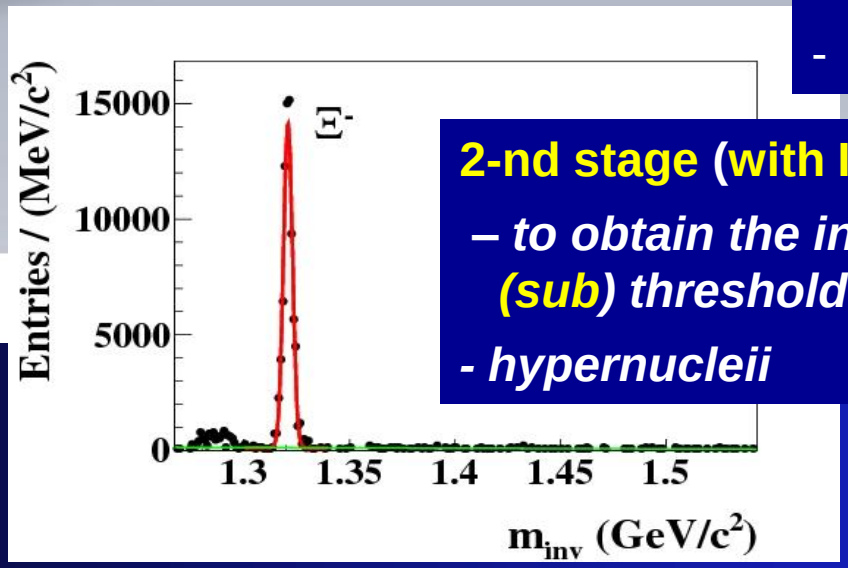
BM@N Collaboration

Technical project – in preparation

19 scientific centers: INR, SINP MSU, IHEP + 2 Universities (Russia);
GSI, Frankfurt U., Gissen U. (Germany):
+ CBM-MPD IT-Consortium,
+ …. *expressed an interest*



1-st stage((w/o IT):
- *vector mesons*
- *flows & azhimuthal correlations*
- *femtoscopy*



2-nd stage (with IT):

– to obtain the information on EOS
(sub) threshold production of cascades

- hypernucleii

the area for BM@N allocation in bld. 205

08 Oct 2012

progress in BM@N preparation (bld. 205)

modernized magnet СП-41

area prepared for detector allocation

counting rooms

progress in BM@N preparation (bld. 205)

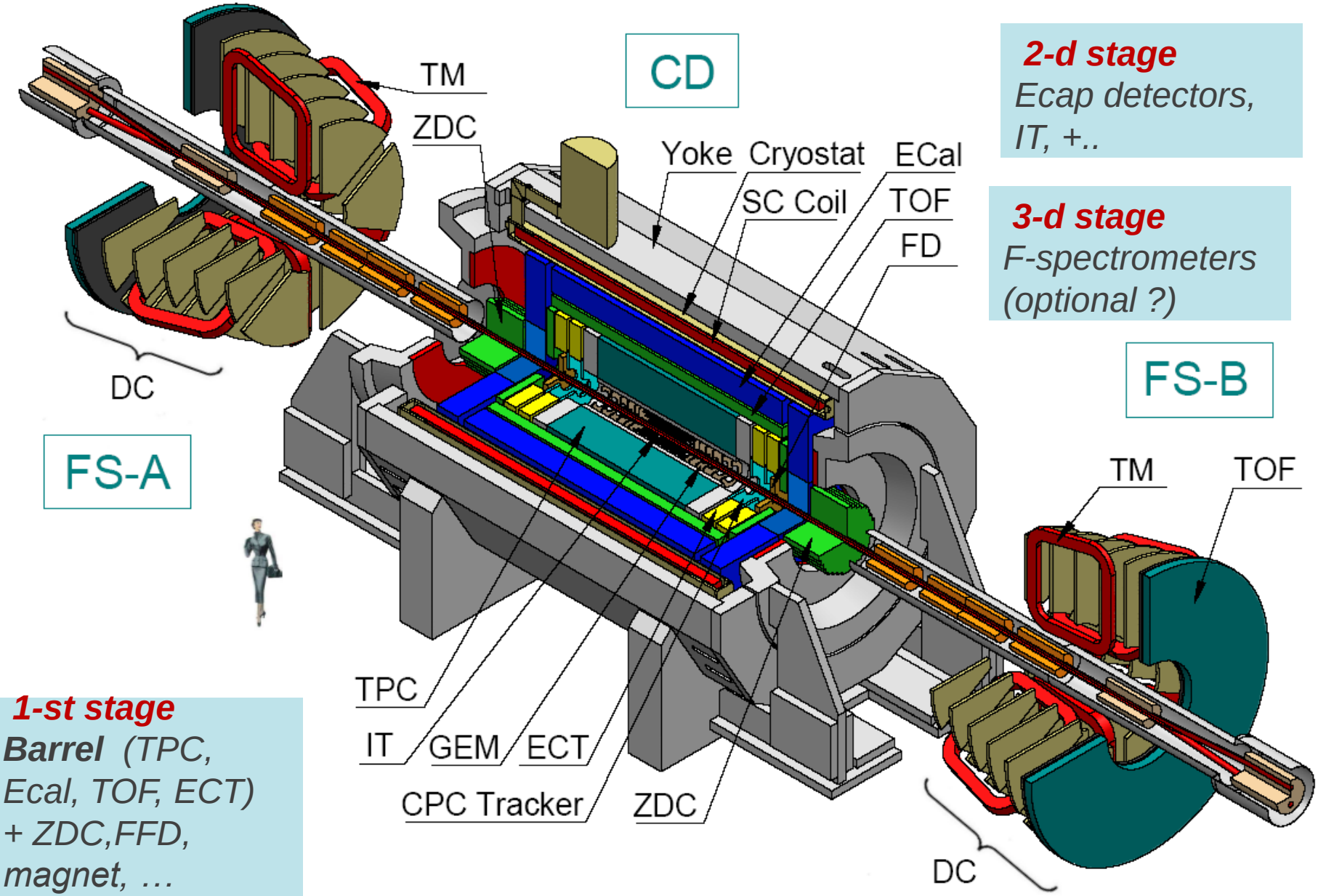
Drift chambers
in specially prepared
clean room

chambers are tested
& ready for operation

MultyPurpose Detector (MPD)

1-st IP @ NICA Collider

4 GeV $< \sqrt{s_{NN}} <$ ***11 GeV*** ***(for*** Au^{79+}***)***



2-d stage
Ecap detectors, IT, +..

3-d stage
F-spectrometers (optional ?)

1-st stage
Barrel *(TPC, Ecal, TOF, ECT) + ZDC,FFD, magnet, …*

MPD Staging

I stage: Barrel (*TPC, TOF, ECAL), ZDC, FFD (+Ecap ?)*

mid rapidity region *(good performance)*

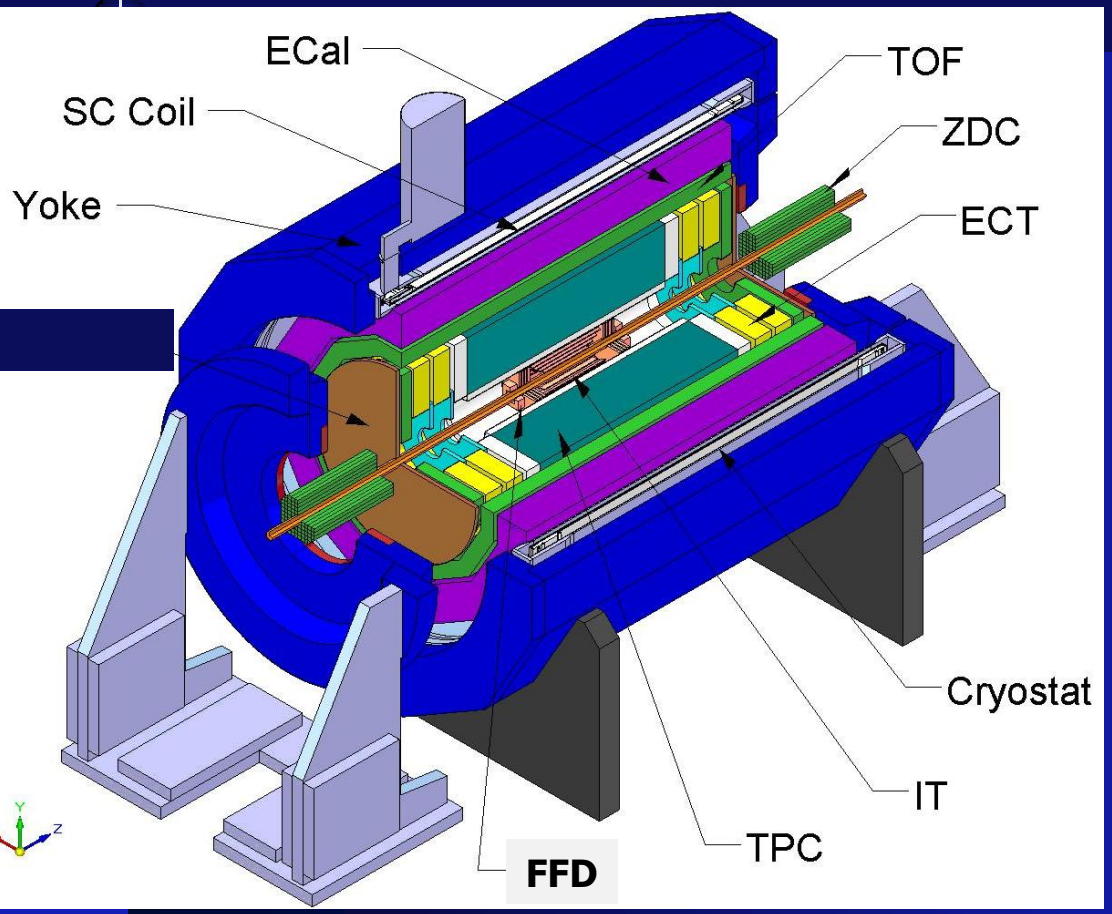
- ***Particle yields and spectra (p,K,p,clusters,L, X ,W)***
- ***Event-by-event fluctuations***
- ***Femtoscopy involving π, K, p, Λ***
- ***Collective flow for identified hadron species***
- ***Electromagnetic probes (electrons, gammas), vector mesons***

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)***

III stage: will be considered later

Start up configuration of the MultiPurpose Detector (MPD)



Magnet: *0.66 T SC solenoid*

Basic tracking: **TPC**

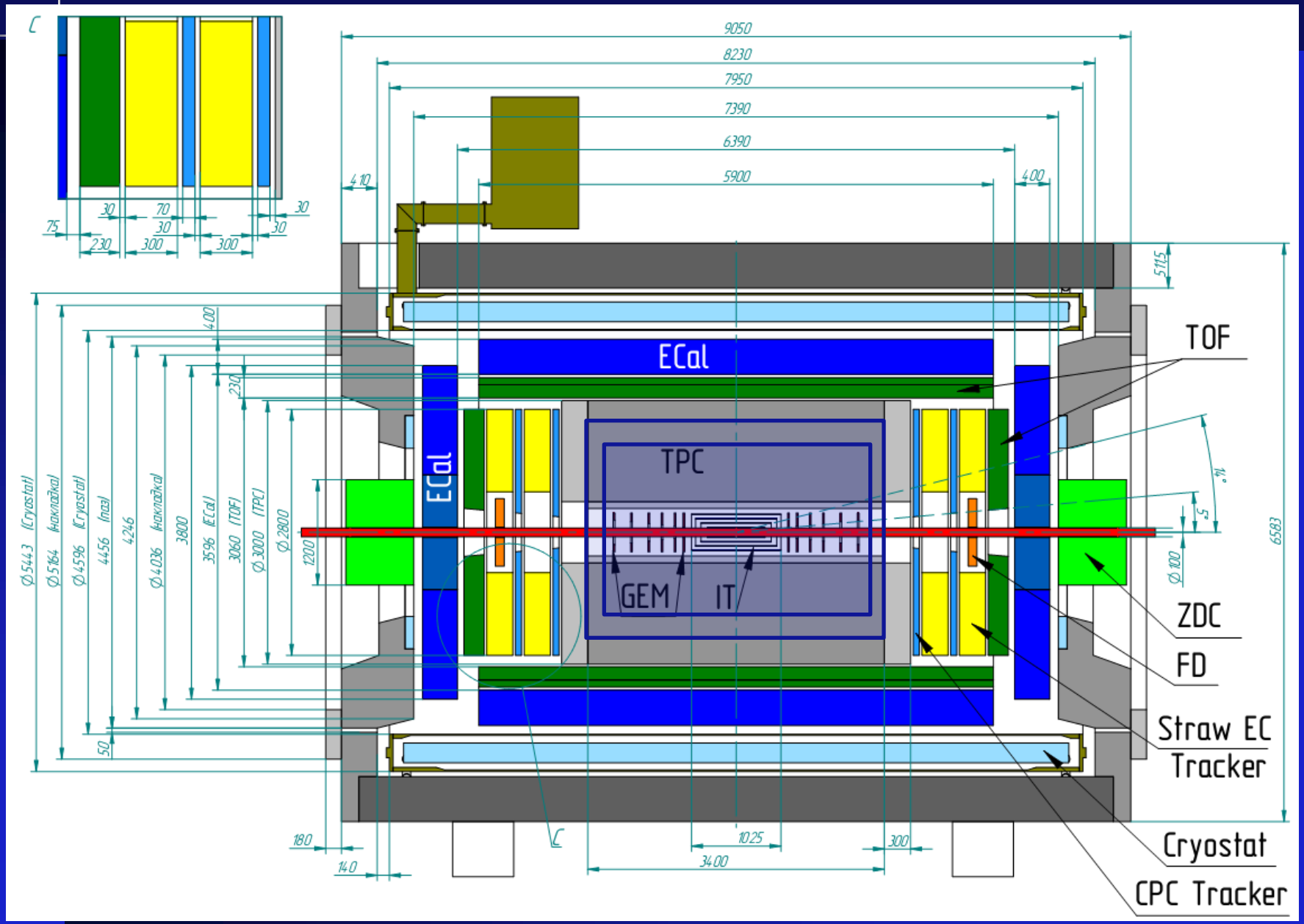
ParticleID: **TOF, ECAL, TPC**

T0, Triggering: **FFD**

Centrality, Event plane: **ZDC**

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*


ECal
ECal
TPC
GEM
IT
TOF
ZDC
FD
Straw EC Tracker
Cryostat
CPC Tracker

NICA Physics plan for 2017-19 (Stage 1)

In the beginning energy-system size scan will be performed at NICA/MPD with the listed beam species varying the collisions energy from 4 to 11 GeV in steps of 1-2 GeV.

Beam	Luminosity ($cm^{-2} c^{-1}$)		Data sample per 1 week at $\sqrt{s}$ = 4 GeV
	$\sqrt{s}$=4 GeV	$\sqrt{s}$=11 GeV	
p	10^{32}	10^{32}	$1.5 \cdot 10^{10}$
^{12}C	$4 \cdot 10^{28}$	$2 \cdot 10^{29}$	$1.5 \cdot 10^{10}$
^{64}Cu	$6 \cdot 10^{27}$	$3.5 \cdot 10^{28}$	$5 \cdot 10^{9}$
^{124}Xe	$8 \cdot 10^{26}$	$6 \cdot 10^{27}$	$1 \cdot 10^{9}$
^{197}Au	$1.5 \cdot 10^{26}$	10^{27}	$3 \cdot 10^{8}$

Disk storage for data ≈ 10 PB/year

Measurements of hadrons (π, K, (anti)p, (anti)hyperons, light (anti)nuclei and dilepton spectra as a function of energy, system size, centrality, pT, rapidity and azimuthal angle.

The strategy

- **Localize the QCD CEP, then investigate in detail the critical region (in finer steps)**
- **Detailed study of the LMR dilepton enhancement in the unexplored region of the highest baryon density. If an indication for dropping mass found → detailed look in this region**
- **Study of the QCD mixed phase - hadroproduction and rare probes**

NICA-MPD physics cases

Observable	Set-up	Coverage	New insights
Hadron yields & ratios	TPC, TOF ZDC	|h| < 1.5 pT < 3 GeV/c	Data for 5<√s<7 GeV, critical assessment of y-spectra and K/p-ratio
Hyperons: yields, flow, Polarization	TPC, TOF ZDC	|h| < 1.5 pT < 3 GeV/c	High statistics data on yields, flow and polarization √s < 7 GeV
Dileptons	TPC, TOF ECAL, ZDC	|h| < 1.1 pT < 3 GeV/c	New data at √s > 5 GeV
Fluctuations & Correlations	TPC, TOF ECAL, ZDC	|h|< 1.5 pT < 3 GeV/c	New data on Ev-by-Ev fluct. for √s > 4 GeV
Anti-protons Anti-nuclei	TPC, TOF ZDC	|h| < 1.1 pT < 2 GeV/c	New data on antinuclei, Flow of Pbar and antiL
Flow (v1,2,3) Hadrons & nuclei	TPC, TOF ZDC	|h| < 1.5 pT< 3 GeV/c	New measurements @ √s<7GeV Precise v_n data for f,W
Chiral Magnetic & vortical effects	TPC, TOF ZDC	|h| < 1.5 pT < 3 GeV/c	Data @ √s < 7GeV (CME) Vortical @ 4 < √s < 11 GeV
(Hyper)Nuclei	TPC,TOF,ZDC	|h|<1.5, pT<5 GeV/c	New data at 5 < √s < 11

Particle yields, Au+Au @ $\sqrt{s_{NN}}$ = 8 GeV *(central collisions)*

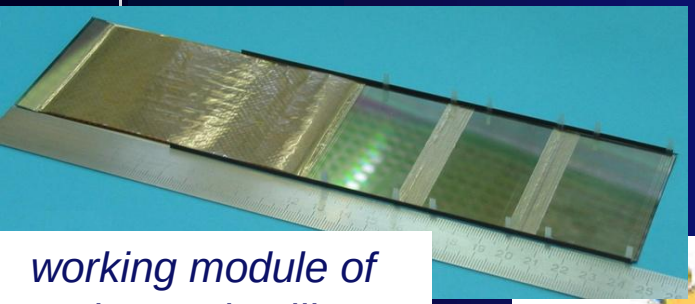
Expectations for 10 weeks of running at L = $10^{27}cm^{-2}s^{-1}$ (duty factor = 0.5)

Particle	Yields		Decay mode	BR	*Effic. %	Yield/10 w
	4π	y=0				
π^+	293	97	----	---	61	$2.6 \cdot 10^{11}$
K^+	59	20	---	----	50	$4.3 \cdot 10^{10}$
p	140	41	---	----	60	$1.2 \cdot 10^{11}$
ρ	31	17	e+e-	$4.7 \cdot 10^{-5}$	35	$7.3 \cdot 10^{5}$
ω	20	11	e+e-	$7.1 \cdot 10^{-5}$	35	$7.2 \cdot 10^{5}$
φ	2.6	1.2	e+e-	$3 \cdot 10^{-4}$	35	$1.7 \cdot 10^{5}$
Ω	0.14	0.1	ΛK	0.68	2	$2.7 \cdot 10^{6}$
D^0	$2 \cdot 10^{-3}$	$1.6 \cdot 10^{-3}$	$K^+\pi^-$	0.038	20	$2.2 \cdot 10^{4}$
J/ψ	$8 \cdot 10^{-5}$	$6 \cdot 10^{-5}$	e+e-	0.06	15	10^3

*Efficiency includes the MPD acceptance, realistic tracking and particle ID.
Particle yields are from experimental data (NA49), statistical and HSD models.
Efficiency from MPD simulations. Typical efficiency from published data (STAR)

The clean area for assembly & test of Vertex Detector:

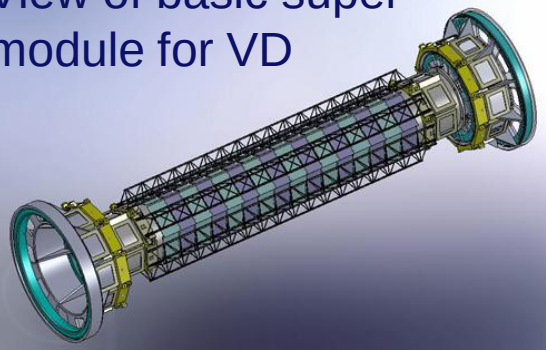
CBM/FAIR-MPD/NICA Consortium (**Germany**, **Russia**, **Ukraine**)



working module of 3 micro-strip silicon

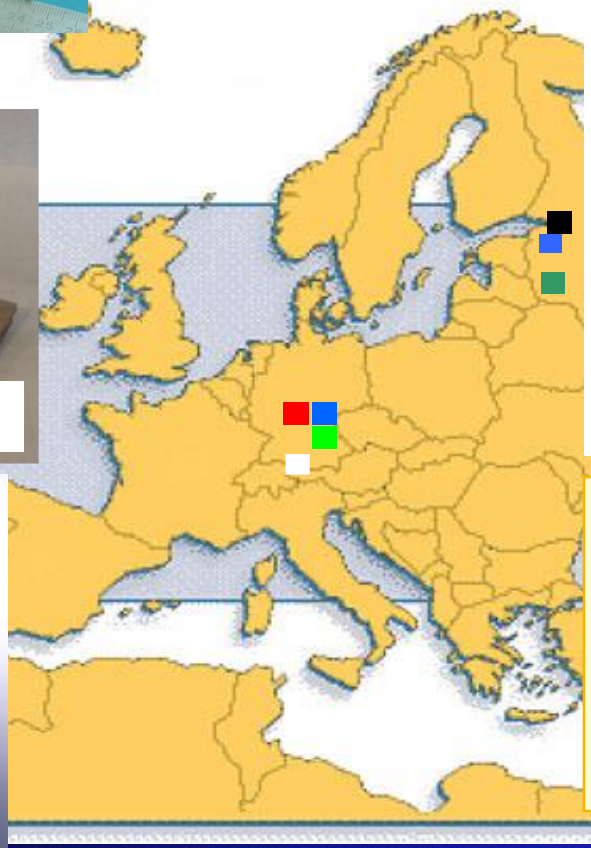
Carbon-plastic structure (15 g)

View of basic super-module for VD



CBM @ FAIR	MPD @ NICA

- **7 institutes**
- **3 countries**



- JINR, Dubna
- GSI, Darmstadt Germany
- IHEP, Protvino, Russia
- MSU, Moscow, Russia
- KRI, St.Petersburg, Russia
- University, -"-
- SE SRTIIE, Kharkiv, Ukraine

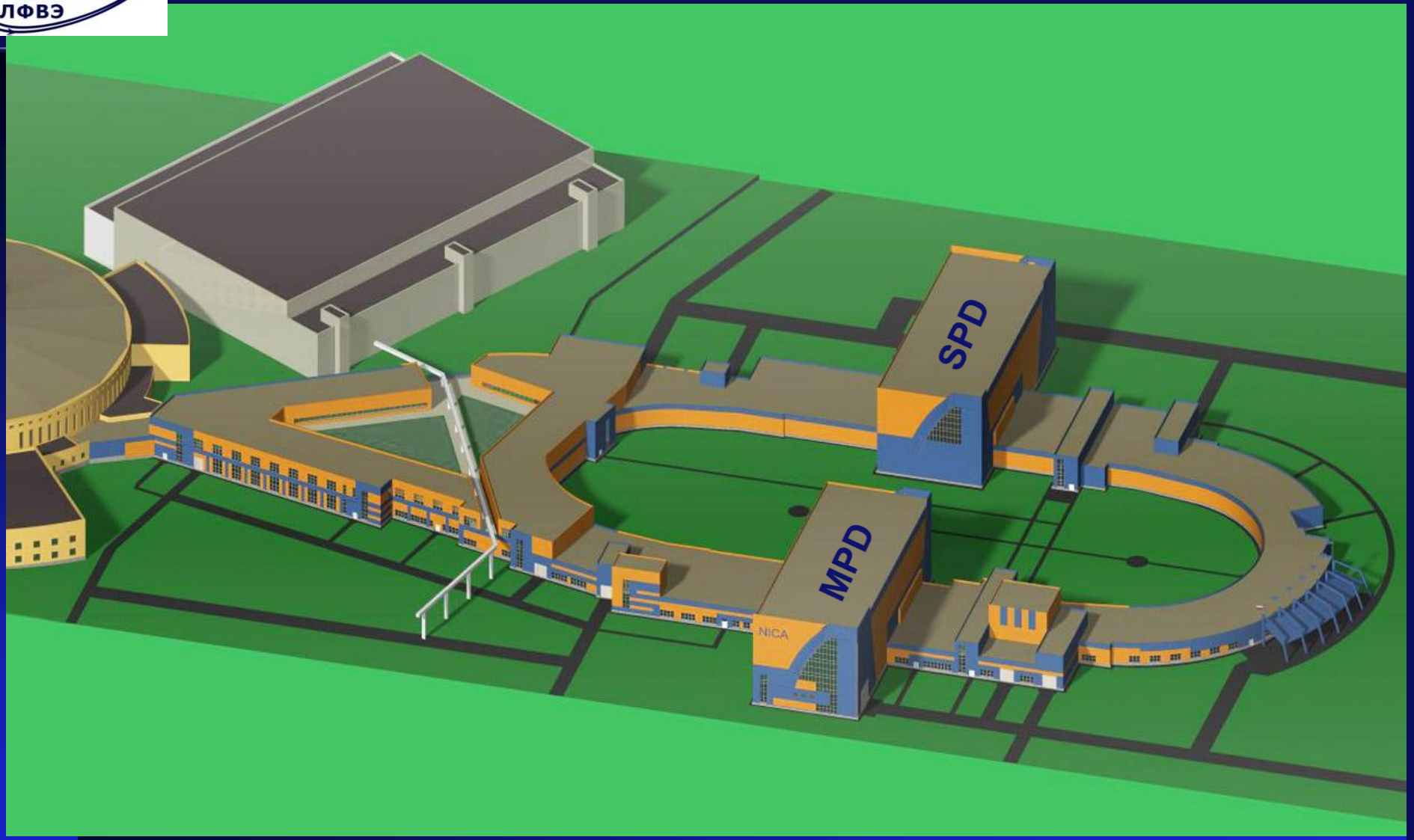
- Modules assembly
- Components
- Ladder assembly
- Radiation tests
- In-beam tests

Infrastructure

SC magnets assembly and test area (b.217):

Exp.hall with SC magnets

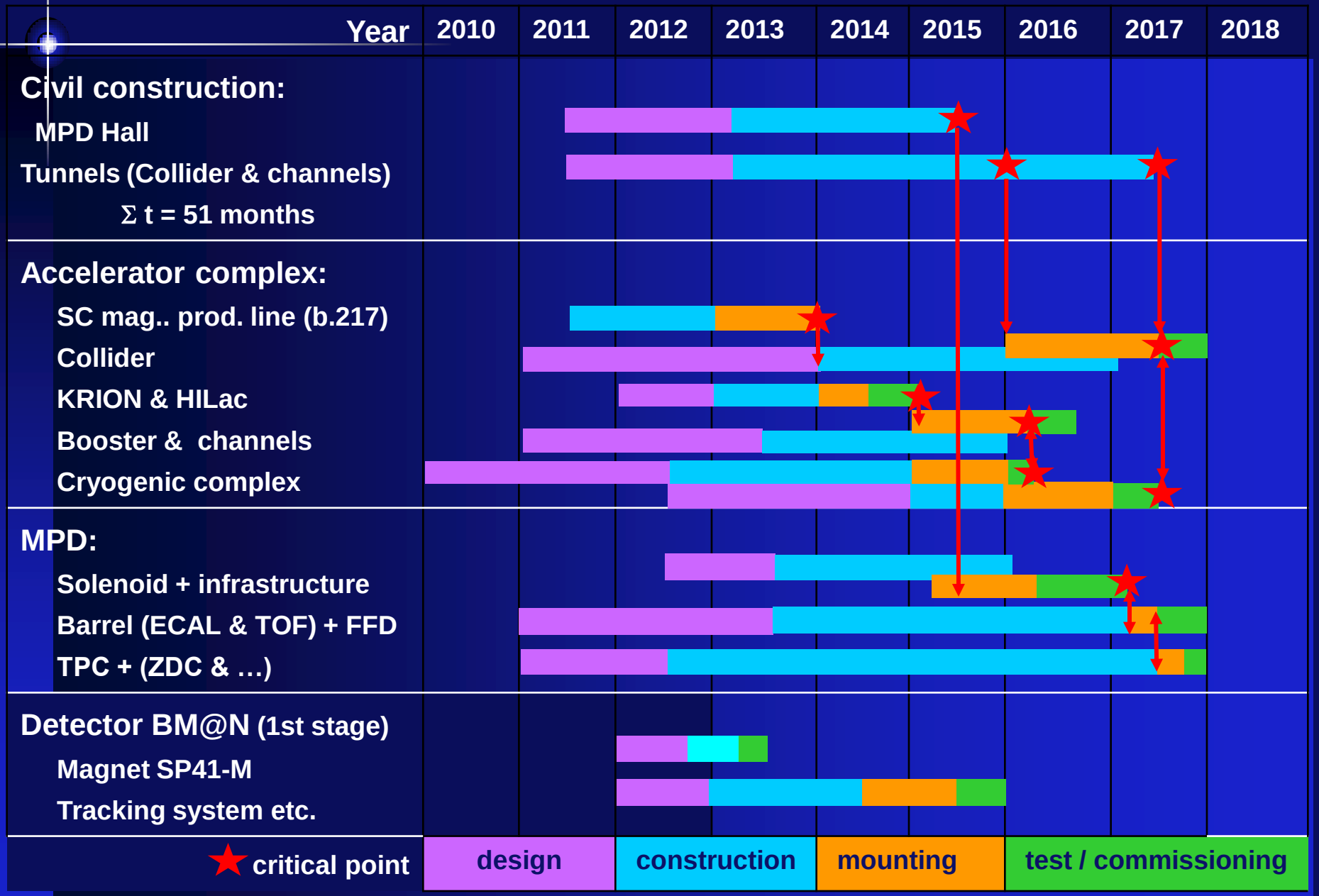
Design project for collider tunnels & experimental halls



- the project is approved by State Expertise in October 2013
- international tender for companies will be finalized in November 2013

area preparation for civil construction has started *(cut trees)*

General schedule and basic milestones



Nearest milestones:

- Completion of the ion sources commissioning (2013)

- Assembly and commissioning of HILac (mid of 2014)

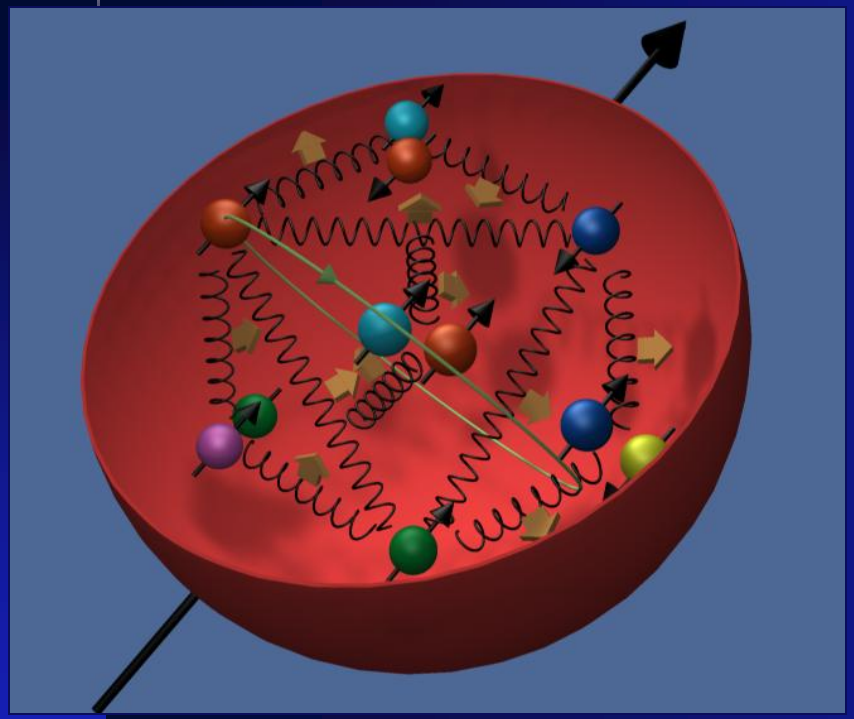
- Serial production of the Booster magnets (beginning of 2014)

Start of the Booster commissioning, BM@N experiment – end of 2015

Spin Physics

Study of the nucleon spin structure

current status



"Experiments with spin have killed more theories than any other single physical parameter"

Elliot Leader

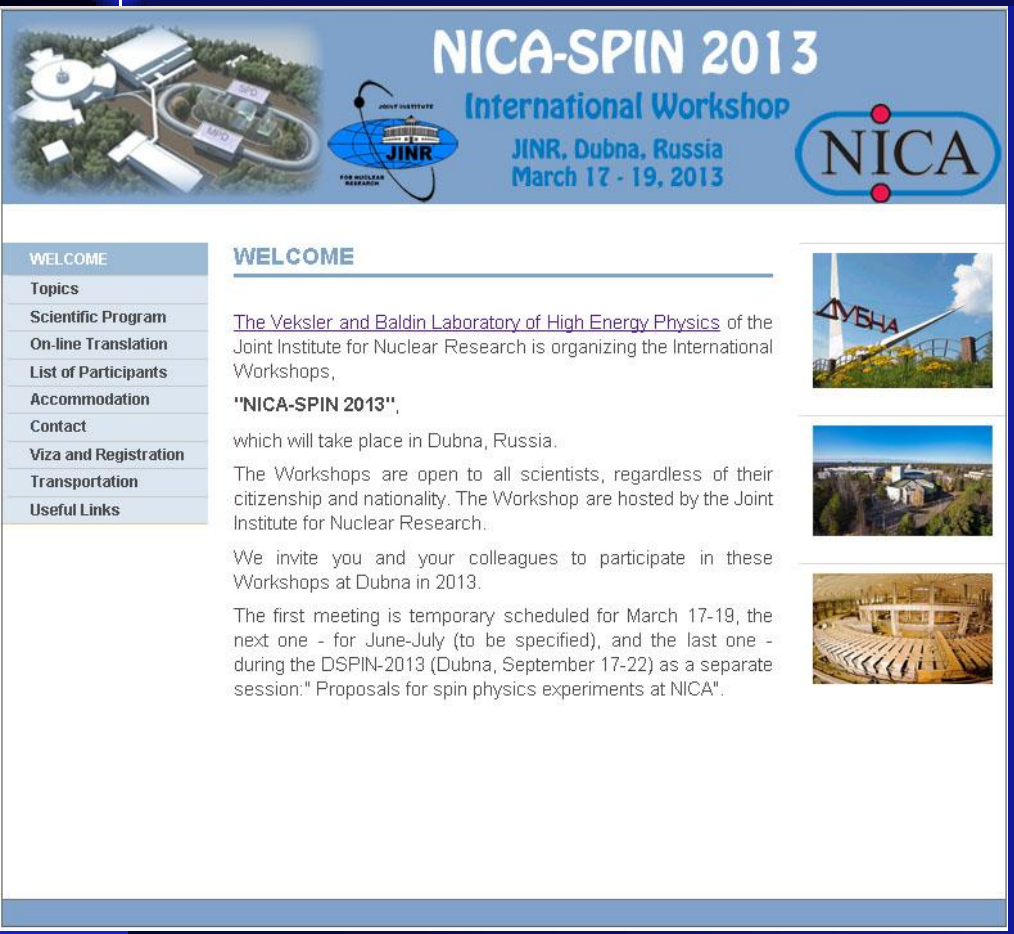
Spin in Particle Physics, Cambridge U.Press, 2001

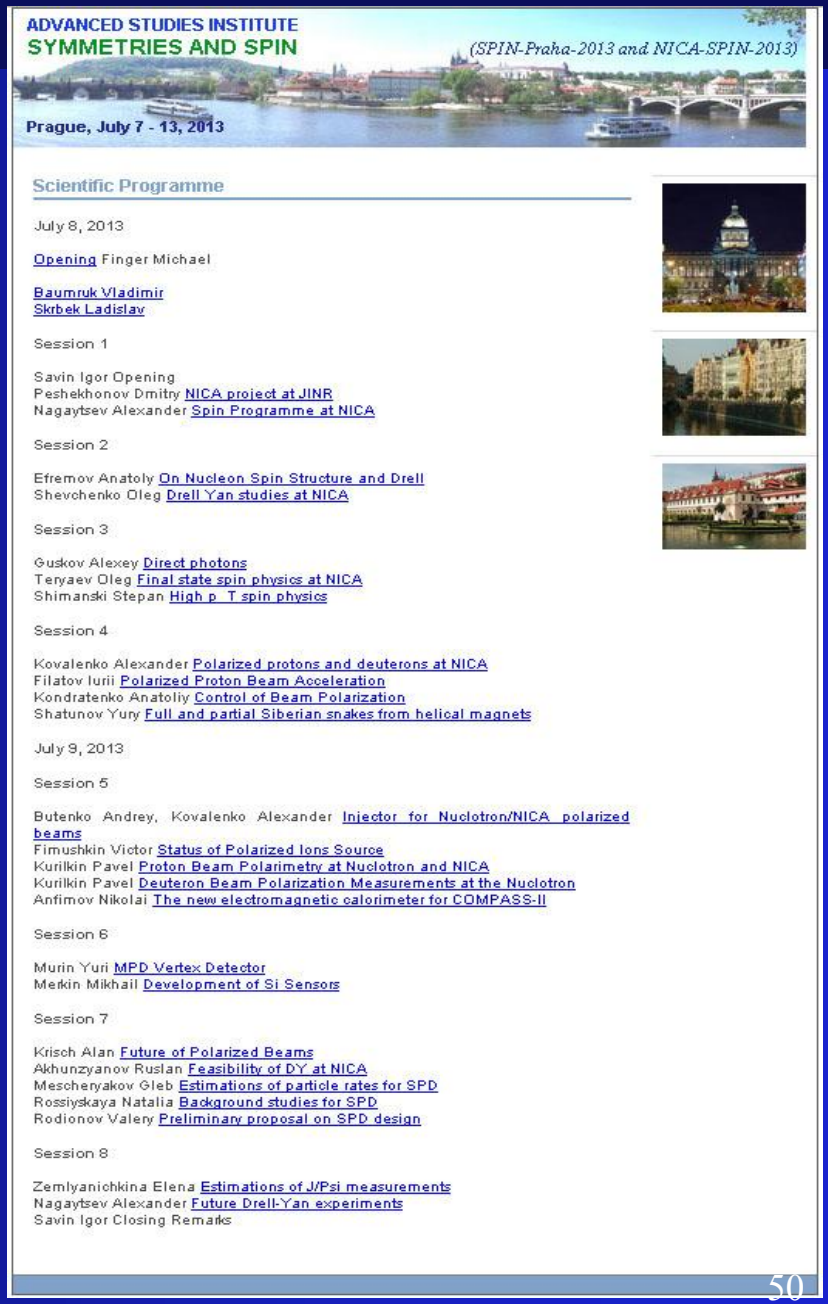
XX International Symposium on Spin Physics (SPIN2012)

Dubna, September 17 – 22, 2012

Working Group has started preparation of the spin physics program to operate with polarized pp, pD & DD beams.

Progress with the SPD program

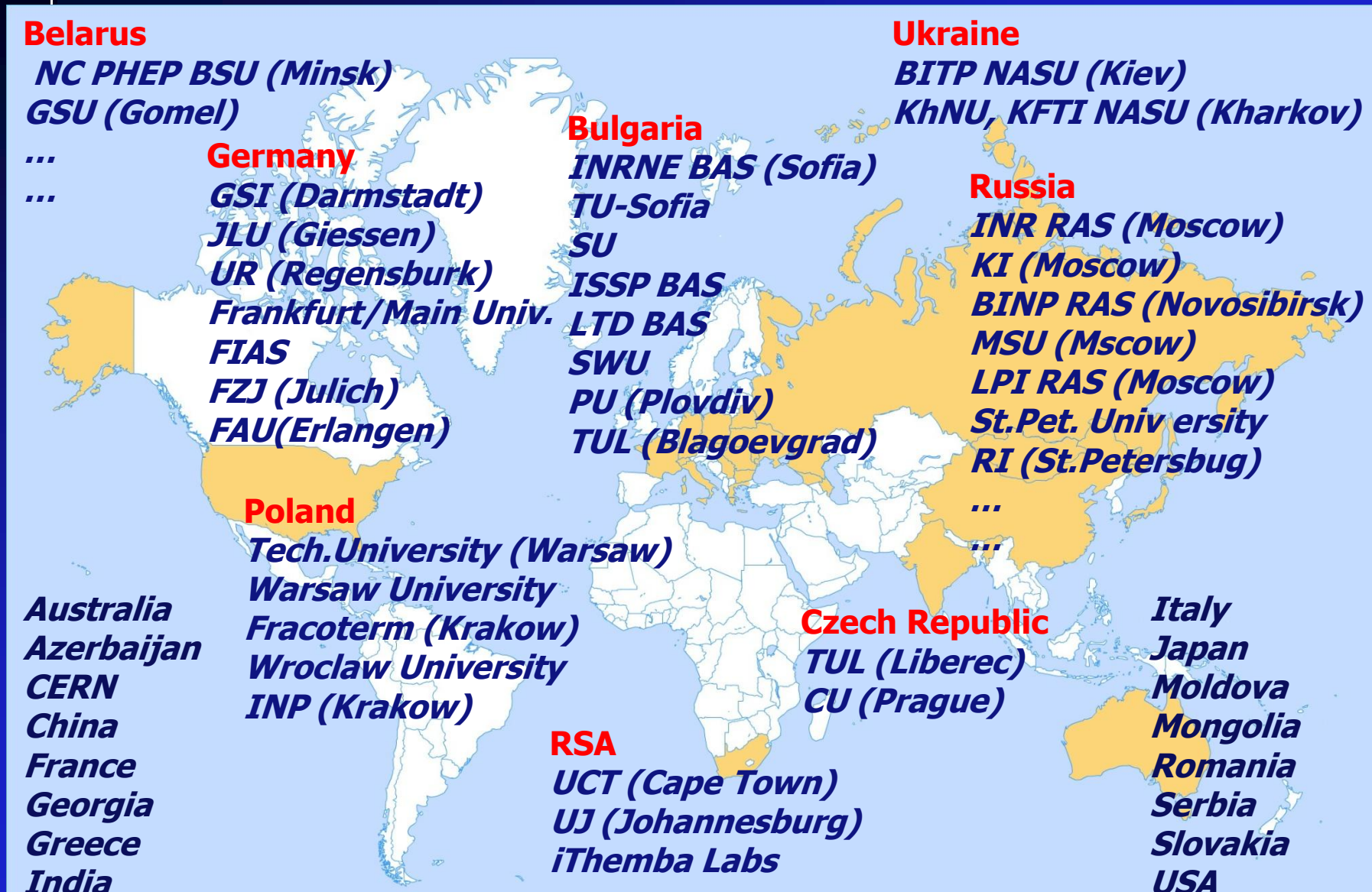




Collaboration formation is in progress.
LoI is under preparation

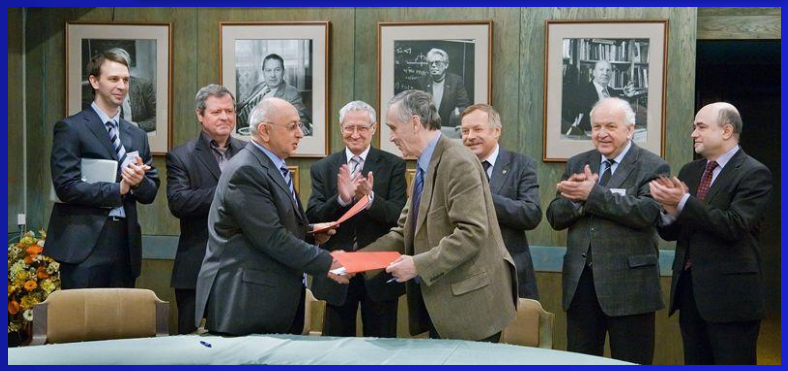
International Cooperation

Scientific cooperation of LHEP on the NICA project



Already signed agreements in cooperation with

- CERN
- GSI
- State committee in science & technology of Belarus
- Kurchatov Federal Center
- Institute for Nuclear Research RAS
- Moscow State University
- Budker Institute of Nuclear Physics RAN
- Tsinghua University, China
- Institute of Plasma Physics CAS, China
- University of Science and Technology of China
- and others



Experts from the EU visited the Ministry of Education & Science *(Moscow, May 16)* and JINR *(Dubna, May 17)*

visit of the EU experts to JINR, May 16, 2013

discussion on the NICA project

The meeting dedicated to consideration of mega-science projects took place in the EU Science Commission on 19 June (Brussels)

***NICA project** was positively evaluated*

PROTOCOL

of the International Meeting on Prospects for Collaboration in the Mega-Science Project "Complex of Superconducting Rings for Heavy Ion Colliding Beams" — the NICA Complex

5. The Parties have agreed to inform their Governments about the Meeting on Prospects for Collaboration in the Mega-Science Project "Complex of Superconducting Rings for Heavy Ion Colliding Beams" – the NICA Complex and to express their interest in preparing a corresponding multilateral Agreement and in taking steps towards its approval by their countries

6 of them + JINR signed the Protocol

Signed:

F. Krylov — for the State Committee of Science and Technology of the Republic of Belarus

L. Kostov — for the Nuclear Regulatory Agency of the Republic of Bulgaria

B. Vierkorn–Rudolph — for the Federal Ministry of Education and Research (BMBF) of the Federal Republic of Germany

N. Burtebaev — for the Atomic Energy Committee of the Ministry of Industry and New Technologies of the Republic of Kazakhstan

A. Povalko — for the Ministry of Education and Science of the Russian Federation

B. Grynyov — for the State Agency for Science, Innovation and Informatization of Ukraine

V. Matveev — for the Joint Institute for Nuclear Research

Representatives of 13 countries

Concluding Remarks

The NICA White Paper attracts new contributions from leading experts in the field

This demonstrates the unique physics potential of the NICA/MPD Complex. Broad international resonance to the NICA White Paper is an important step towards an international collaboration for the creation of the NICA/MPD and BM@N experiments. It was the initial goal for starting the WP process!

Model calculations have been performed for NICA and Nuclotron parameters and show suitability of NICA fixed target experiments for testing the mixed phase. Dedicated simulations including the detector specifics should follow …

Critical assessments of the grown NICA WP have been initiated. Their results are not yet representative and should be seen as a first step and preparation for a broader discussion.

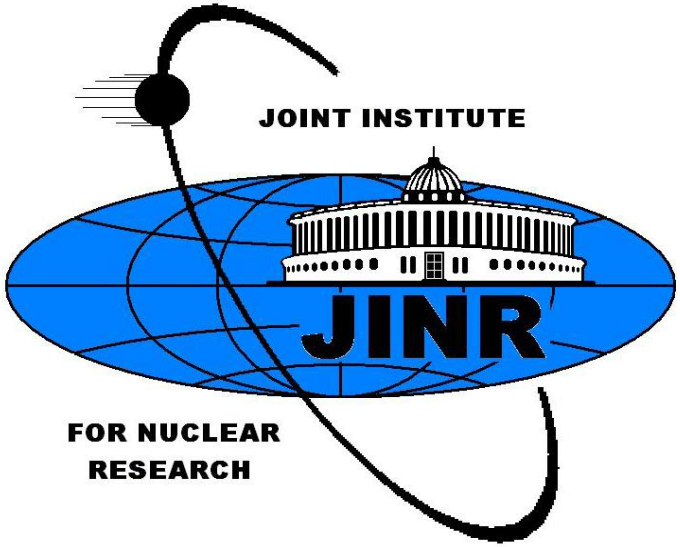
Physics in the NICA energy range is rich and attractive!

Concluding Remarks

- *The NICA project is going well in accordance with the approved plans*
- *The basic R&D stages for both accelerator complex & MPD are close to completion; preparation for mass production is going on*
- *The Nuclotron extracted beams provide unique potential for experiments already now*
- *The NICA project attracts obvious interest & is getting an international recognition!*
- *The NICA and FAIR projects represent a good partnership of common and complementary scientific infrastructure for basic and applied researches*

- ***The next major step – mega-science multilateral international collaboration to provide the participating centers with required resources***

WELCOM TO COLLABORATION!



Thank you for attention!