NICA project NICA at JINR

G.Trubnikov
on behalf of the team

NICA-SPIN, Prague, 11 February 2014

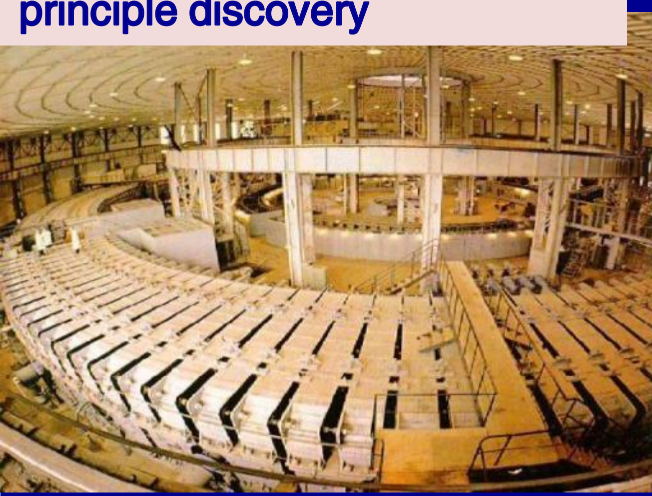
Synchrophasotron – Nuclotron – NICA

1957 - Synchrophasotron

10 GeV proton accelerator – world leader in energy.

Beginning of era of high-energy physics

V.Veksler – phase stability principle discovery



1993 – Nuclotron

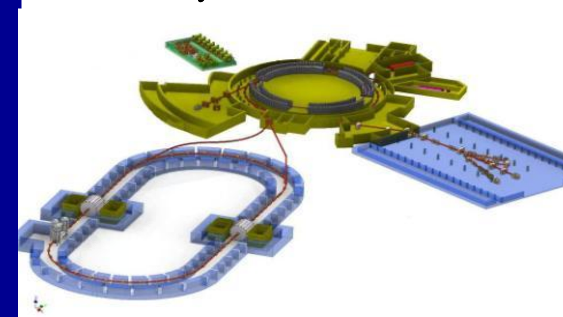
First in the world

Superconducting Synchrotron of heavy ions

A.Baldin –start of relativistic nuclear physics era

2017 – NICA

Superconducting collider of heavy ions



Study of baryonic matter at extreme conditions

NICA Collider parameters:
Energy range: $\sqrt{s_{NN}}$ = 4-11 GeV
Particles: from p to Au
Luminosity: L~10^{27} (Au), 10^{32} (p)
Detectors: MPD; SPD

Evolution of collision region in Nucleus-Nucleus Interaction

Deconfinement!

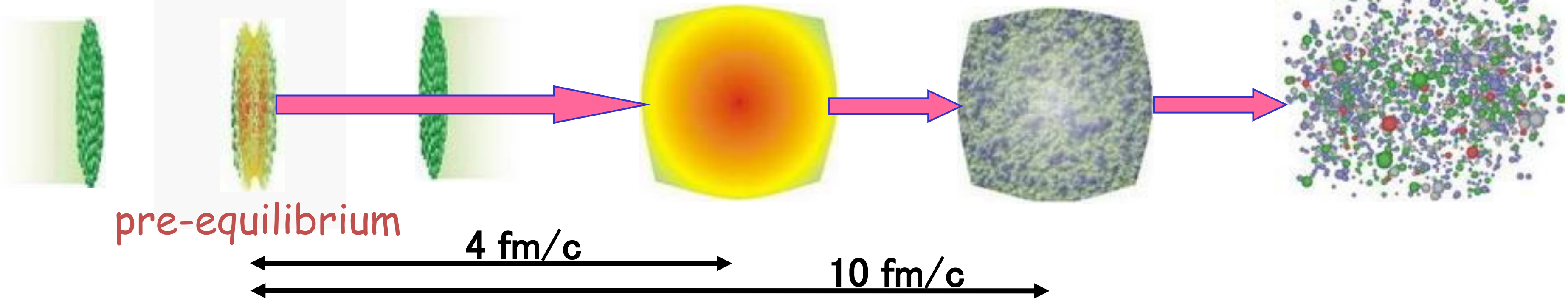
QGP – Quark-gluon plasma

QGP and hydrodynamic expansion

Hadronisation, hadronic phase & **chemical freeze-out**

Hadronic phase & **kinetic freeze-out**

Start of the collision



$$1\ \mathrm{fm/c} = 1\cdot 10^{-13} / \ 3\cdot 10^{10} = 3.33\cdot 10^{-23}\ \mathrm{sec}$$

"Chemical freeze-out" – finish of inelastic interactions;
"Kinetic freeze-out" – finish of elastic interactions.

*) freeze-out – here means "to get rid" (phys. slang)

Au × Au collisions

The First Proposals:

Towards Searching for A Mixed Phase of Strongly Inteacting QCD Matter at The JINR Nuclotron

A.N. Sissakian, A.S. Sorin, M.K. Suleymanov, V.D. Toneev, and G.M. Zinovjev

arXiv:nucl-ex/0601034 v1 24 Jan 2006

A.N. Sissakian, A. S. Sorin, and V. D. Toneev

Proc. of the 33rd Intern. High Energy Physics conference, ICHEP'06, Moscow, Russia 1, 421 (2006), nuclth/0608032

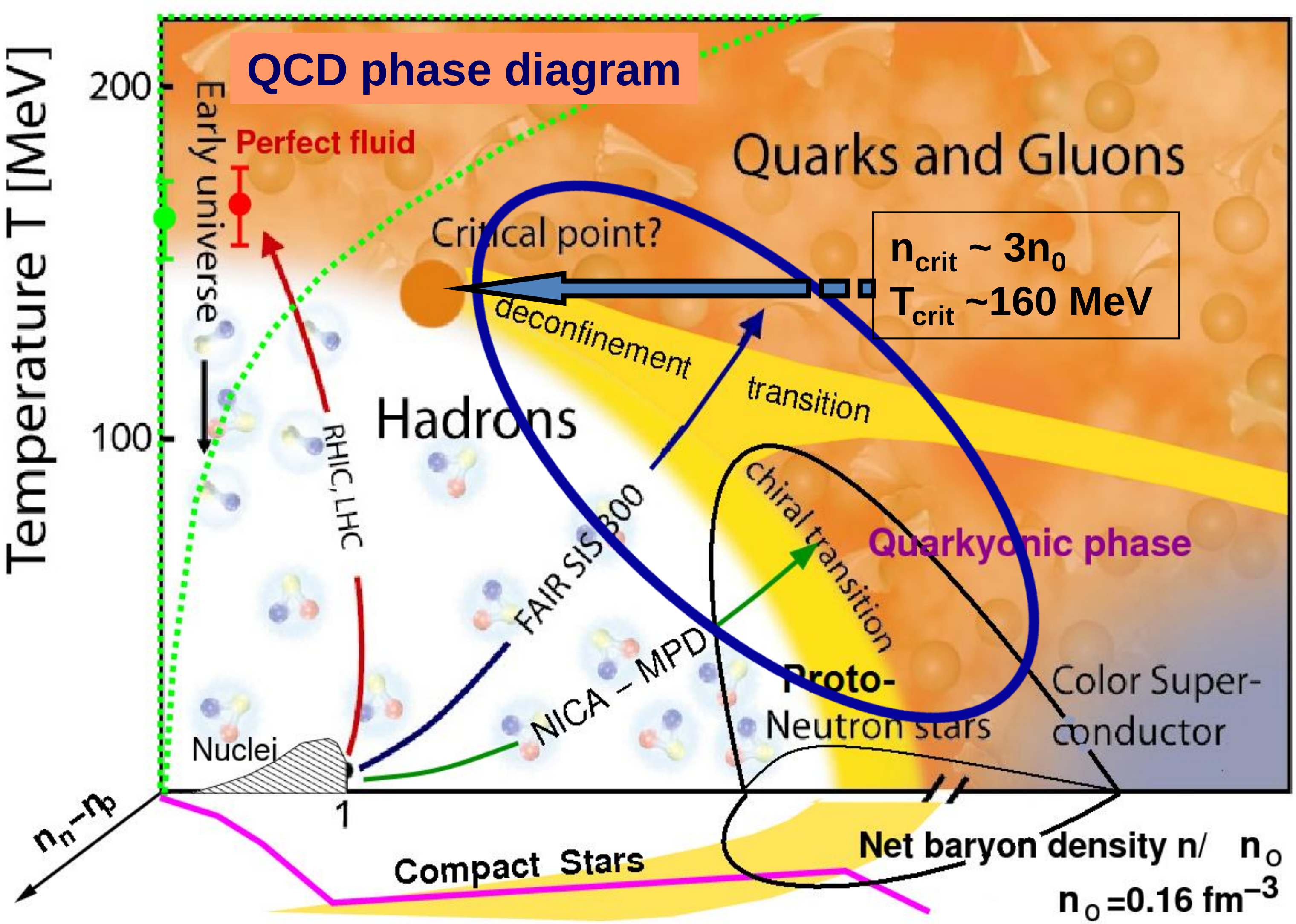
An optimal way to reach the highest possible baryon density is

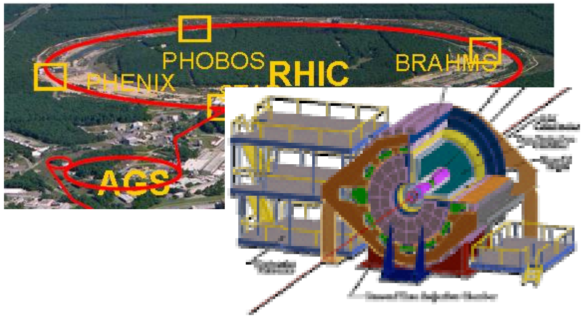
heavy ion collision at $\sqrt{S_{NN}}$ = 4 - 11 GeV/u

Introduction: the goal of the project

A) Heavy Ion Physics

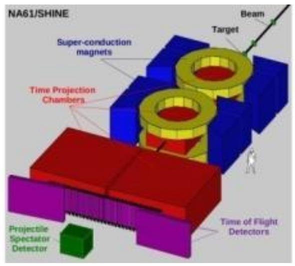
Au x Au collisions





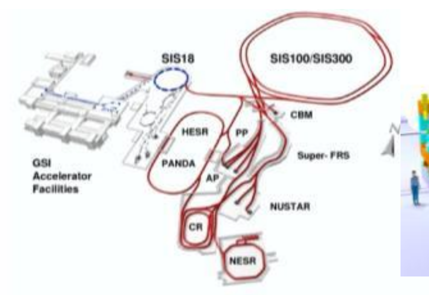
2^{nd} generation HI experiments

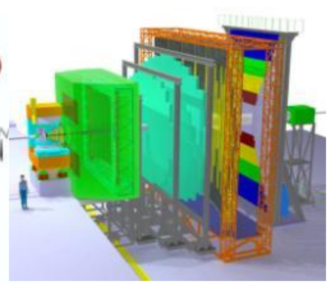
STAR/PHENIX @ BNL/RHIC.
designed for high energy researches ($\sqrt{s_{NN}}$ > 20 GeV),
low luminosity for LES program L<10^{26} $cm^{-2}s^{-1}$ for Au^{79+}



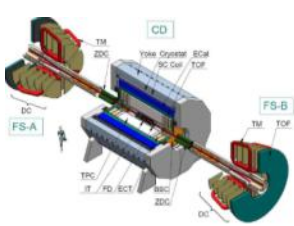
NA61 @ CERN/SPS.
Fixed target, non-uniform acceptance, few energies (10,20,30,40,80,160A GeV), poor nomenclature of beam species

3^{nd} generation HI experiments





CBM @ FAIR/SIS-100/300
Fixed target, E/A=10-40 GeV, high luminosity



MPD & SPD @ JINR/NICA.
Collider, small enough energy steps in the range $\sqrt{s_{NN}}$ = 4-11 GeV, a variety of colliding systems, L~10^{27} $cm^{-2}s^{-1}$ for Au^{79+}

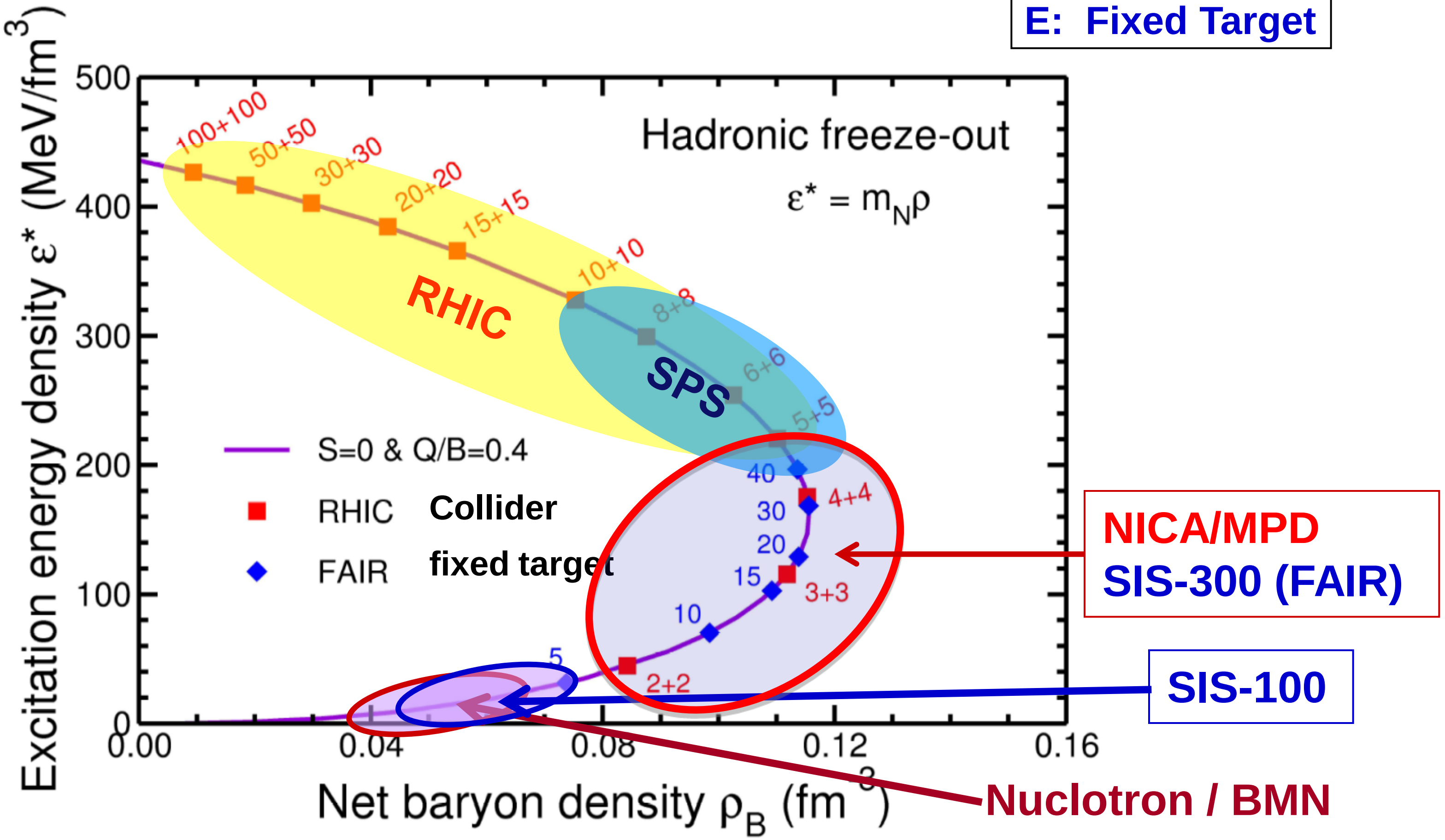
Colliders and fixed target experiments

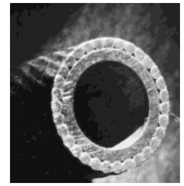
Facility	Kinetic energy GeV/u	√s GeV/u
Accelerators		
Nuclotron-M	1.0 ÷ 4.5	2.33 ÷ 3.47
AGS	4.0 ÷ 10.7	3.33 ÷ 4.9
SIS-100	1.0 ÷ 11.19	2.33 ÷ 4.96
SIS-300	10 ÷ 35.36	4.7 ÷ 8.4
SPS	10 ÷ 160.36	4.7 ÷ 17.5
Colliders		
NICA	2x(1 ÷ 4.5)	4 ÷11
RHIC	2x(1.5 ÷ 100)	5 ÷200

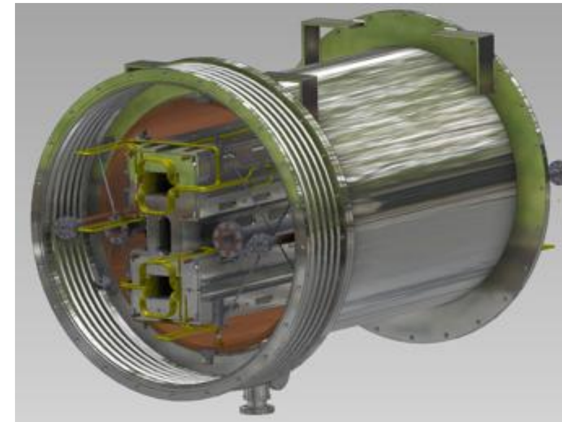
Baryon density in Au + Au collisions
at $\sqrt{S_{NN}}$ = 4 - 11 GeV/u

E1+E2: collider
E: Fixed Target

J.Randrup, J.Cleymans PR C74 (2006) 047901







Unique Dubna technologies of fast-cycling superconducting magnets tested during several tens of Nuclotron runs and chosen as basic for accelerator complexes NICA and FAIR

Common European Research infrastructure for Heavy Ion High Energy Physics: NICA + FAIR

NICA White Paper – International Effort

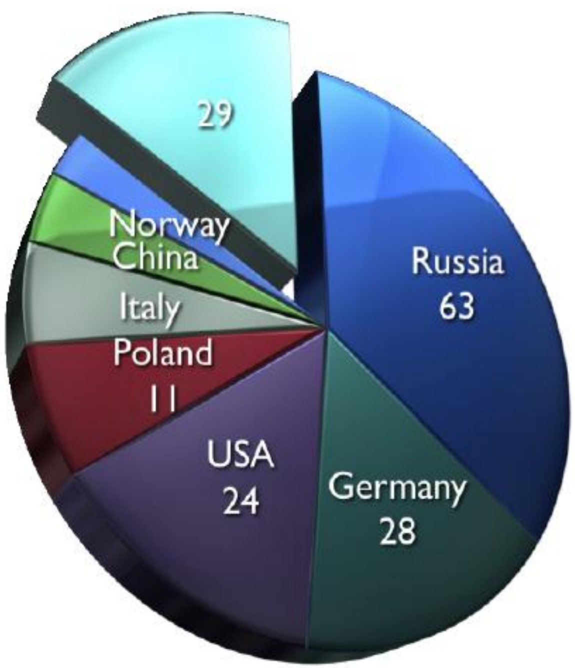
Draft v 10.01
January 24, 2014

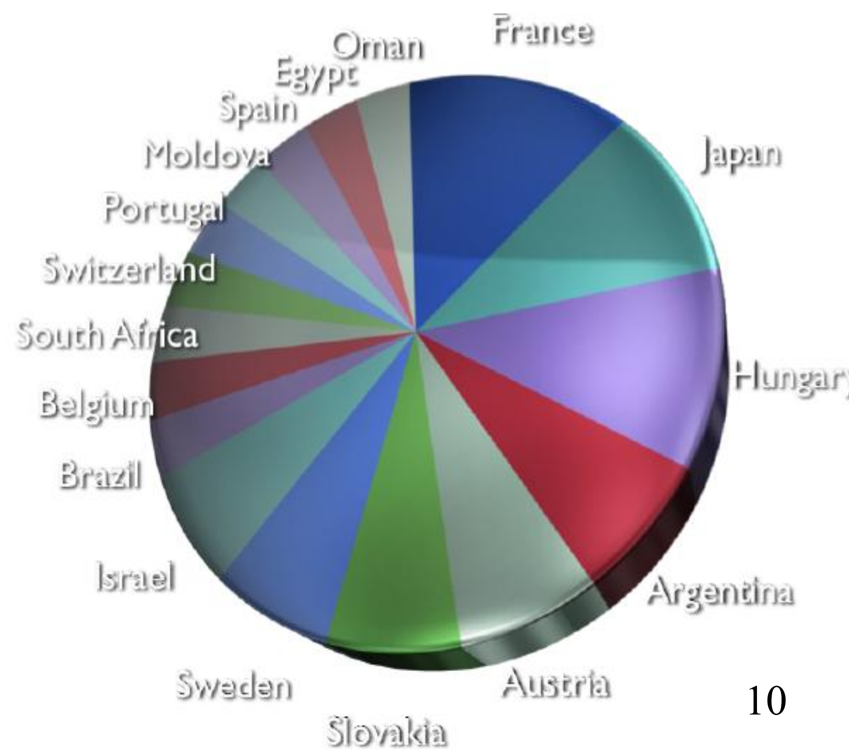
SEARCHING for a QCD MIXED PHASE at the
NUCLOTRON-BASED ION COLLIDER FACILITY
(NICA White Paper)

Statistics of White Paper Contributions

111 contributions:
188 authors from 70 centers in 24 countries

Indicates the activity of scientific community





NICA goals

1a) Heavy ion colliding beams 197Au79+ x 197Au79+ at

$\sqrt{s_{NN}}$ = 4 ÷ 11 GeV (1 ÷ 4.5 GeV/u ion kinetic energy)

at $L_{average}$= $1x10^{27}$ $cm^{-2}\cdot s^{-1}$ (at $\sqrt{s_{NN}}$ = 9 GeV)

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

2) Polarized beams of protons and deuterons in collider mode:

p↑p↑ $\sqrt{s_{pp}}$ = 12 ÷ 27 GeV (5 ÷ 12.6 GeV kinetic energy)

d↑d↑ $\sqrt{s_{NN}}$ = 4 ÷ 13.8 GeV (2 ÷ 5.9 GeV/u ion kinetic energy)

$L_{average}$ ≥ $1x10^{30}$ $cm^{-2}\cdot s^{-1}$ (at $\sqrt{s_{pp}}$ = 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 on ion beams at kinetic energy

from 0.5 GeV/u up to 12.6 GeV (p) and 4.5 GeV /u (Au)

B. Spin Physics

Motivation:

"Experiments with spin have killed more theories than any other single physical parameter." (J.D.Bjorken)

[Cited by Elliot Leader, "Spin in Particle Physics", Cambridge Univ. Press, 2001]

Introduction: the goal of the project

B) Polarized Beams – Particle Spin Physics

The problem => Nucleon quark structure and nucleon spin

First hypothesis: 3 quarks are polarized in such a way that

Spin (p↑) = (u↑ u↑ d↓) = ↑ ≡ 1/2

However:

HERMES experiment at HERA e↑x p-collider

(DESY Lab., 1995 – 2007):

Not more 30% of proton spin can be explained with constituent quarks, i.e. Nucleon spin $\neq \Sigma\, S_{quark}$

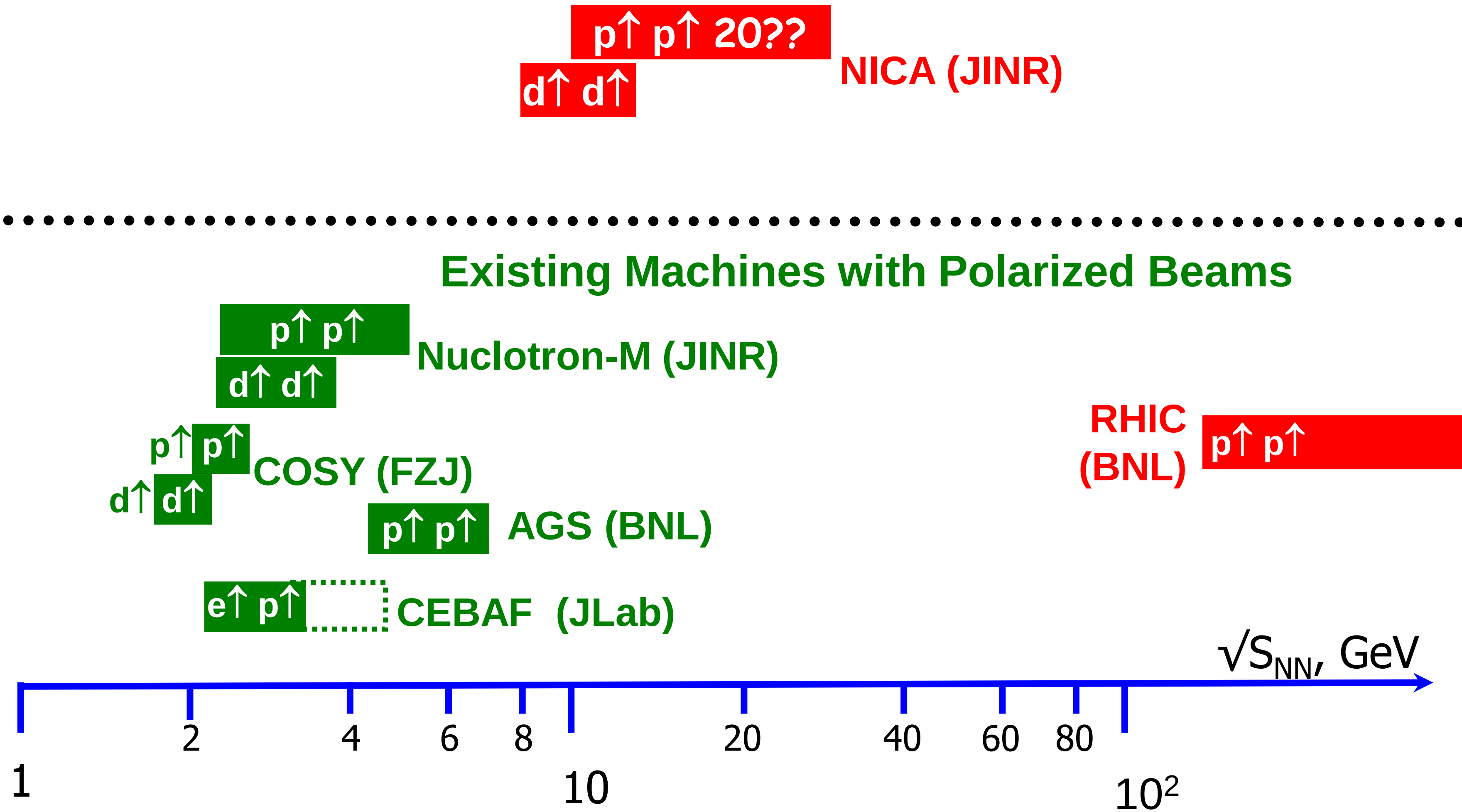
Modern hypothesis:

$$S_{nucleon} = \Sigma S_{quark} + \Sigma S_{gluon} + \Sigma L_{quark} + \Sigma L_{gluon} \, ,$$

L – orbital momentum of the quark/gluon

1. NICA Physics Case
B. Spin Physics

Future Machines with Polarized Beams



1. NICA Physics case
B. Spin Physics

At SPIN'2012 Conference in Dubna

(September 17 – 22, 2012)

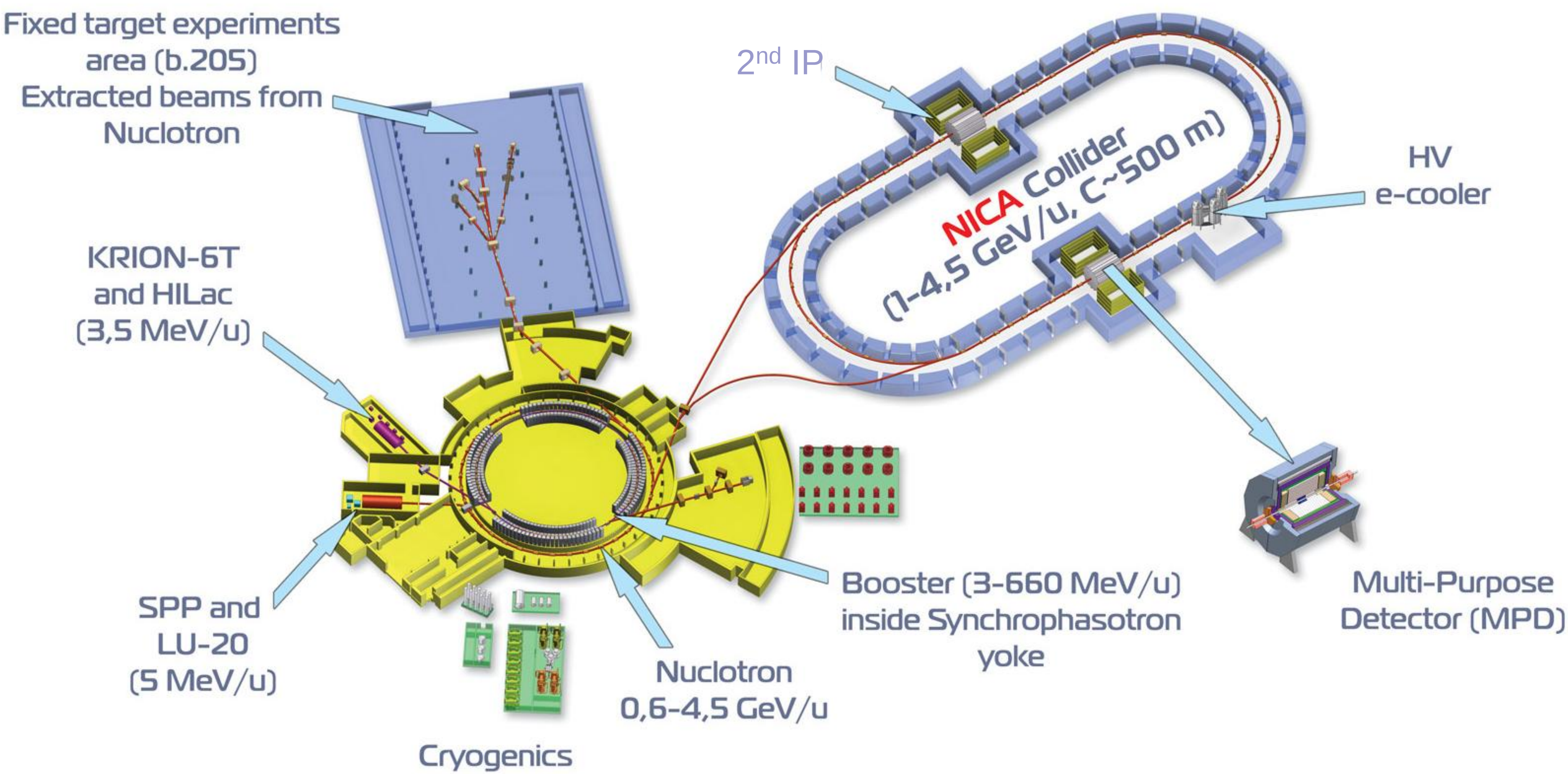
the Working Group has started preparation of the spin physics program to operate with polarized pp, pd & dd beams at NICA,

continued at Prague Workshop Spin'2013

(July 2013).

Conf. participants at Vladimir Veksler monument inauguration

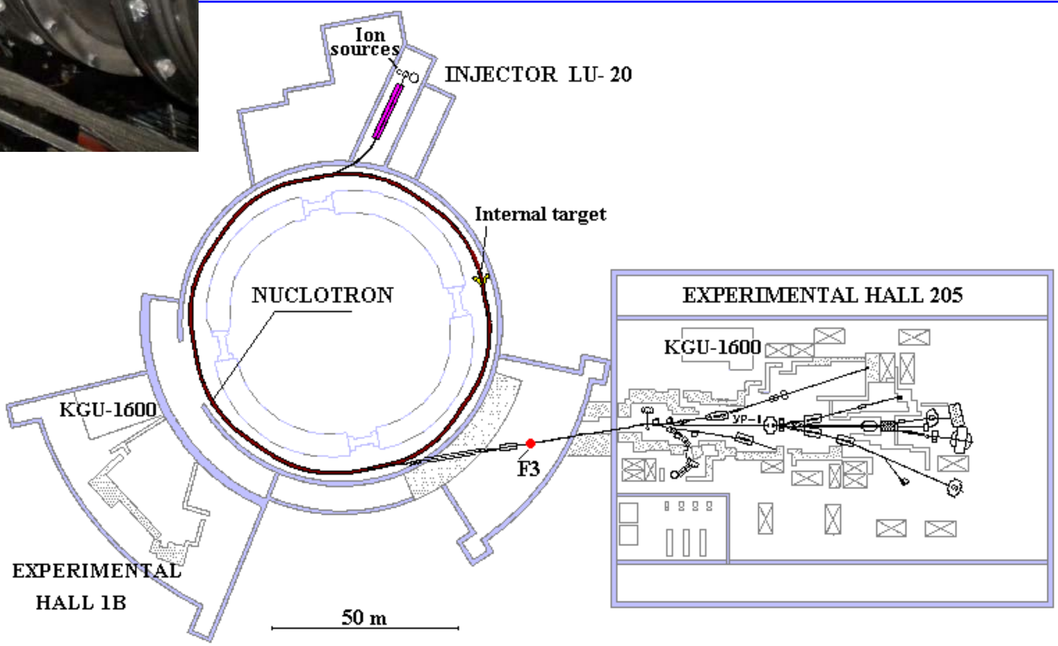
Superconducting accelerator complex NICA
(Nuclotron based Ion Collider fAcility)



NICA: Nuclotron based Ion Collider fAcility

Routine
beam extraction at 5.2 GeV/u

Acceleration up to 5.8 GeV/u (C6+)



Summary. Status of the Nuclotron

Perfect test-bench for NICA booster/collider modes

Energy:
5 GeV/u (~ 1.8 T) – routine operation
(At higher field the routine operation after 2015)

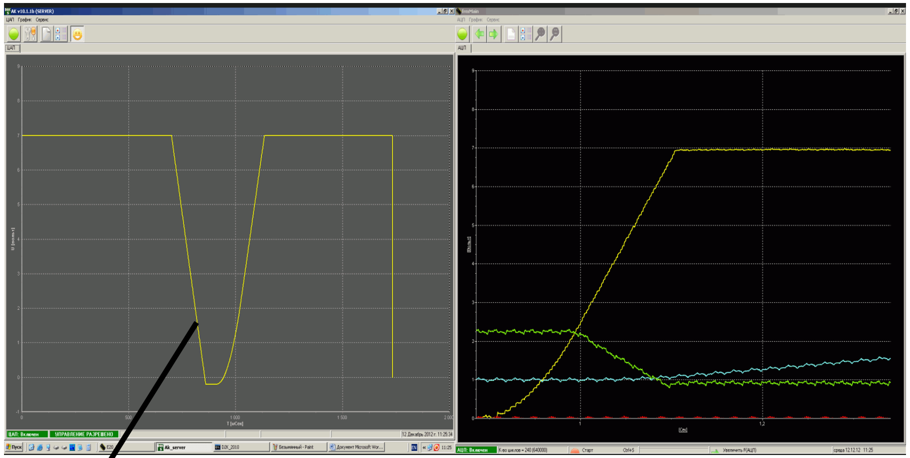
Intensity:
Deuterons - 3e10 (maximum achieved 5e10)
Light ions – 5e9 ppp (new LIS)
Heavy ions – 1e6, after the Booster commissioning – 1e9 (2016)
Polarized deuterons – 1e10 starting from 2015

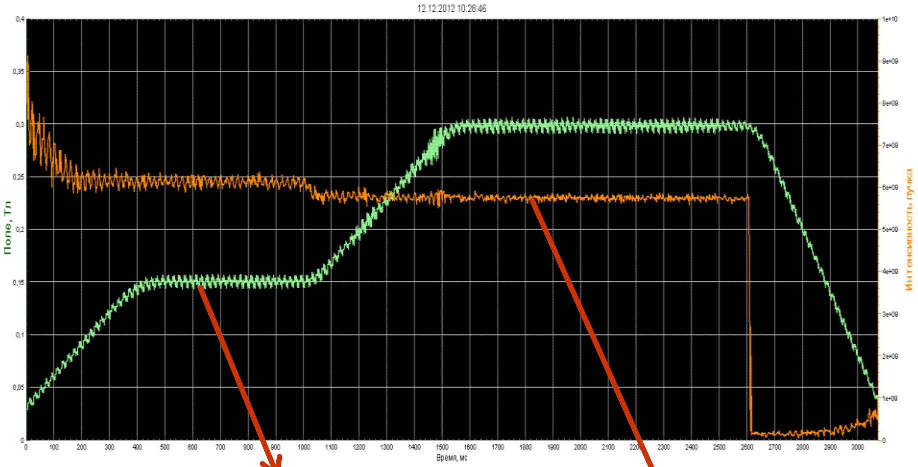
Slow extraction:
K_dc = 0.8 – 0.9

Duty factor:
50%
(the beam lines in bld. #205 have to be tested and recertified)

Two (three) plateaus

Adiabatic debunching and recapture at efficiency of about 95% was demonstrated





RF amplitude

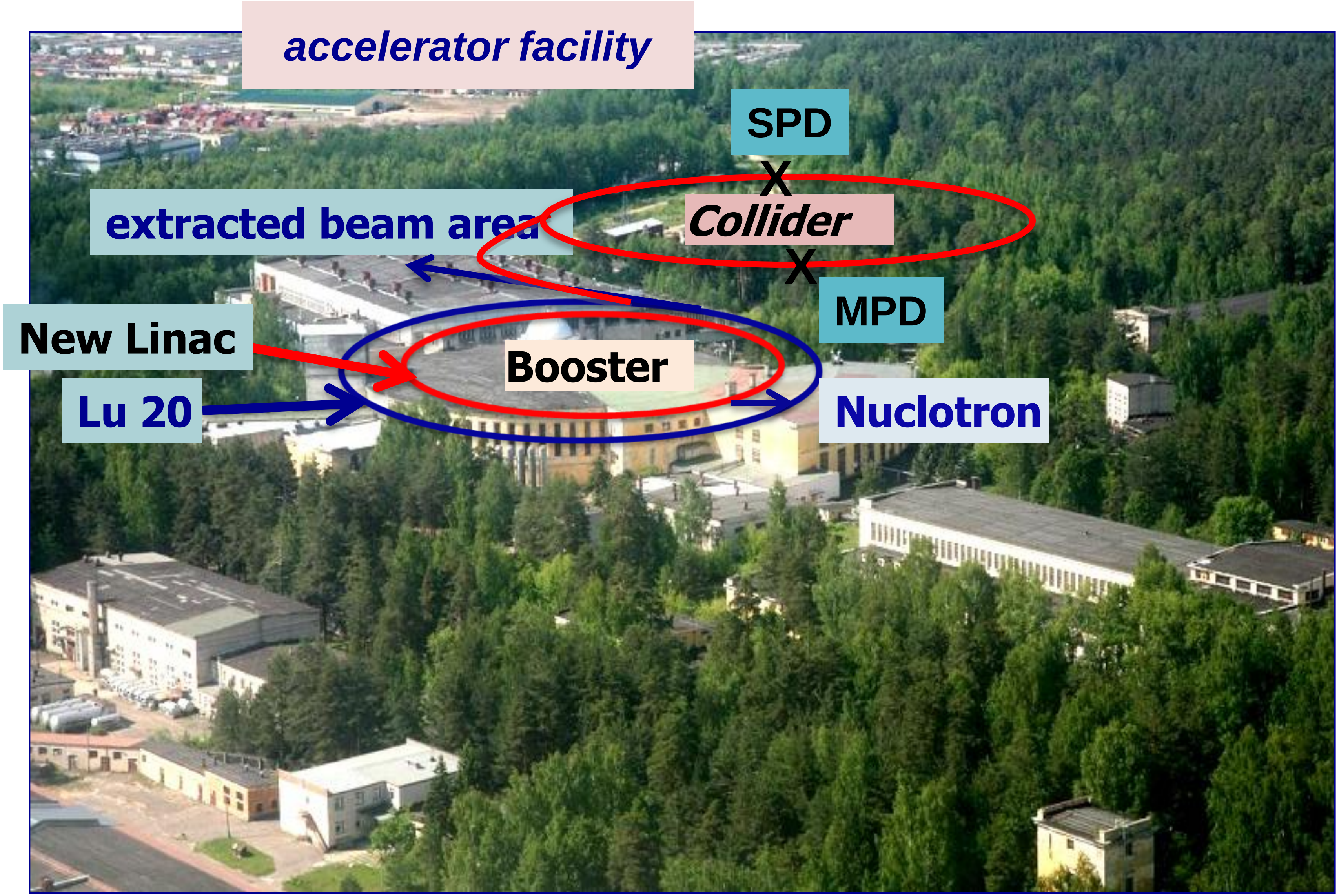
Magnetic field

Beam current

Technical limit of the intermediate plateau duration is about 0.5 s now.

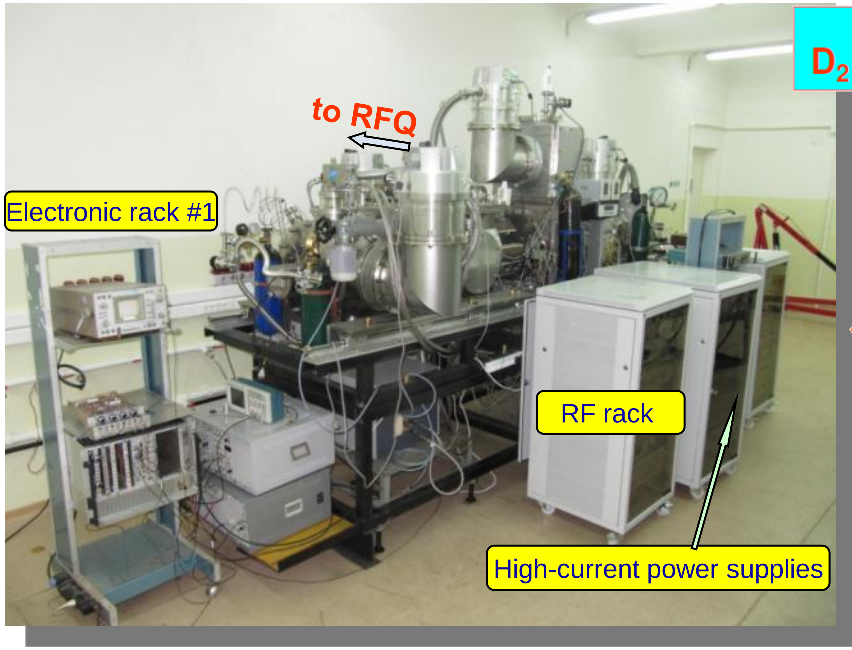
During 2013 (it is a question to the RF station control system)
It will be realized possibility to operate with 3 flattops:
1^{st}–on the arising front, 2^{nd}–main plateau, 3^{rd}–on the back front (useful for polarimetry).

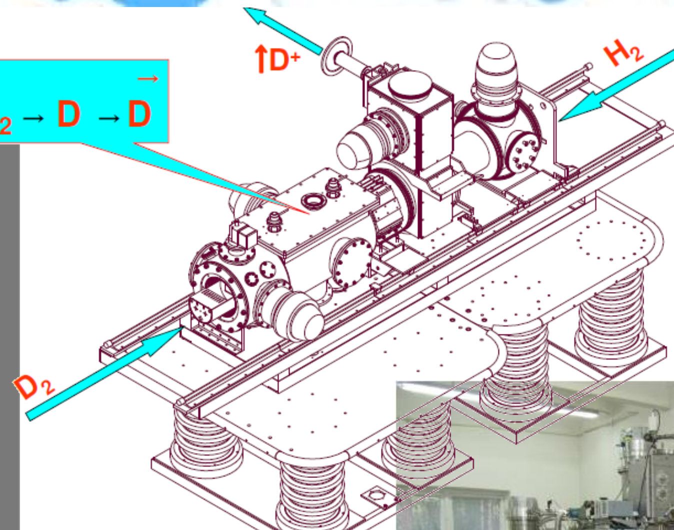
Veksler & Baldin Laboratory of High Energy Physics, JINR

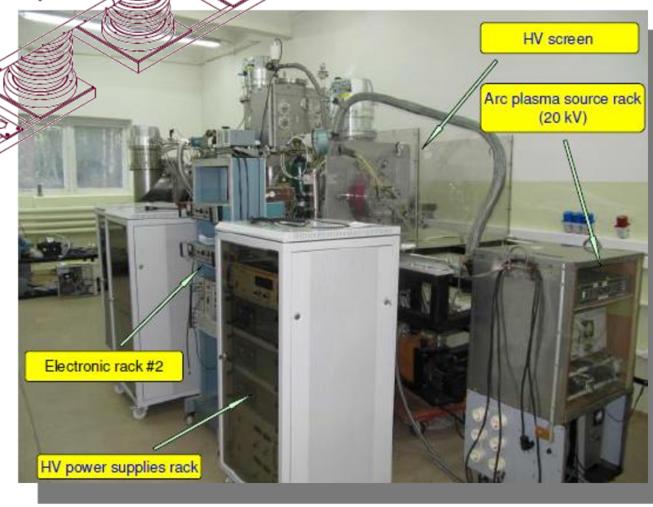


V.Fimushkin, A.Belov

Source of polarized ions (p, d, H) JINR+INR RAS







The main purpose of the SPI-project is to increase the intensity of the accelerated polarized beams (D+,H+) at the JINR Accelerator Complex up to **10^{10} p/pulse**

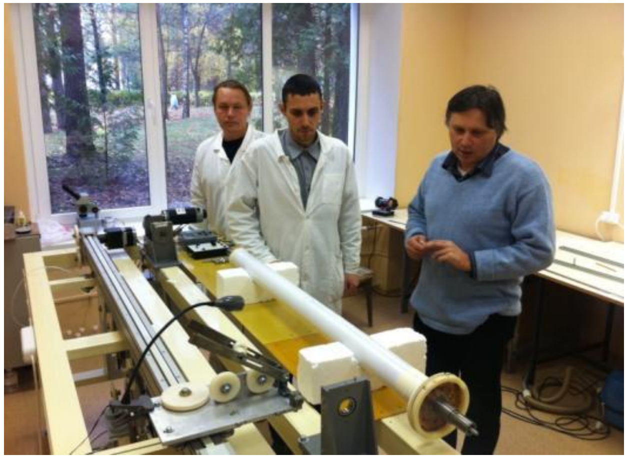
We plan to assemble and TEST SPI at Nuclotron with ↑d in 2015 year After commissioning of the new RFQ foreinjector for LU-20

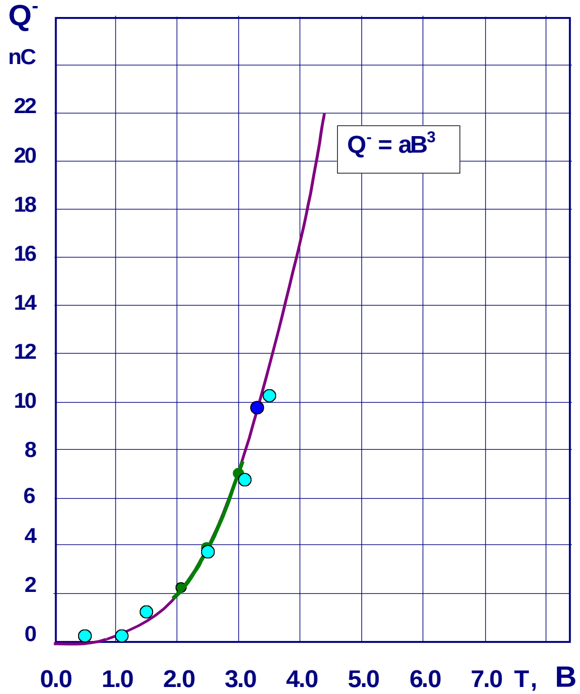
- Intensive work was carried out at INR of RAS (Moscow) and testing of the ABS systems was finished in July 2012
- In August 2012, the ABS was transported from the INR of RAS (Moscow) and assembled at JINR
- All-inclusive SPP-testing will be carried out in 2013-2014 at JINR

Heavy ions for fixed target experiments

E.E.Donets, E.E.Donets, D.E.Donets, A.Butenko, A.Govorov, V.Monchinsky

Present status of Krion-6T ESIS





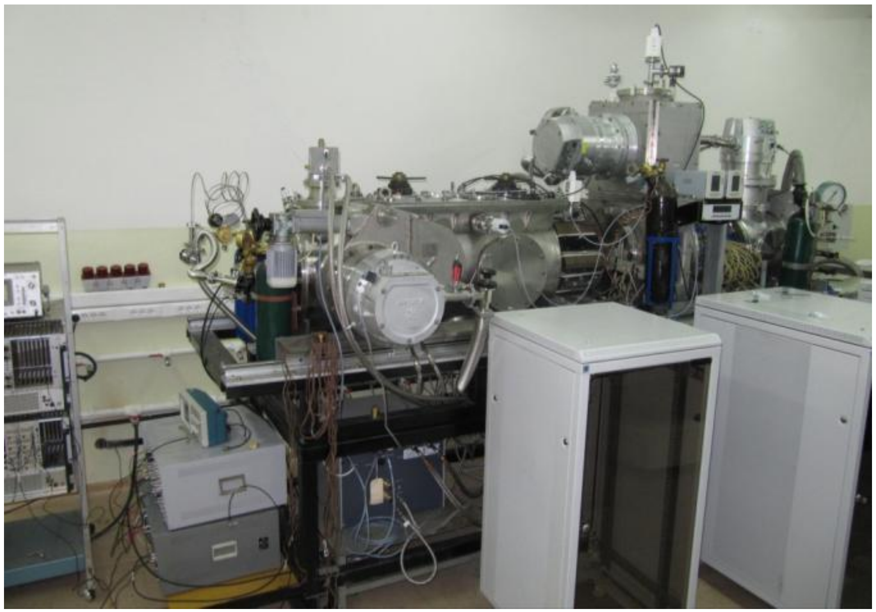
Dependency of a number of string electrons on solenoid magnetic field (1 m string)

5.4 Tesla magnetic field was reached in a robust regime

First full-scale tests of new ESIS in reflex mode of operation started in spring 2013.

Progress in ion sources development and commissioning

Source for polarized particles (SPP)



Source is assembled in 2013 and works on its commissioning had been started in June 2013. The goal is to get 10^{10} deuterons per pulse.

Heavy ion source: Krion-6T ESIS

B= 5.4 Tesla magnetic field reached in a robust regime. Full-scale tests of new ESIS in reflex mode of operation was started in spring 2013.

Test gold ion beams have been produced:

- **$Au^{30+} \div Au32^{32+}$, $6{\cdot}10^{8}$, T_{ioniz}= 20 ms for**
- **Au^{32+} -> repetition rate 50 Hz.**
- **ion beams $Au^{51+} \div Au^{54+}$ are produced.**

Now the goal is: production of $Au^{65+} \div Au^{69+}$ ion beams for their possible injection into LU-20 -> Nuclotron in spring 2014.

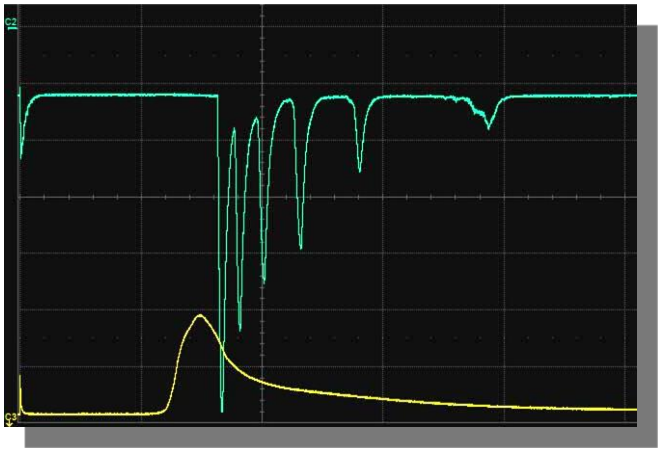
Development of the injection complex

New laser source

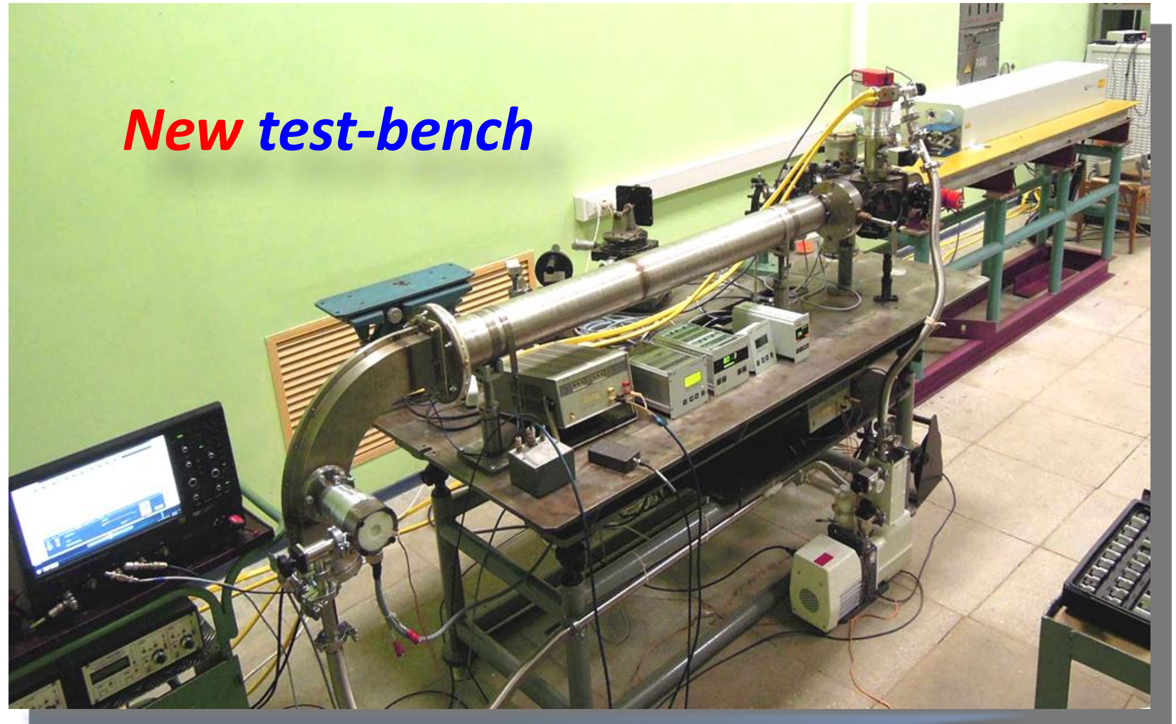
NEw Nd-YAG laser,

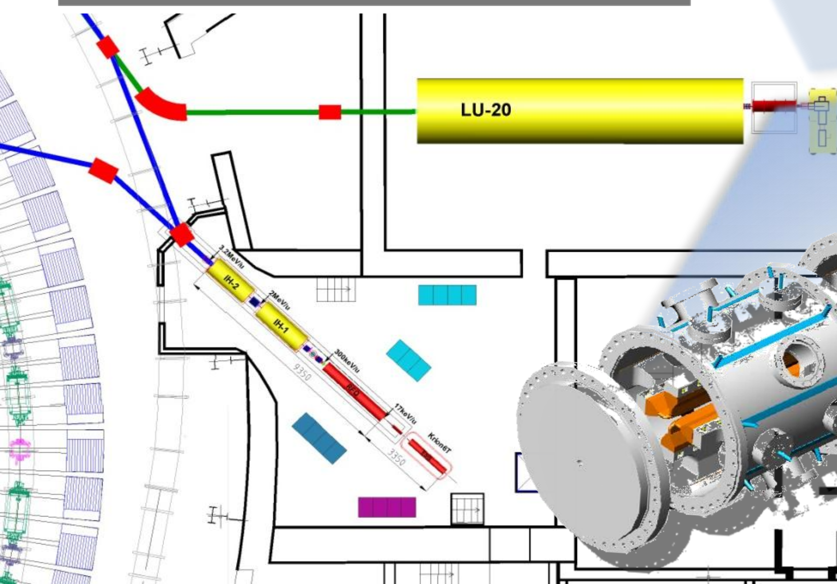
$E \geq 2$ J , $\tau \approx$ 7-8 ns, ~ $5 \cdot 10^{12}$ W/cm²

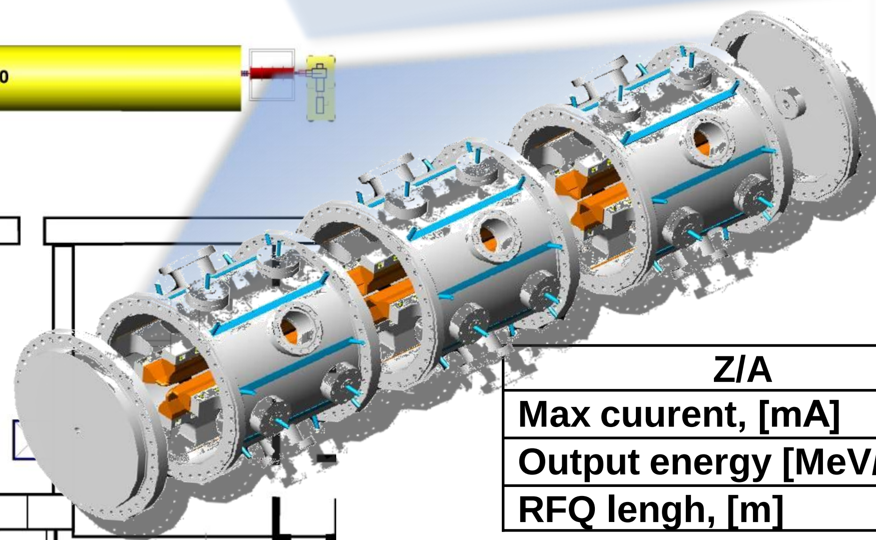
Acceleration of $^{12}C^{6+}$ without stripping



New test-bench







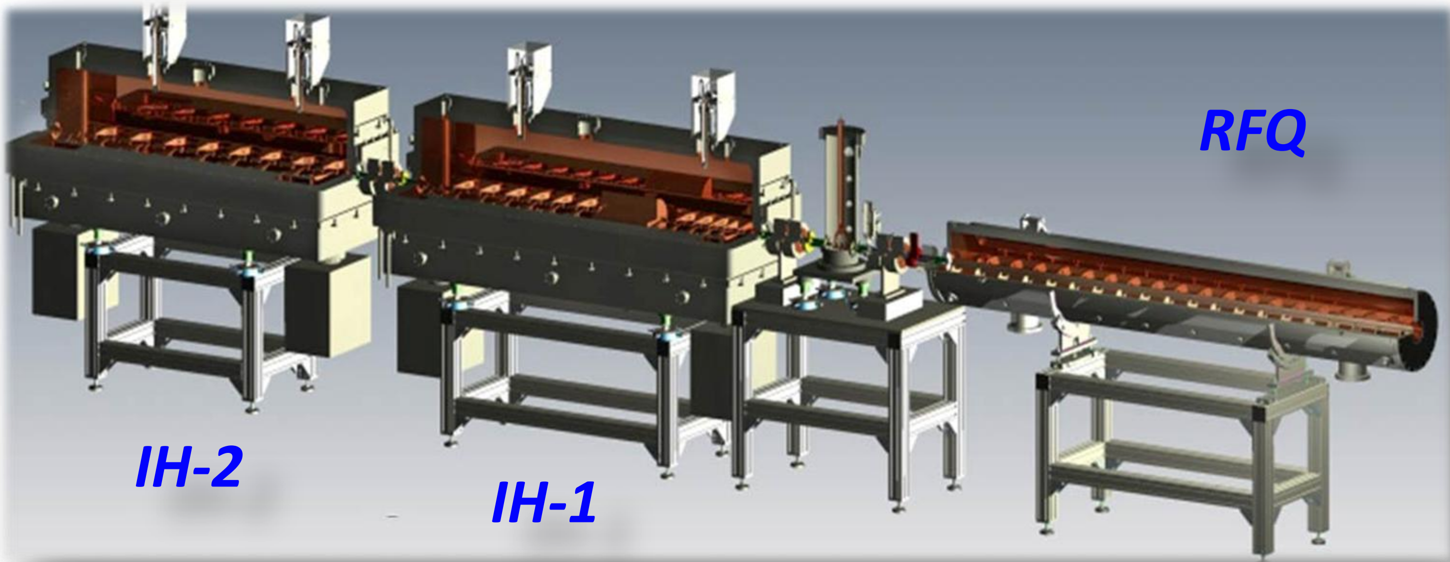
New foreinjector
For LU-20

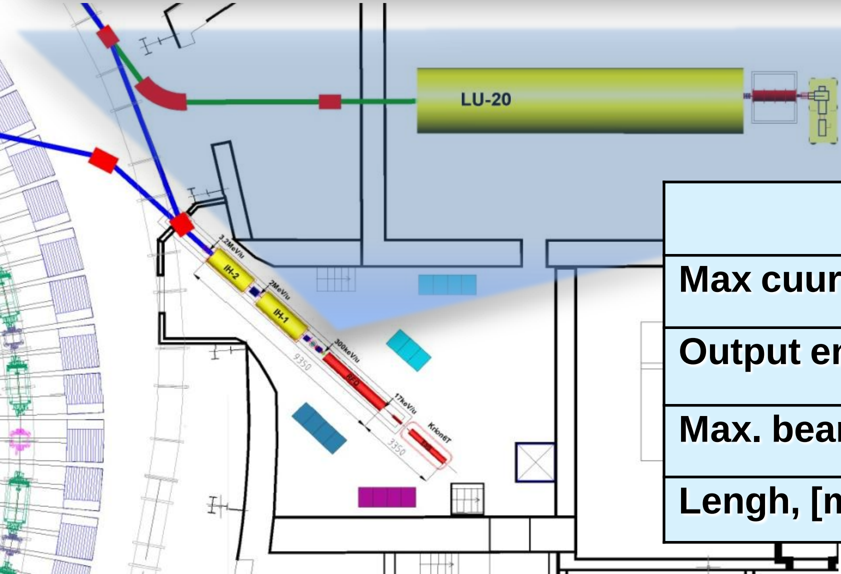
JINR-ITEP-Snezhinsk

Z/A	1.0- 0.3
Max cuurent, [mA]	≤20
Output energy [MeV/u]	0.156
RFQ lengh, [m]	≤ 3

Development of the injection complex

New Heavy Ion Linac (HILac) is under manufacturing





Z/A	≥ 1/6
Max cuurent, [mA]	≤ 10
Output energy [MeV/u]	3.2
Max. beam puls length [μs]	30
Lengh, [m]	9

ЛФВЭ ОИЯИ, ИТЭФ, в коллаборации с:

BEVATECH

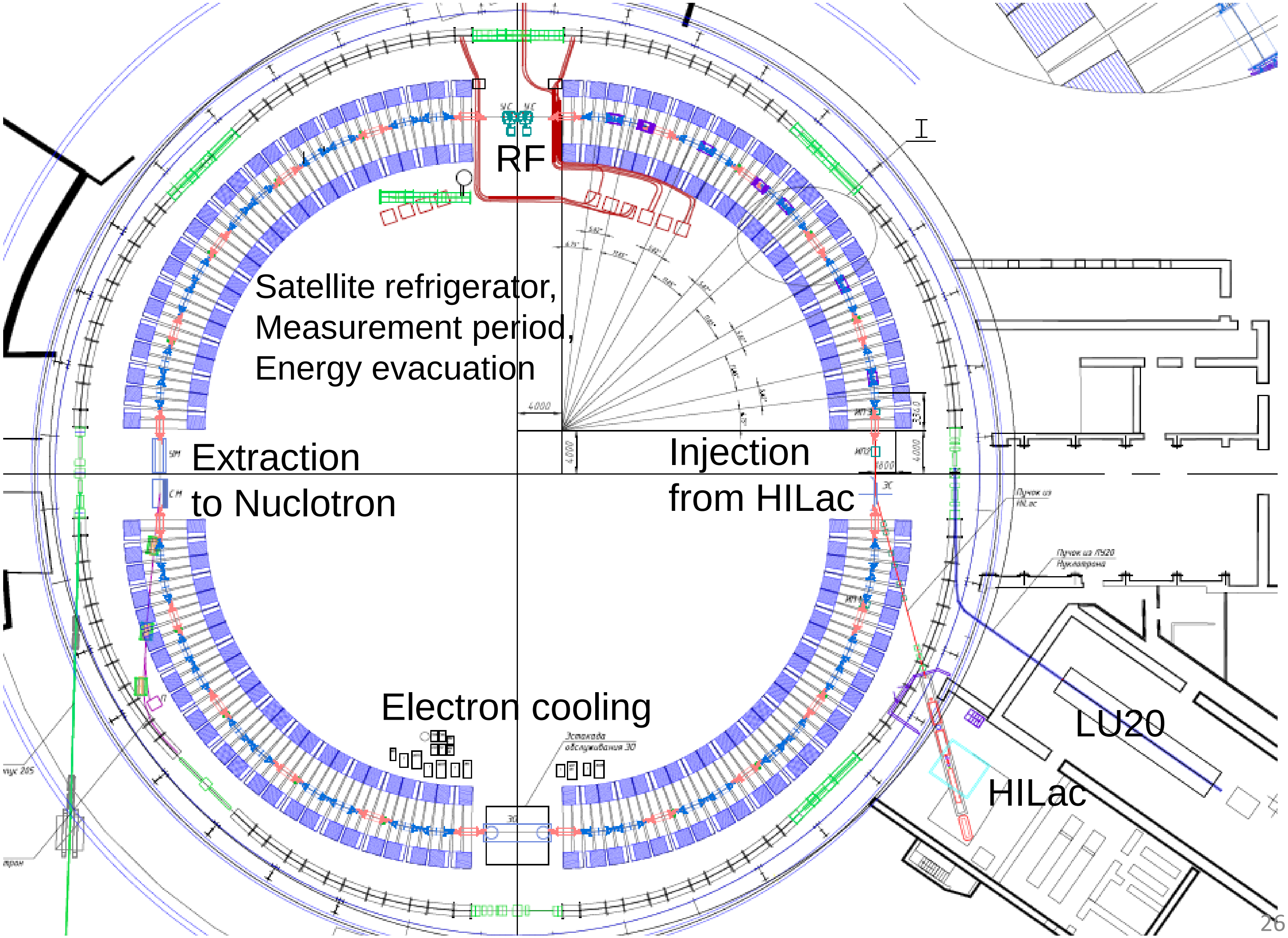
IH Tanks, RFQ Tank:

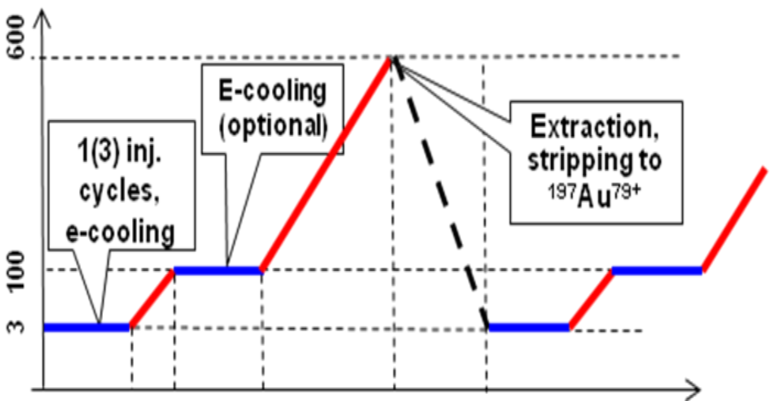
REUTER TECHNOLOGIE

Kreß GmbH Sondermaschinenbau

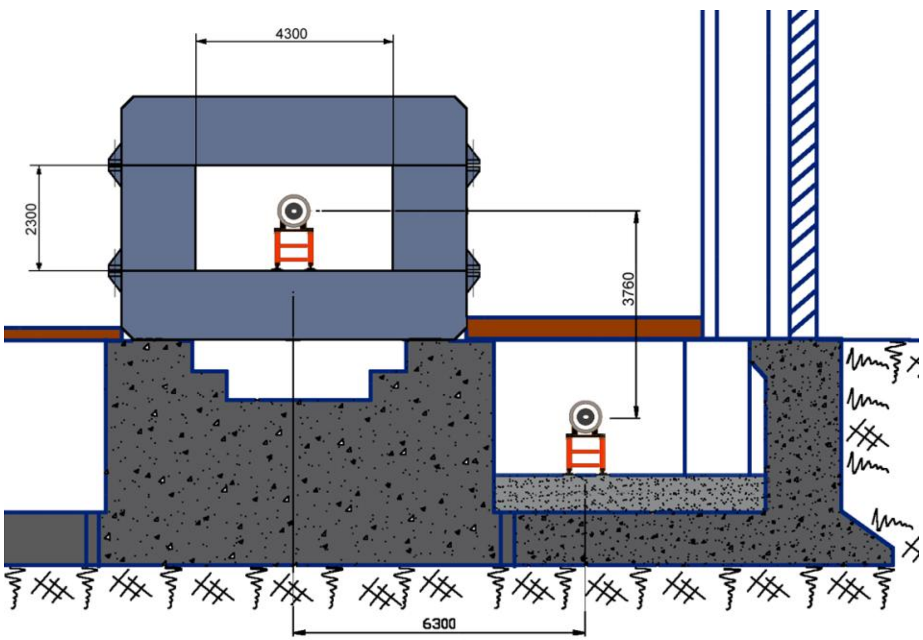
Diagnostics:
NTG

Booster synchrotron



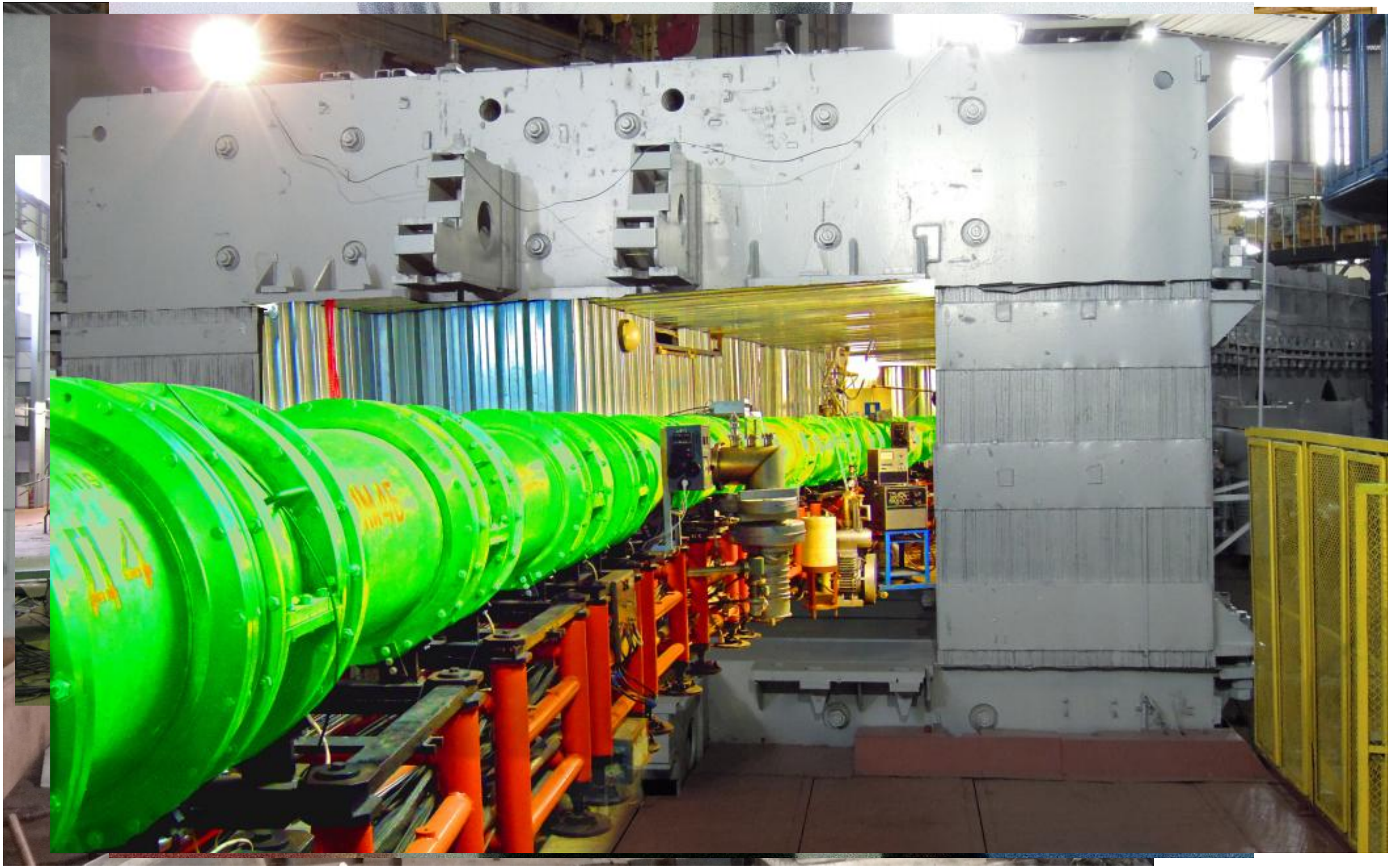


Fold symmetry		4
Number of the FODO lattice cells per arc		6
Number of large straight sections		4
Length of large straight sections, m		2×4
Length of small straight sections, m		1.2/0.6
Betatron tunes		5.8/5.85
Amplitude of β-functions, m	14.3	
Maximum dispersion function, m		2.9
Momentum compaction factor	0.039	
Gamma-transition	5.064	
Chromaticity		-6.5/-6.9
Horizontal acceptance, π·mm·mrad		138
Vertical acceptance, π·mm·mrad		40



Sort of ions:	
before stripping station	Au^{31+}, Au^{52+}, Au^{65+}
after stripping station	Au^{79+}
Maximum energy of ions, MeV/u	685
Maximum magnetic rigidity of ions, T m:	
before stripping station	25
after stripping station	11
Ion number	$2 \cdot 10^9$

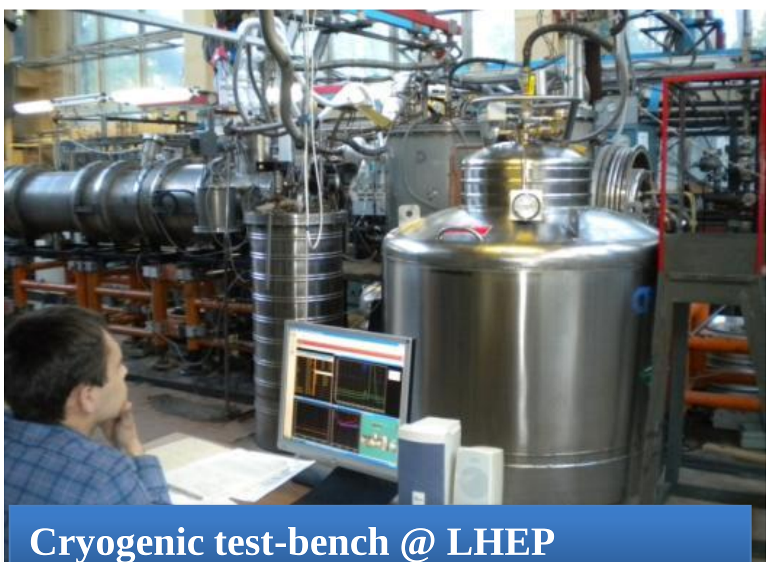
Бустерный синхротрон комплекса NICA



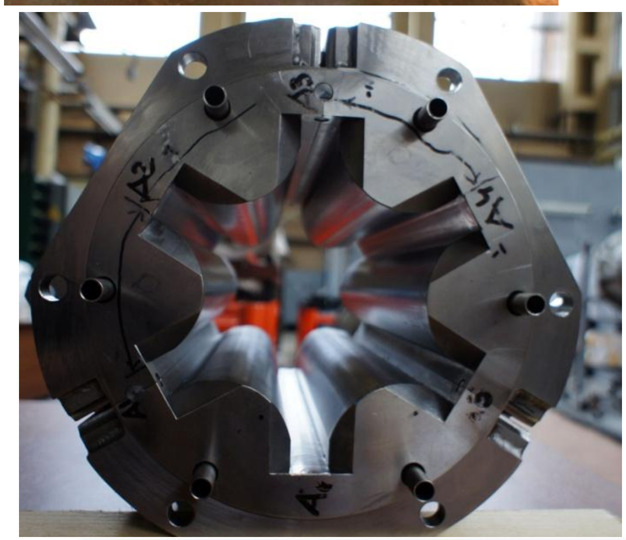
Magnets for the Booster

Booster dipole at cryo-test (9690A) and magnetic measurements

Quadrupole lense at assembly for test



Cryogenic test-bench @ LHEP



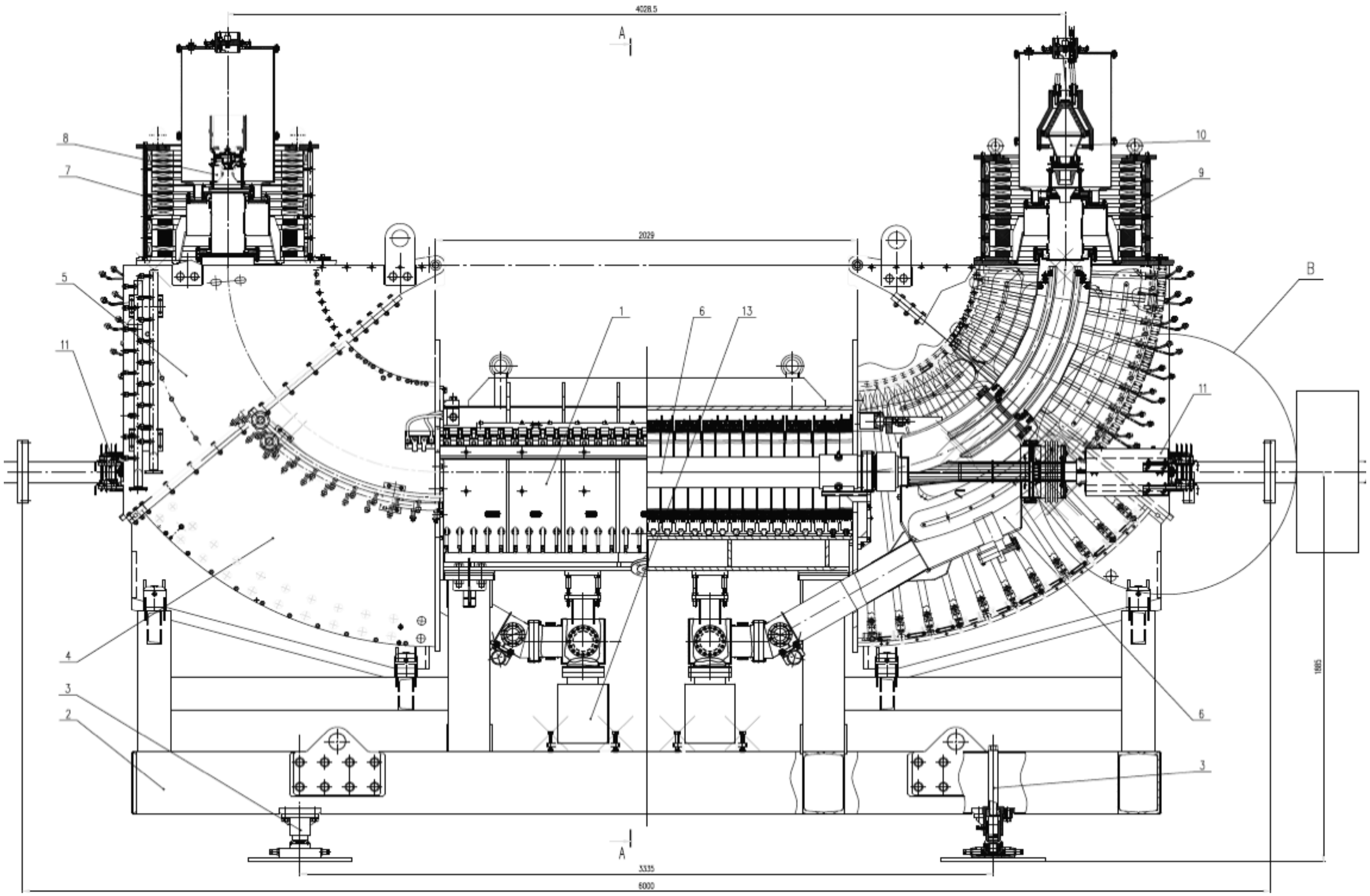
Sextupole corrector prototype (for SIS100 and NICA booster) at assembly

Accelerating RF system

RF stations during test in BINP (Novosibirsk) Autumn 2013

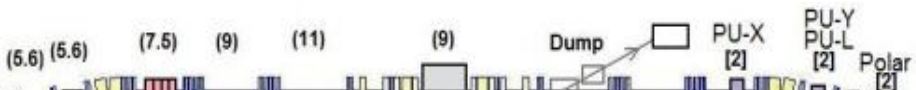
Shipment to Dubna – May 2014

Booster electron cooling system

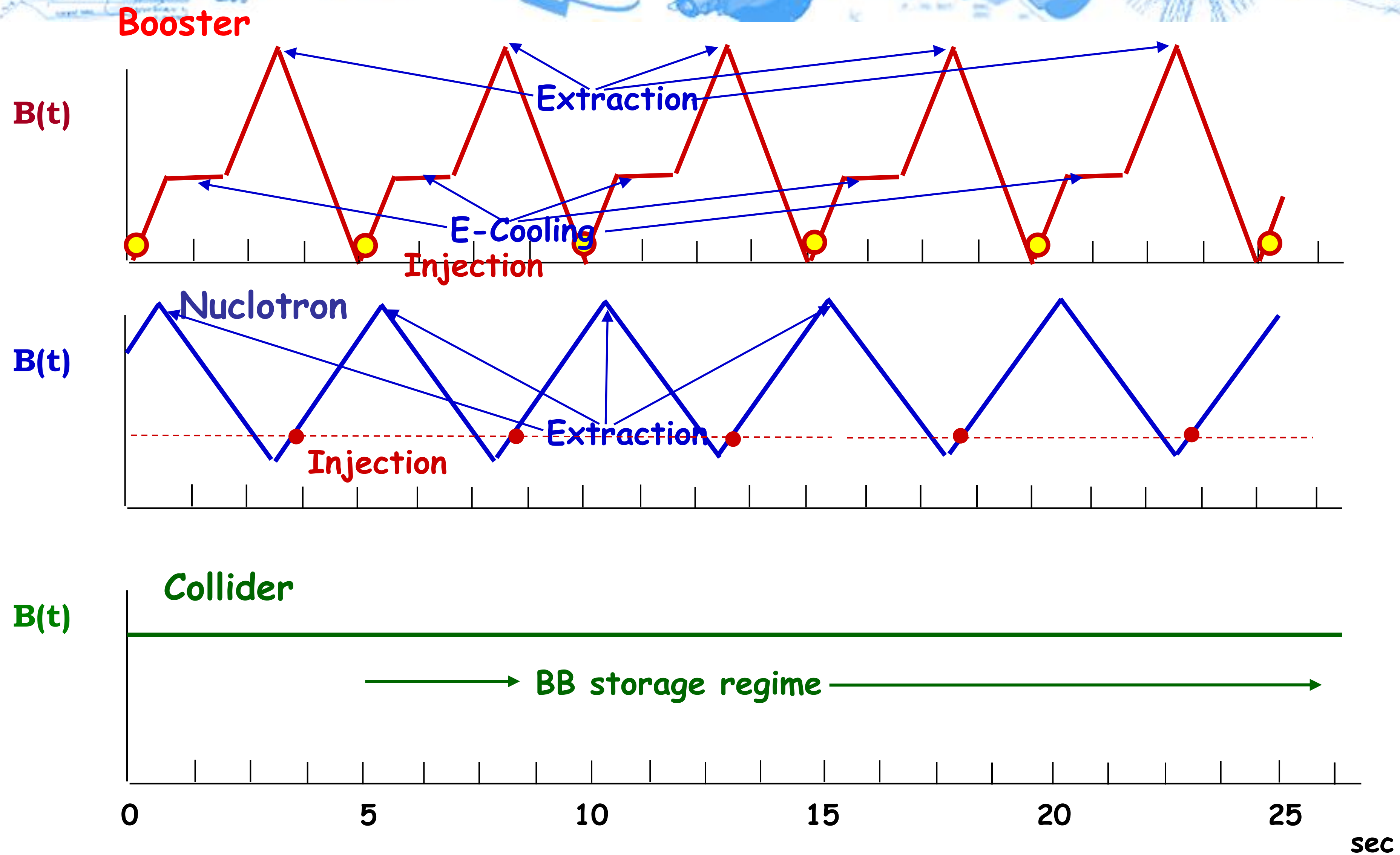


Under construction in BINP, **delivery to JINR – end of 2015**

Collider NICA



1. Facility structure and operation regimes



Startup version of the collider

Energy range from 3 to 4.5 GeV/u (optimum ~ 3.5 GeV/u)

Operation scenario:

- Stacking with BB + Stoch. longitudinal cooling
- Bunching at h = 22 and Stoch. longitudinal cooling

Parameters

Bunch length is about 1.2 m (instead of 0.6 m)

Momentum spread of $4.2 \cdot 10^{-4}$ (instead of $1 \cdot 10^{-3}$)

Bunch intensity $5 \cdot 10^{8}$ (instead of $2 \cdot 10^{9}$)

Luminosity $(1 \div 7) \cdot 10^{25}$ $cm^{-2}s^{-1}$

Startup version of the collider: goals

-Test of the beam stacking procedure:

stacking efficiency, evolution of transverse emittance

- Test and optimization of Stoch. cooling system

-Test of the beam bunching with cooling

-Investigation of IBS, ring tune ability, beam life-time…

-Test of MPD systems at L ~ $5 \cdot 10^{25}$ cm^{-2}s^{-1}

Ma

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May 22, 2013

Nuclotron tests out stochastic cooling in Dubna

Recent runs of JINR's Nuclotron have tested the stochastic-cooling system being prepared for the future NICA facility.

Résumé

Le Nuclotron teste le refroidissement stochastique à Doubna

Le projet NICA (collisionneur d'ions appuyé sur le Nuclotron) est le futur projet-phare de l'Institut unifié de recherche nucléaire de Doubna. Outre le Nuclotron actuel, ce complexe accélérateur-collisionneur inclura un nouvel accélérateur linéaire d'ions lourds, un synchrotron booster supraconducteur et deux anneaux constituant un collisionneur supraconducteur. Alors que la conception et la construction de ces nouveaux éléments sont en cours, le Nuclotron modernisé est utilisé, entre autres, pour tester les prototypes des systèmes du collisionneur et du booster. Une étape particulièrement importante a été la construction, l'installation et l'essai du prototype de système de refroidissement stochastique pour le collisionneur.

The Nuclotron-based Ion Collider fAcility (NICA) is the future flagship project of the Joint Institute for Nuclear Research in Dubna. In addition to the

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- Sommaire en français
- Ion propulsion for efficient travel
- Coelacanth sequenced

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RELATED PRODUCTS

High-temperature current leads (LN temp.)

Collaboration with China (ASIPP):
Power (high-current) HTSC current-leads up to 17 kA for NICA.

The first of four pair of HTS current leads on 18 kA before acceptance test in Dubna

Dubna, Feb’13

Hefei, Oct 2013

<u>Strategy</u>: to exchange all LHe powerful current leads at Nuclotron to HTSC and to use such HTSC in booster and Collider in order to minimize operational costs (~several times).

China – is our excellent partner.

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

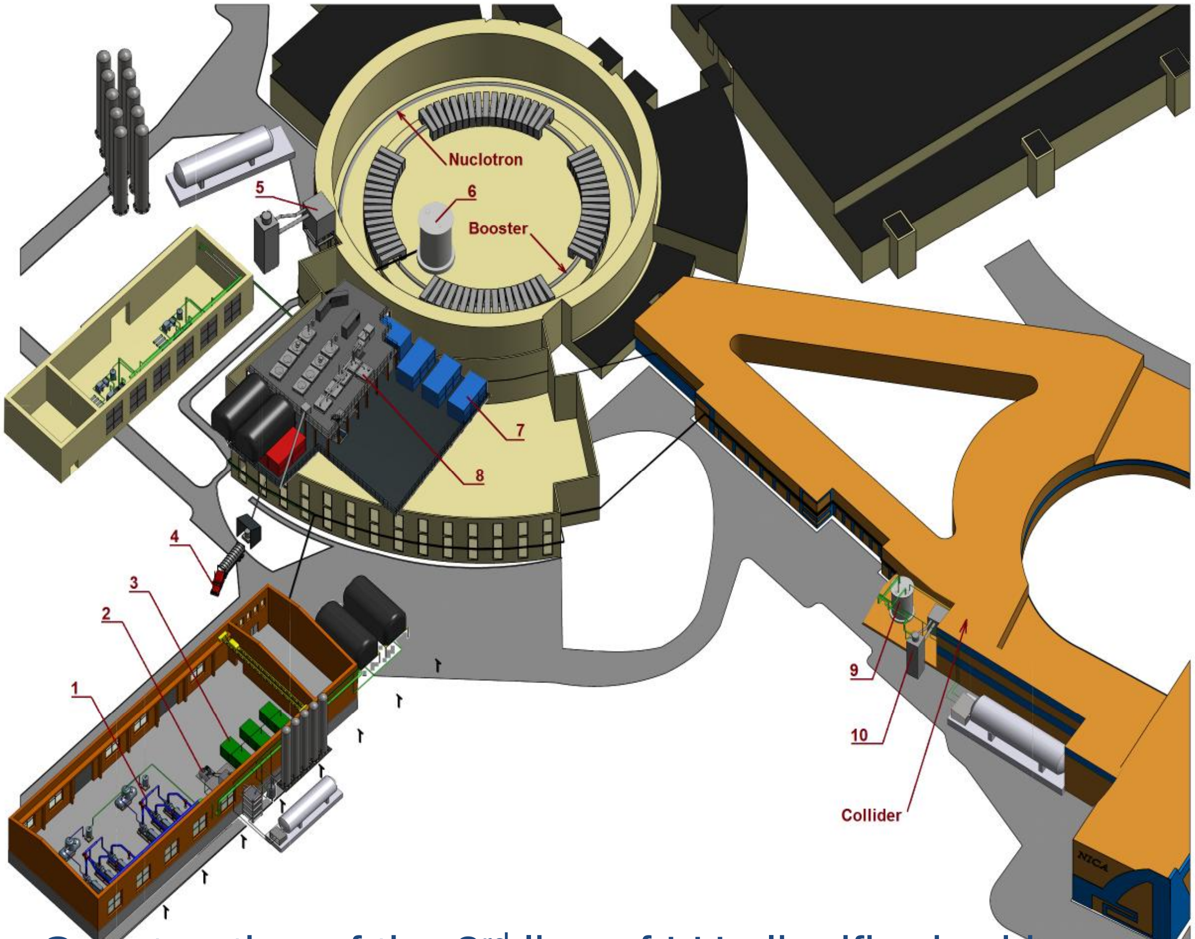
cooperation with German centers

H.Khodzhibagiyan, S.Kostromin
V.Korolev, N.Agapov

oduction

Cryogenic system for the NICA complex

N.Agapov



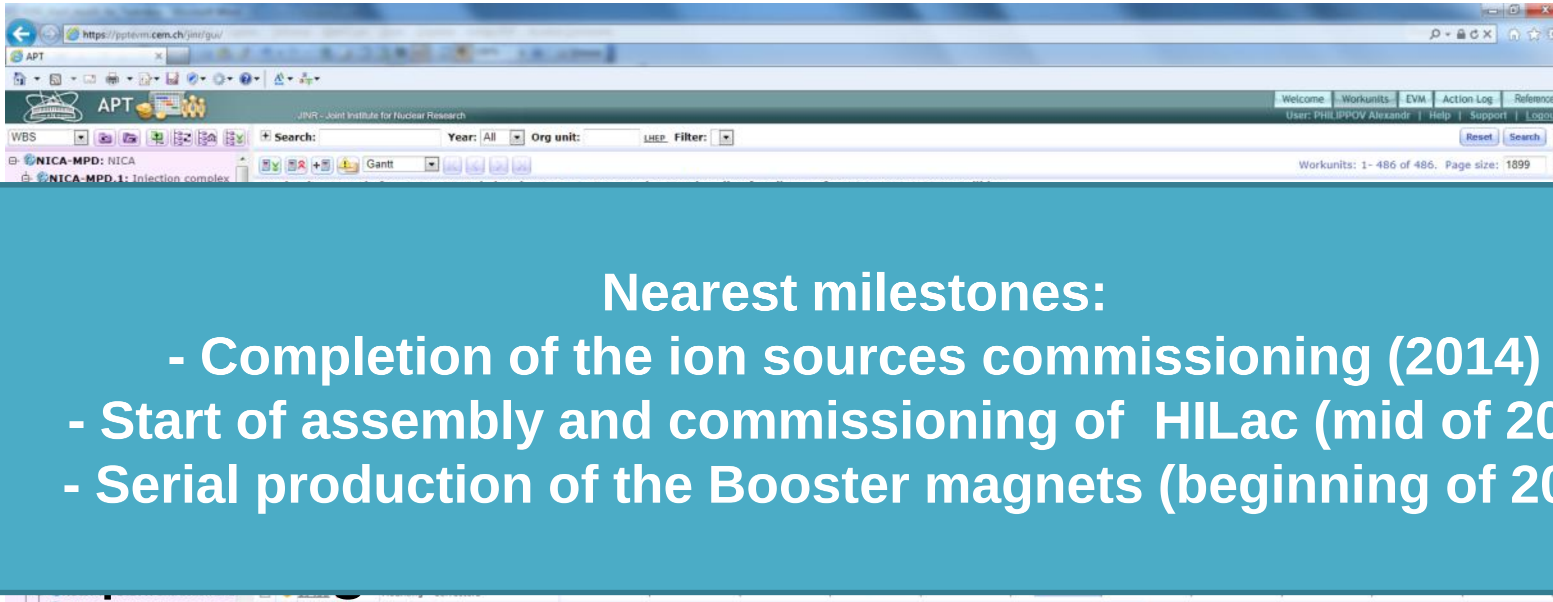
New units for the NICA accelerators:

1 – 6600 Nm^3/h screw compressors Kaskad-110/30;
2 – 1300 kg/h nitrogen liquefier OA-1,3;
3 – nitrogen turbo compressors Samsung Techwin SM – 5000;
4 – liquid helium tank;
5 – 500 kg/h nitrogen re-condenser RA-0,5 of the booster;
6 – satellite refrigerator of the booster;
7 – draining and oil-purification units;
8 – 1000 l/h helium liquefier OG-1000;
9 – satellite refrigerator of the collider;
10 – 500 kg/h nitrogen re-condenser RA-0,5 of the collider.

Construction of the 3rd line of LHe liquifier had been started in 2013

Commissioning – 2014:
Start in June, December – tech. run

The project schedule



Nearest milestones:

- Completion of the ion sources commissioning (2014)
- Start of assembly and commissioning of HILac (mid of 2014)
- Serial production of the Booster magnets (beginning of 2014)

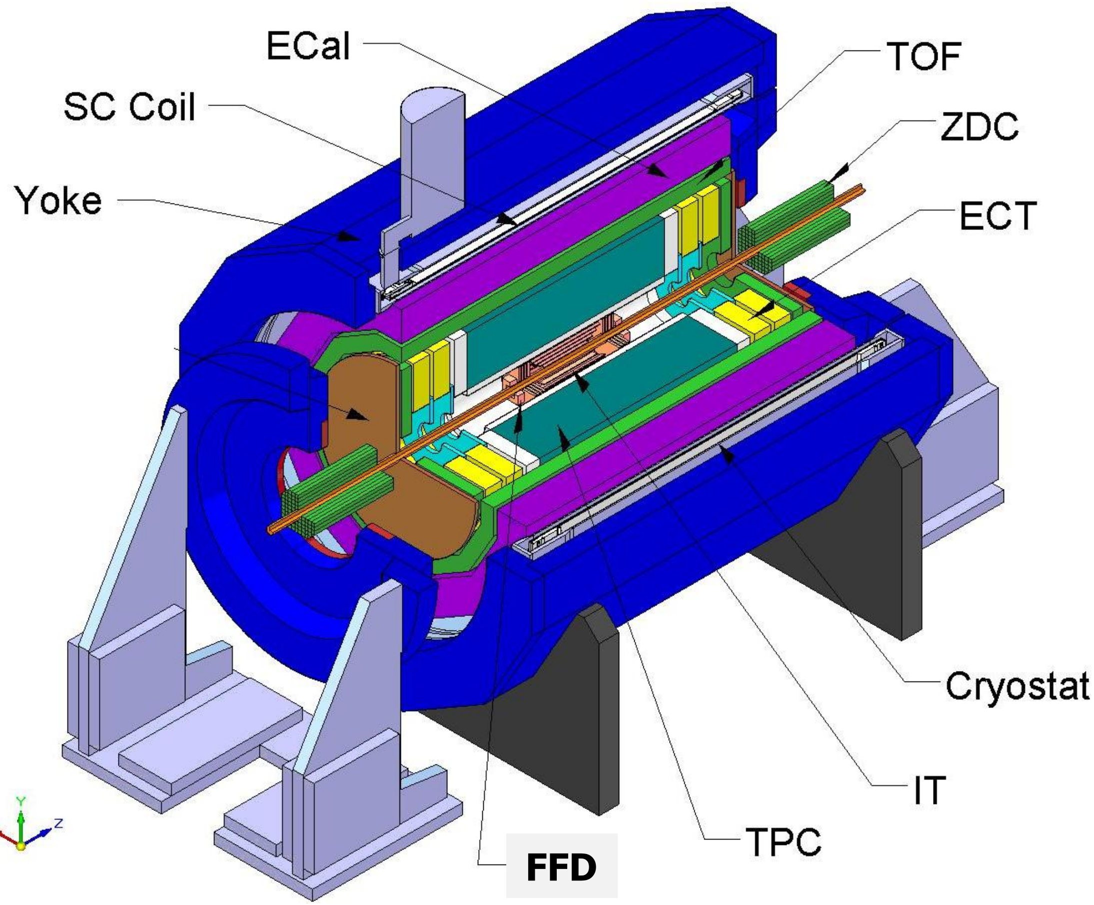
Booster assembly and start of the commissioning 2015

MultyPurpose Detector (MPD)

1-st IP @ NICA Collider

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

Start up configuration of the MultiPurpose Detector (MPD)



Magnet: *0.66 T SC solenoid*

Basic tracking: **TPC**

ParticleID: **TOF, ECAL, TPC**

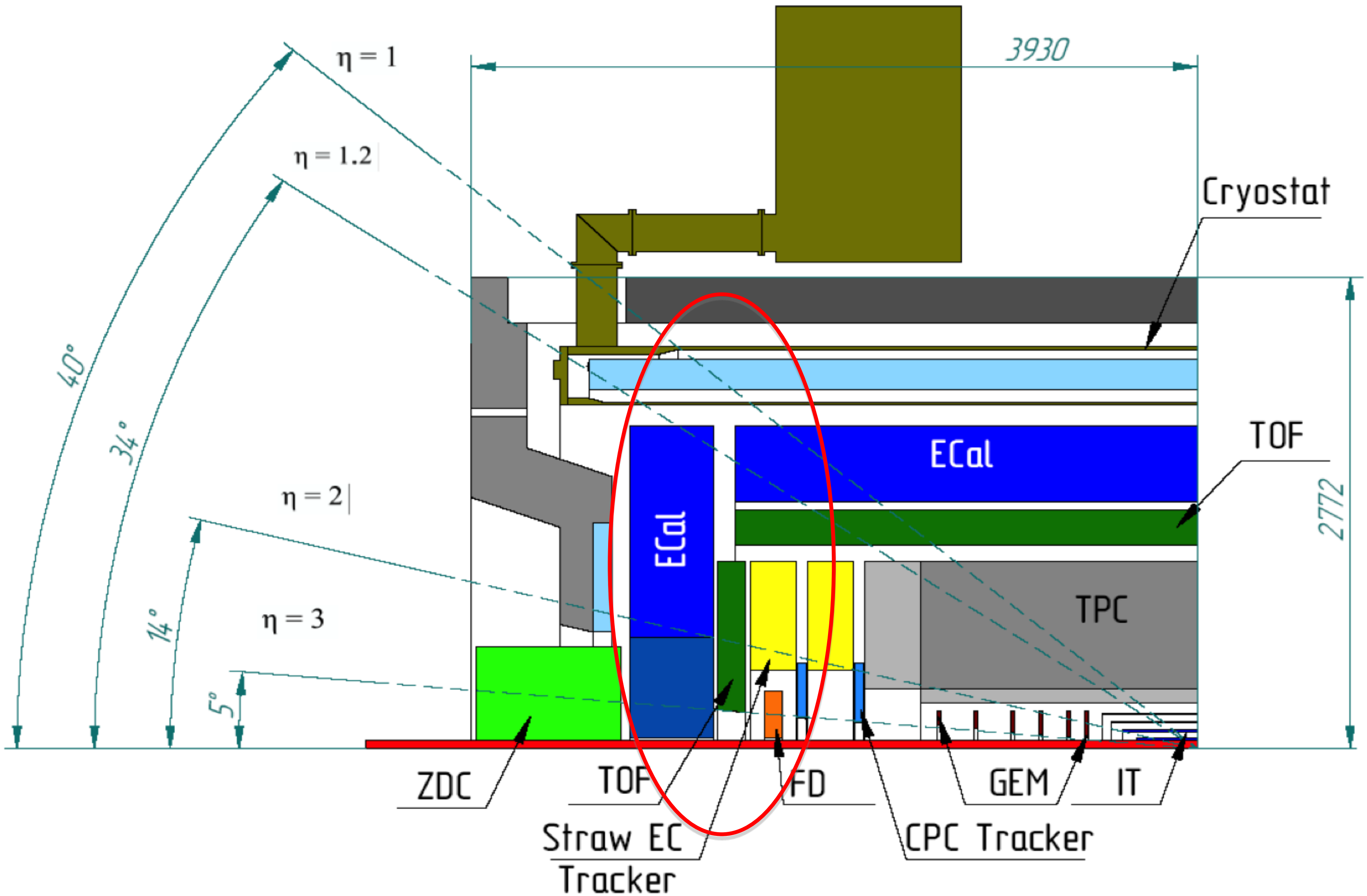
T0, Triggering: **FFD**

Centrality, Event plane: **ZDC**

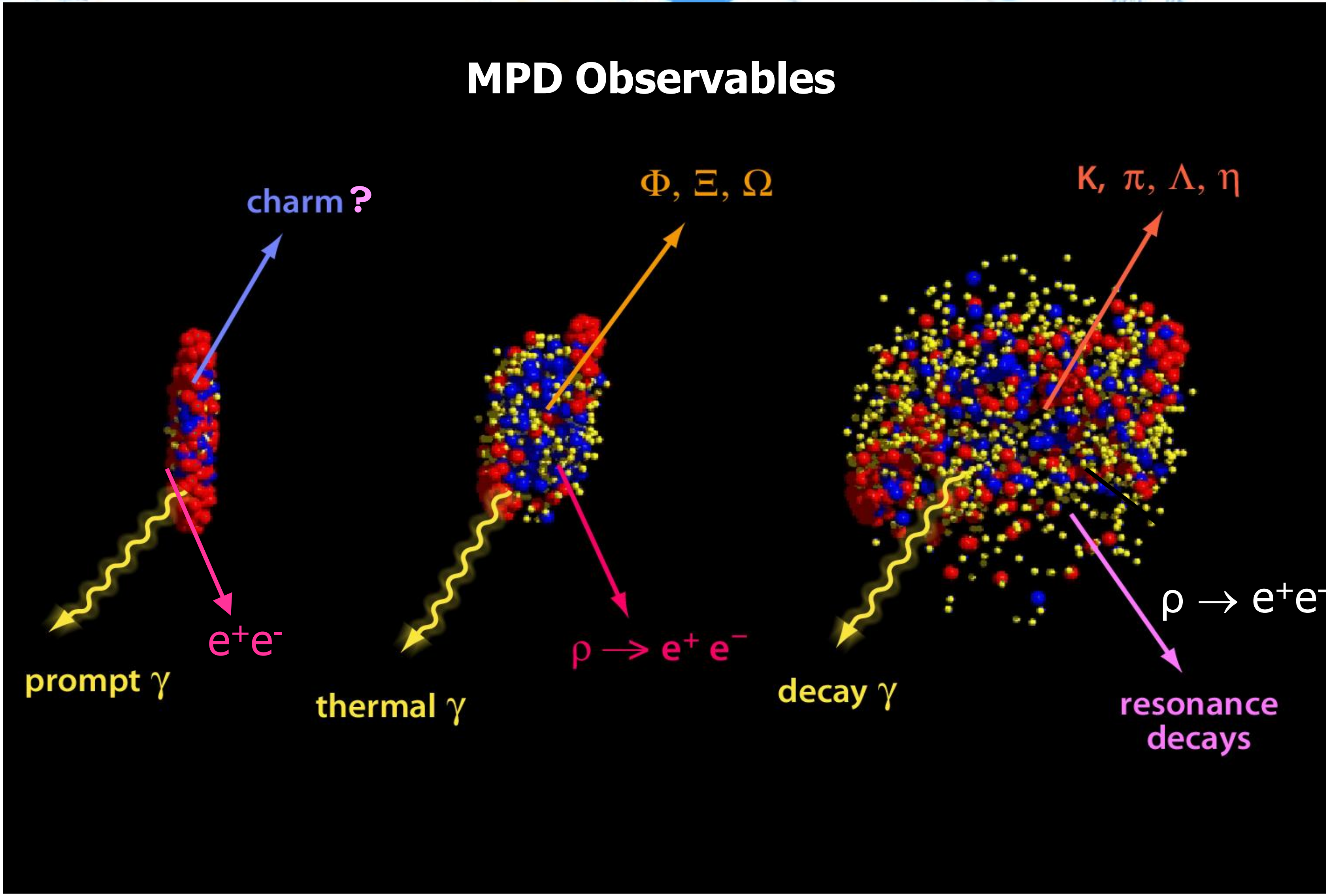
MPD required features:

- *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*

End Cap structure: new version



3. Detection of The Mixed Phase



MPD Staging

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

mid rapidity region *(good performance)*

- *Particle yields and spectra (π,K,p,clusters,Λ, Ξ ,Ω)*
- *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***

…..

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

III stage: will be considered at the later date

3. Detection of The Mixed Phase
MultiPurpose Detector (MPD)

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 particles varying the collisions energy $\sqrt{s_{NN}}$ = 4 ÷11 GeV in steps of 1-2 GeV.

Beam	Luminosity (cm^{-2} c^{-1})		Data sample per 1 week at √s = 4 GeV
	√s=4 GeV	√s=11 GeV	
p	1e32	1e32	1.5e10
^{12}C	4e28	2e29	1.5e10
^{64}Cu	6e27	3.5 e28	5e9
^{124}Xe	8e26	6e27	1e9
^{197}Au	1.5e26	1e27	3e8

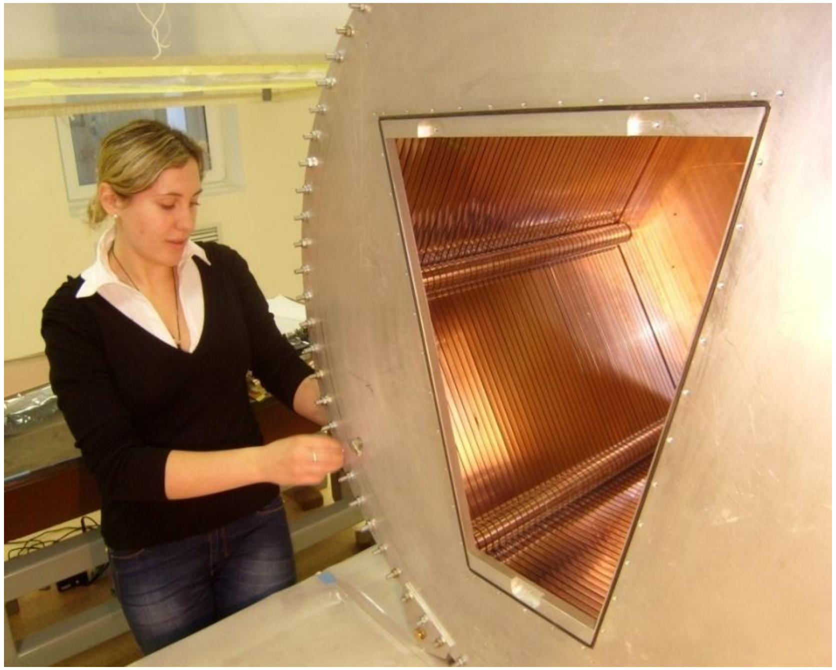
Disk storage for data ~ 10 PB/year

3. Detection of The Mixed Phase
MultiPurpose Detector (MPD)

NICA Physics Plan for 2017-19 (Stage 1)

Observable	Subdetector	Pseudorapidity coverage	New insights
Hadron yields & ratios	TPC, TOF ZDC	$\lvert\eta\rvert < 1.5$ $pT < 3$ GeV/c	Data for $5<\sqrt{s_{NN<7}}$ GeV, critical assessment of yield spectra and K/π-ratio
Hyperons: yields, flow, Polarization	TPC, TOF ZDC	$\lvert\eta\rvert < 1.5$ $pT < 3$ GeV/c	High statistics data on yields, flow and polarization $\sqrt{s} < 7$ GeV
Dileptons	TPC, TOF ECAL, ZDC	$\lvert\eta\rvert < 1.1$ $pT < 3$ GeV/c	New data at $\sqrt{s_{NN}} > 5$ GeV
Fluctuations & Correlations	TPC, TOF ECAL, ZDC	$\lvert\eta\rvert < 1.5$ $pT < 3$ GeV/c	New data on Ev-by-Ev fluct. for $\sqrt{s_{NN}} > 4$ GeV
Anti-protons Anti-nuclei	TPC, TOF ZDC	$\lvert\eta\rvert < 1.1$ $pT < 2$ GeV/c	New data on antinuclei, Flow of Pbar and antiL
Flow (v1, v2, v3) Hadrons & nuclei	TPC, TOF ZDC	$\lvert\eta\rvert < 1.5$ $pT< 3$ GeV/c	New measurements @ $\sqrt{s_{NN}}$ <7GeV Precise v_n data for ϕ,Ω
Chiral Magnetic & vortical effects	TPC, TOF ZDC	$\lvert\eta\rvert < 1.5$ $pT < 3$ GeV/c	Data @ $\sqrt{s_{NN}}$ < 7GeV (CME) Vortical @ $4 < \sqrt{s_{NN}} < 11$ GeV
(Hyper)Nuclei	TPC, TOF ZDC	$\lvert\eta\rvert < 1.5$ $pT< 5$ GeV/c	New data at $5 < \sqrt{s_{NN}} < 11$

Technological TPC prototype & full scale inner part

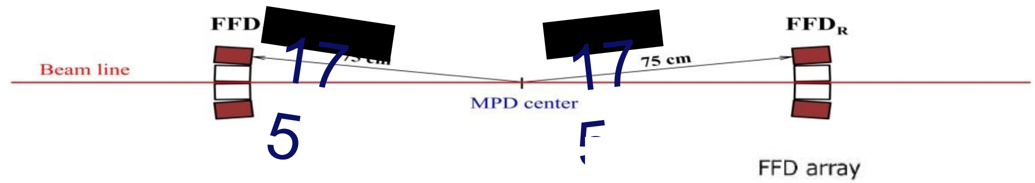


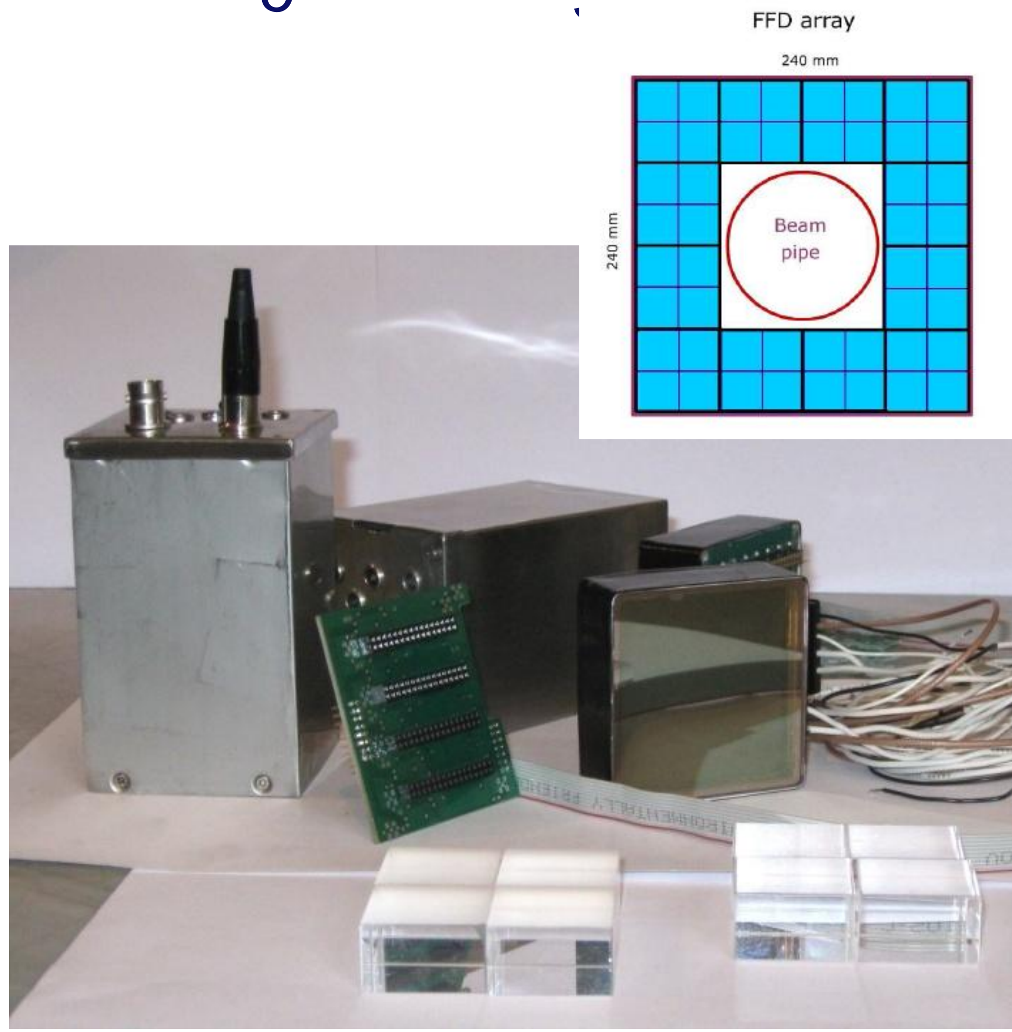
Material:
Kevlar laminated
by Tedlar film

Diameter - 950 mm
Length - 900 mm
Wall thickness - 2 mm
Weight ~ **10 kg**

Straw full scale prototype for EC tracking

FFD module prototype

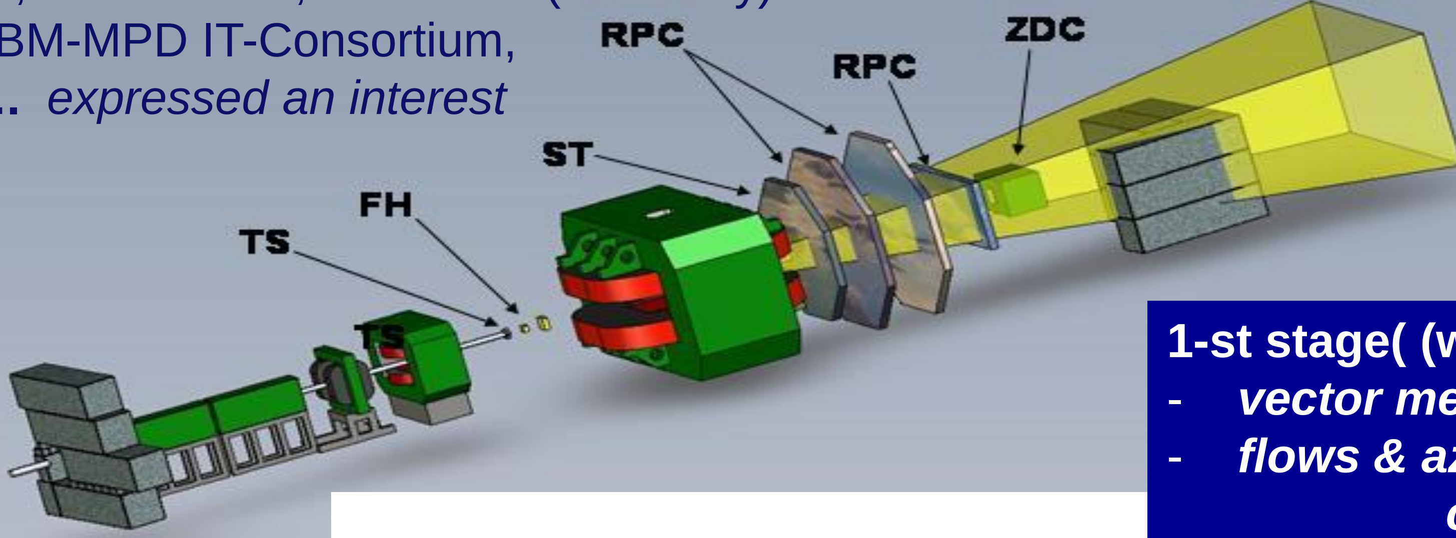


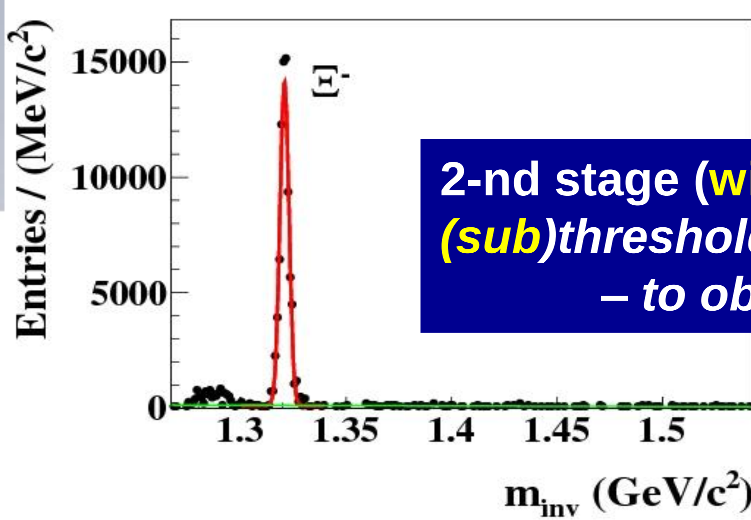


BM@N Collaboration

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*



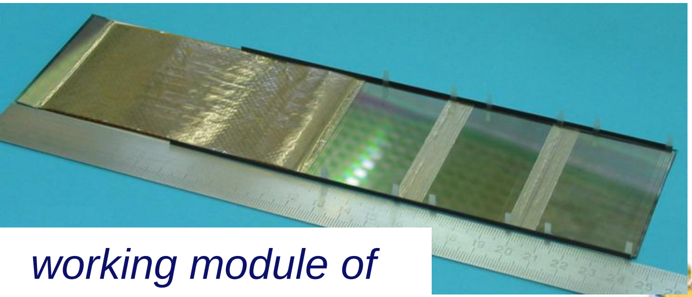


1-st stage((w/o IT):
- *vector mesons*
- *flows & azhimuthal correlations*
- *femtoscopy*

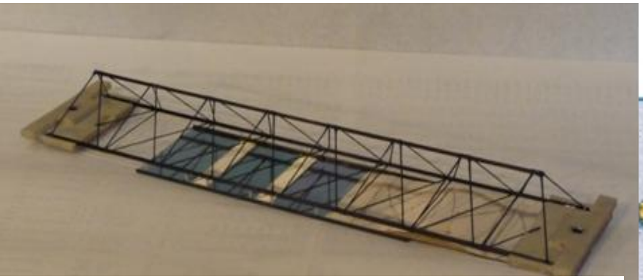
2-nd stage (with IT):
(sub)threshold production of cascades – to obtain the information on EOS

BM@N area at building 205

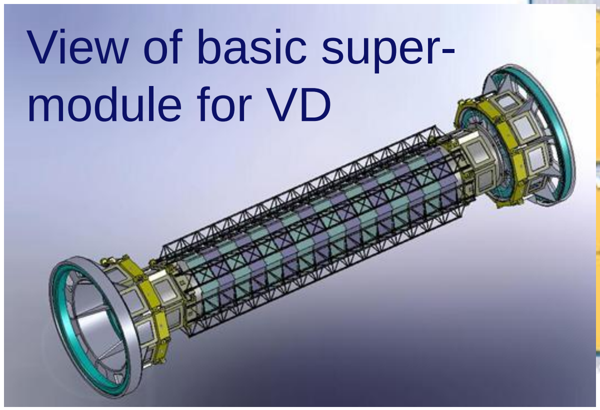
The clean area for assembly & test of Vertex Detector:
CBM/FAIR-MPD/NICA Consortium (Germany, Russia, Ukraine, Czech?)



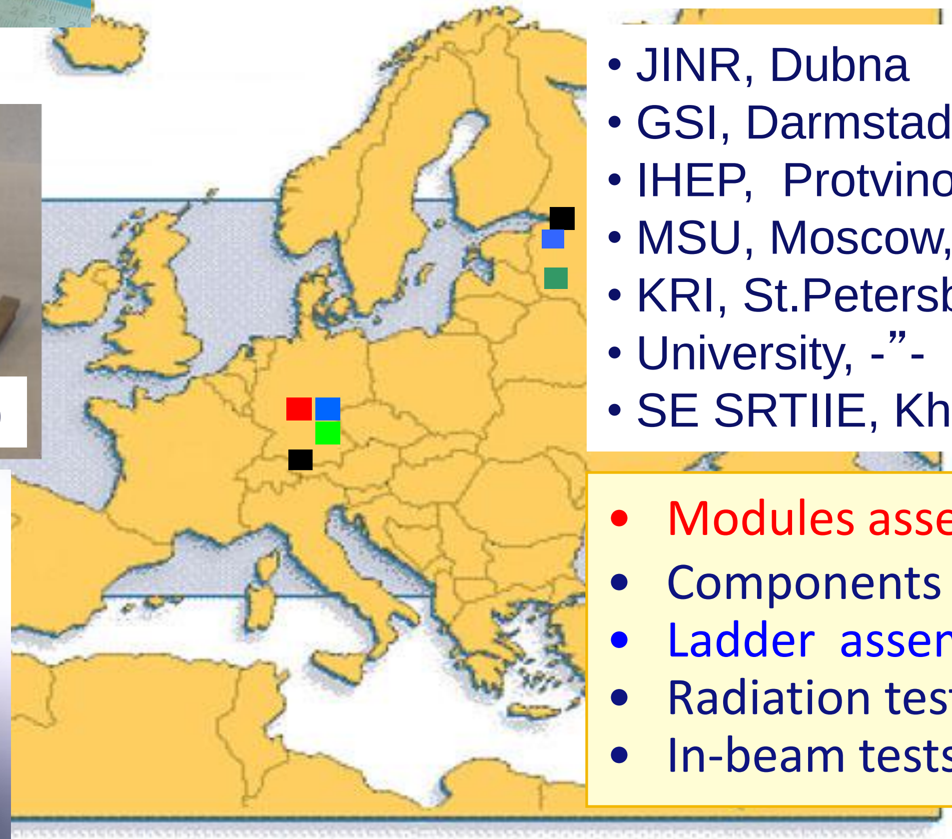
working module of 3 micro-strip silicon



Carbon-plastic structure (15 g)



View of basic super-module for VD



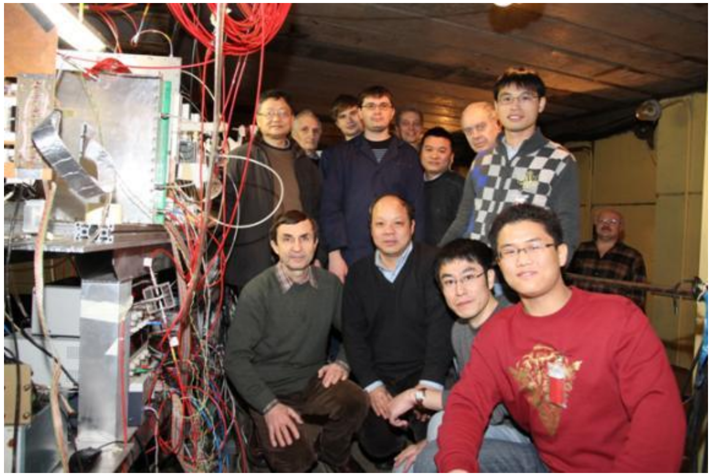
CBM @ FAIR	MPD @ NICA

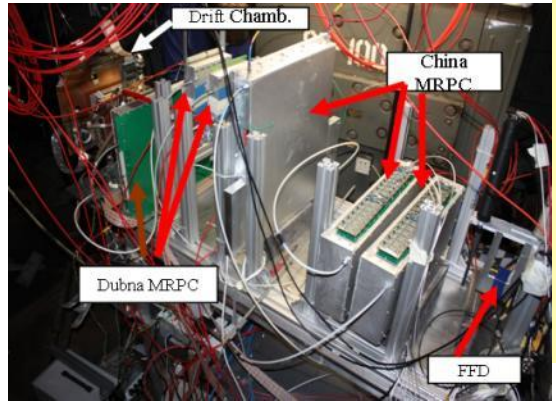
- **7 institutes**
- **3 countries**

- 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

RPC deam test at NUCLOTRON: cooperation with





Radium Inst.

*(**S-Petersburg**);*

*Tsinghua Univ. (**Beijing**),*

*University of Science & Technology of **China***

Preproduction ECAL prototypes:

cooperation with **ISM** *(Kharkiv, **Ukraine**)*

Drift chambers (*in the clean room*) - CERN contribution

chambers are tested
& ready for operation


STRABAG
PSJ
budostal 3 sa
NICA

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

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

6 of them + JINR signed the Protocol

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

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

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scientists...

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4. T... arties note the br...
co...tries and their potenti...

5. The Parties have agreed...
Collaboration in the Mega...


Representatives of 13 countries

Thank you for your attention!

NICA