Status of the NICA project

A.Sidorin, VBLHEP, JINR, Dubna

Workshop "Hot problems of Strong Interactions"
13 November 2020
Theoretical ideas and experimental searches of the critical point

General information

NICA is an international project
realizing by international intergovernmental organization –
the Joint Institute for Nuclear Research
and brings the efforts of 18 member states and 6 associated countries.

Project NICA started as a part of the JINR Roadmap for 2009-2016
was described in the JINR 7-years Program.
It was approved by Scientific Council of JINR and
the Committee of Plenipotentiaries of JINR in 2009.
NICA is a flagship project of JINR presently.

In 2016 between RF and JINR was signed a contract
presuming start of operation of starting configuration of the NICA complex in 2022.

In 2017 the project was included into ESFRI road map.

Project web-site: http://nica.jinr.ru/

The primary purpose of the NICA construction

The project comprises experimental studies of **fundamental** character in the fields of the following directions:

- Relativistic nuclear physics;
- Spin physics in high and middle energy range of interacting particles;
- Radiobiology.

Applied researches based on particle beams generated at NICA are dedicated to development of novel technologies in material science, environmental problems resolution, energy generation, particle beam therapy and others.

Education program is one of the first priority activities at JINR, as formulated in JINR Roadmap.
The proposed NICA facility offers various possibilities for teaching and qualification procedures including practice at experimental set ups, preparation of diploma works, PhD, and doctoral theses.

Stages of the experimental program realization

Stage I

-Fixed target experiment with heavy ions (started 2018)

Stage II

-Starting configuration of the collider and detector (2022)

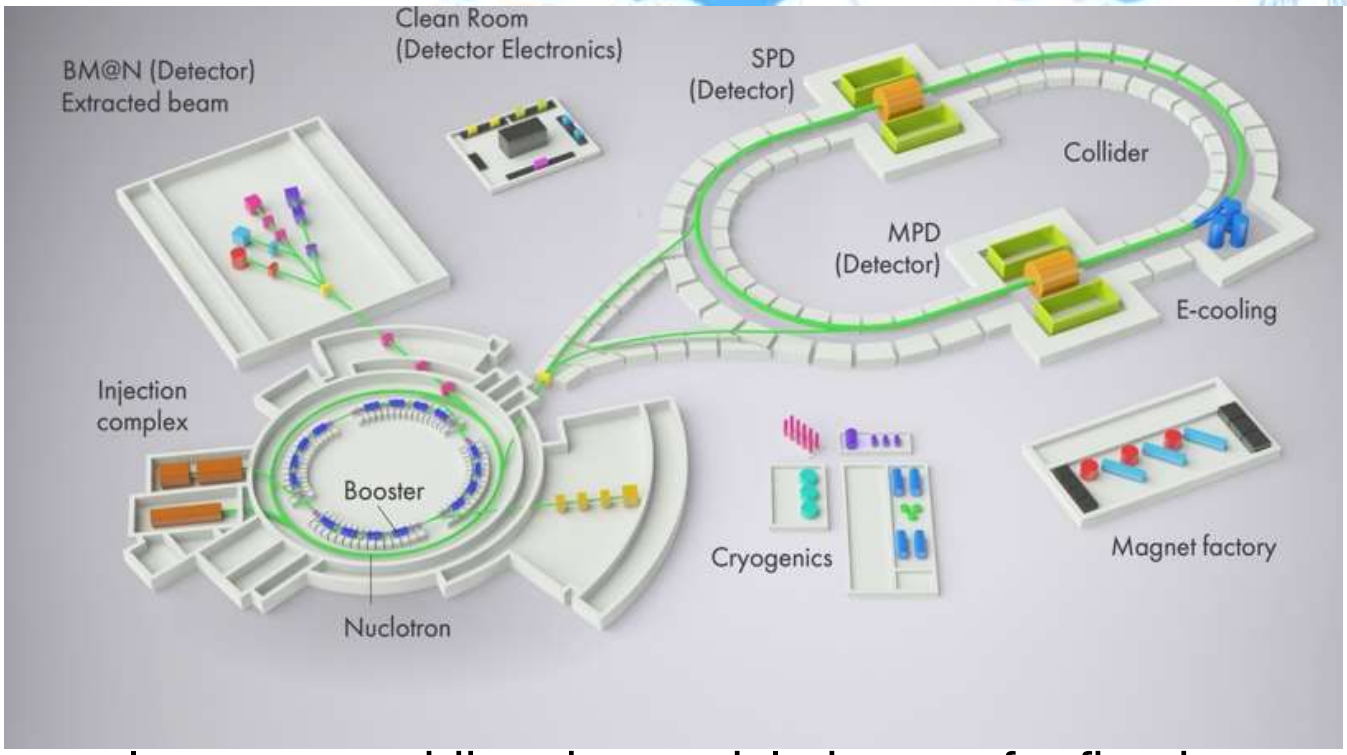
-Basic configuration, heavy ion collisions (2023)

-Collisions of heavy ions with light ions (protons)

Stage III

-Spin physics program

The NICA complex includes:



- Set of accelerators providing the particle beams for fixed target and collider experiments,
- Experimental facilities,
- Line for assembling and cryogenic testing of SC-magnets,
- Workshops for construction of the detector elements,
- NICA innovation center,
- Required infrastructure.

Experimental facilities

Fixed target experiment

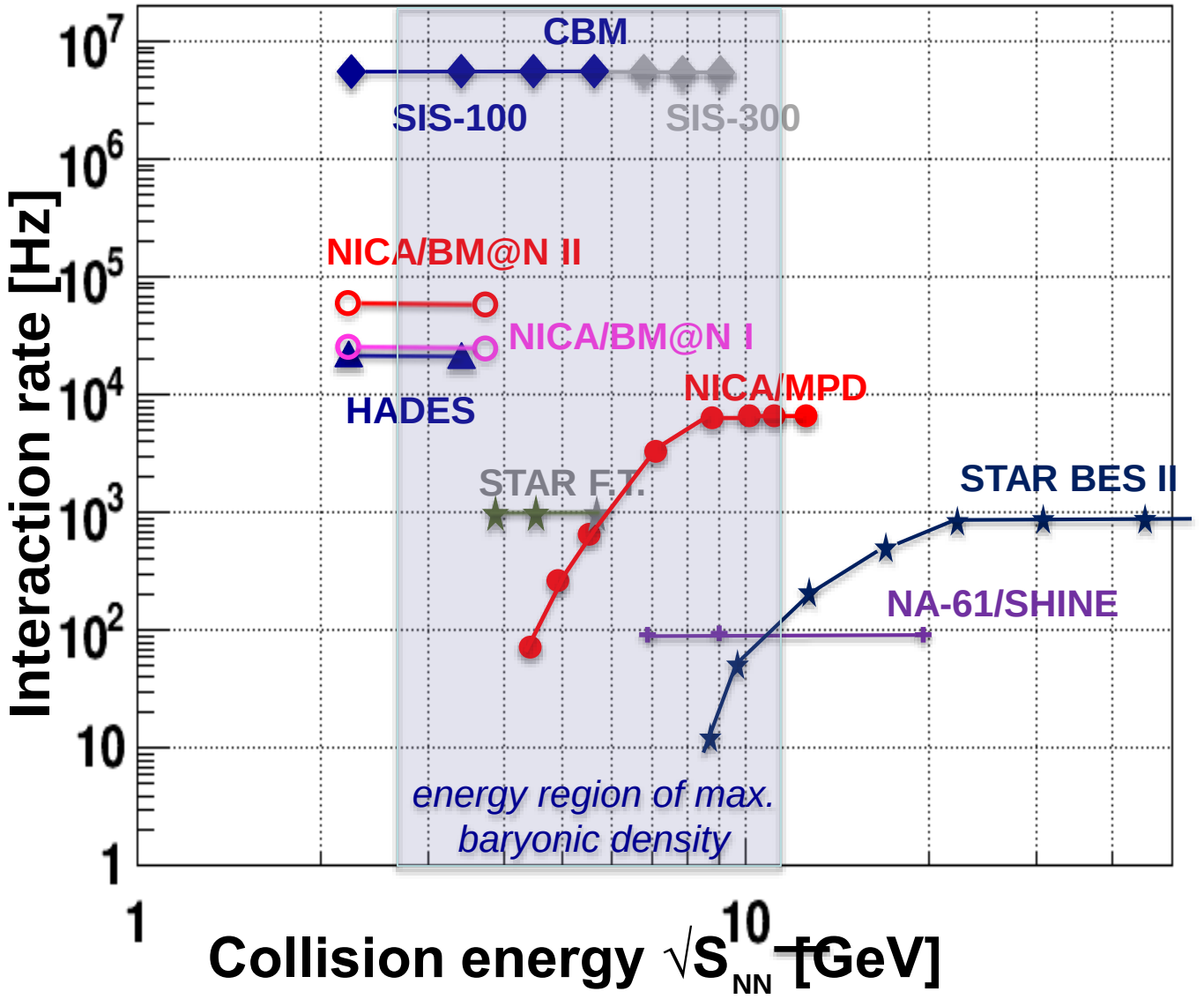
Baryonic Matter at Nuclotron (BM@N)

Collider experiments:

Multi Purpose Detector (MPD)

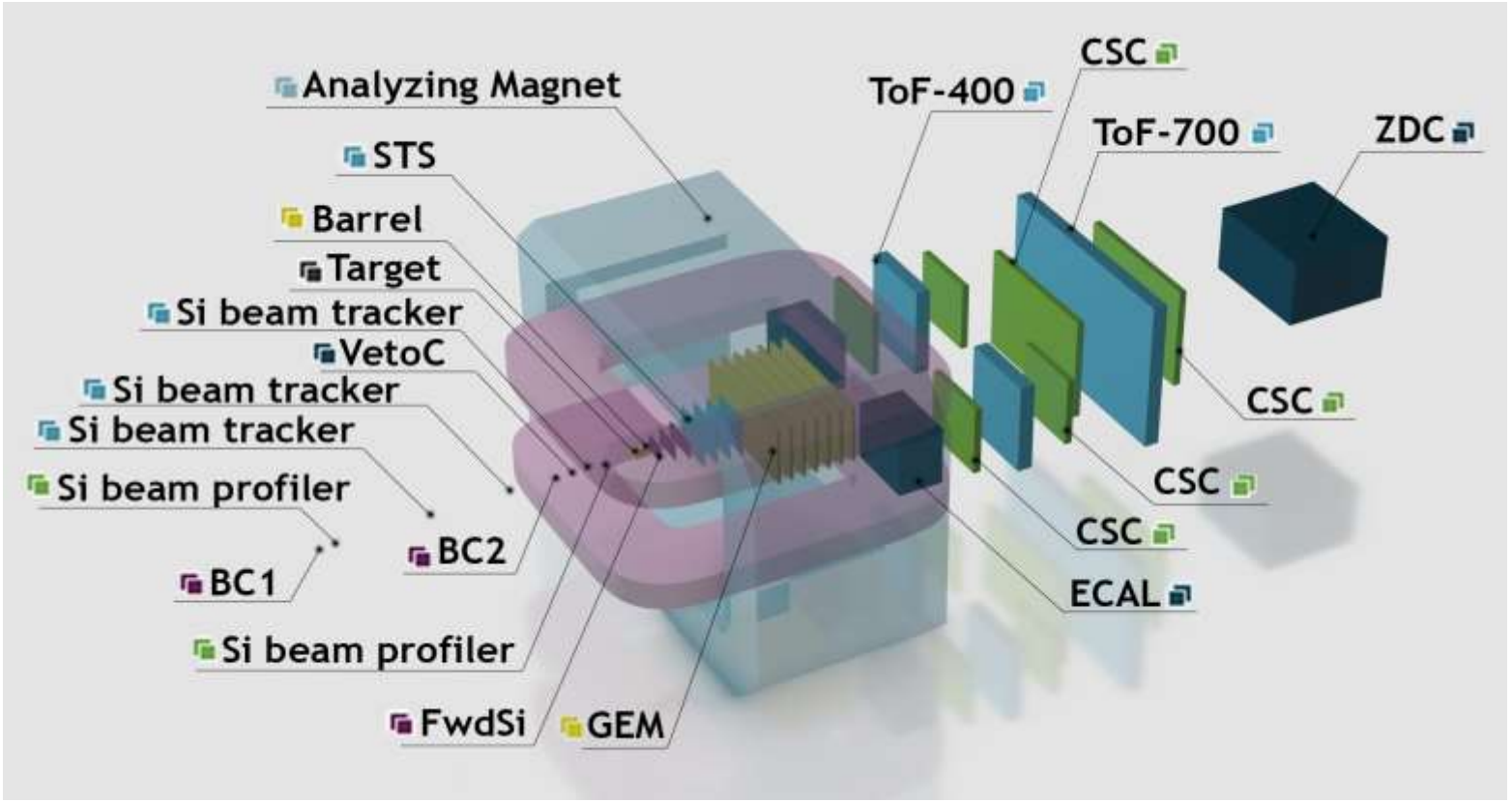
Spin Physics Detector (SPD)

Experimental status



Complementary to the RHIC/BES, CERN and FAIR programs

Baryonic Matter at Nuclotron



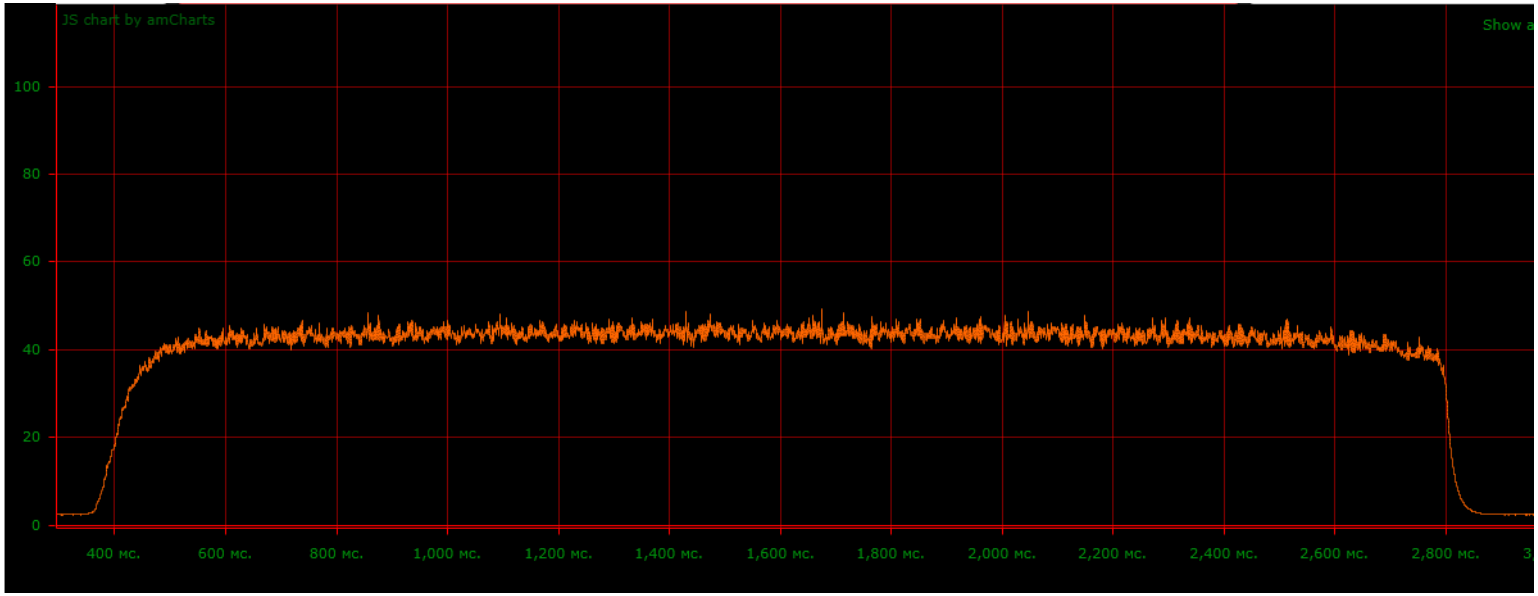
Main goals are

- investigations of strange/multi-strange hyperon, hypernuclei production and short range correlations.

Baryonic Matter at Nuclotron

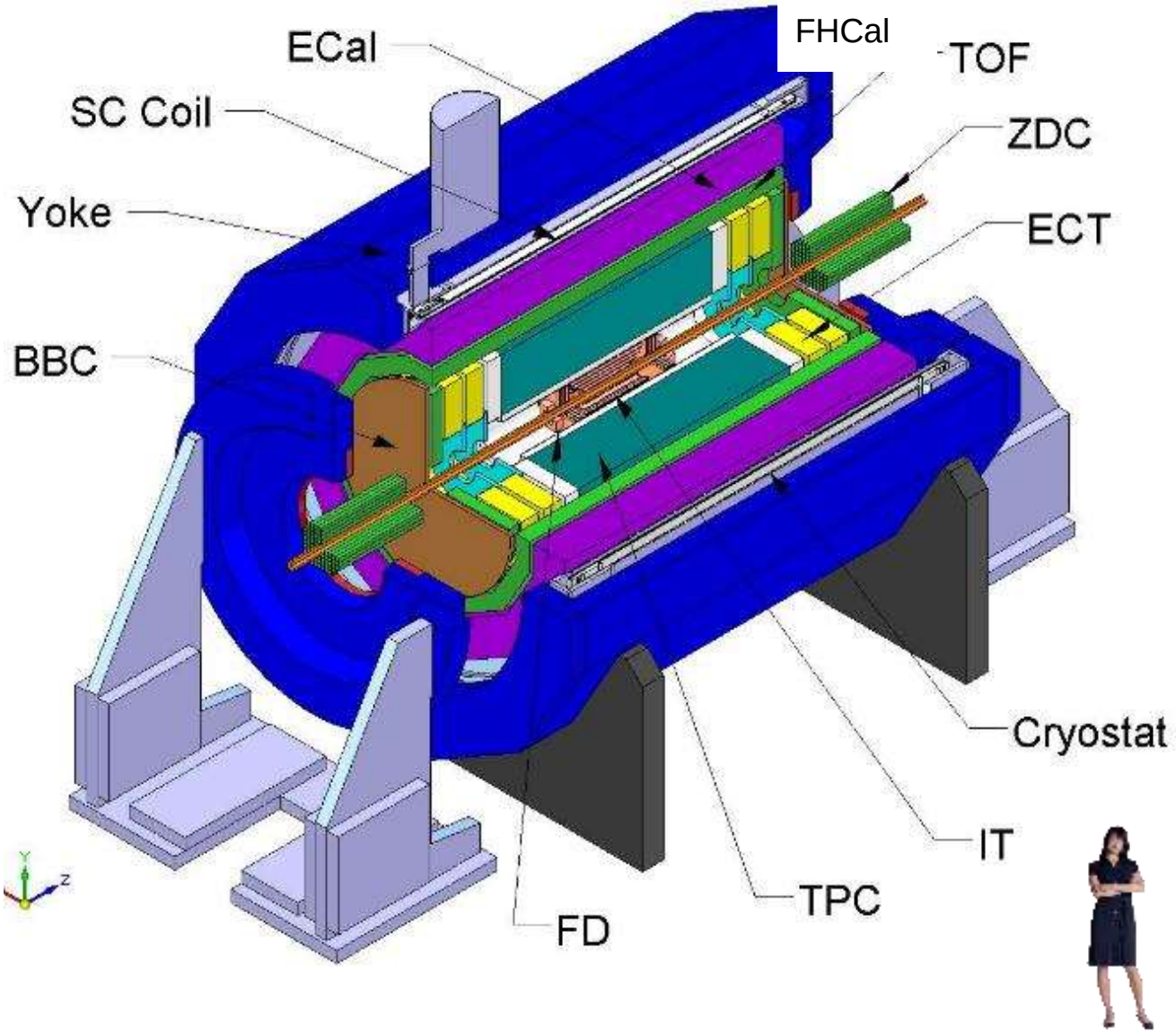
-Three technological runs (2016 – 2017)

-**5.02 – 4.04.2018 experiments** with C, Ar, Kr beams (Short range correlations, strange production)

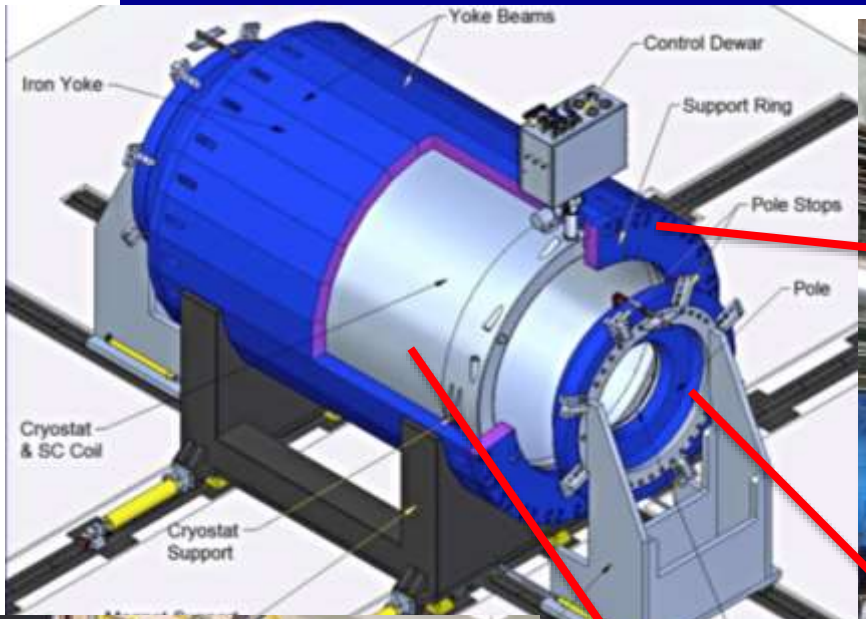


Intensity of extracted Kr beam.
Spill duration 2.5 sec. Up to $5 \cdot 10^5$ ions per cycle

Multi Purpose Detector (MPD)



Magnet fabrication: *ASG (Genova) & Vitkovice HM*



yoke control assembly at HM Vitkovice

winding machine

cryostat

trim coil

Magnetic yoke (720 t)

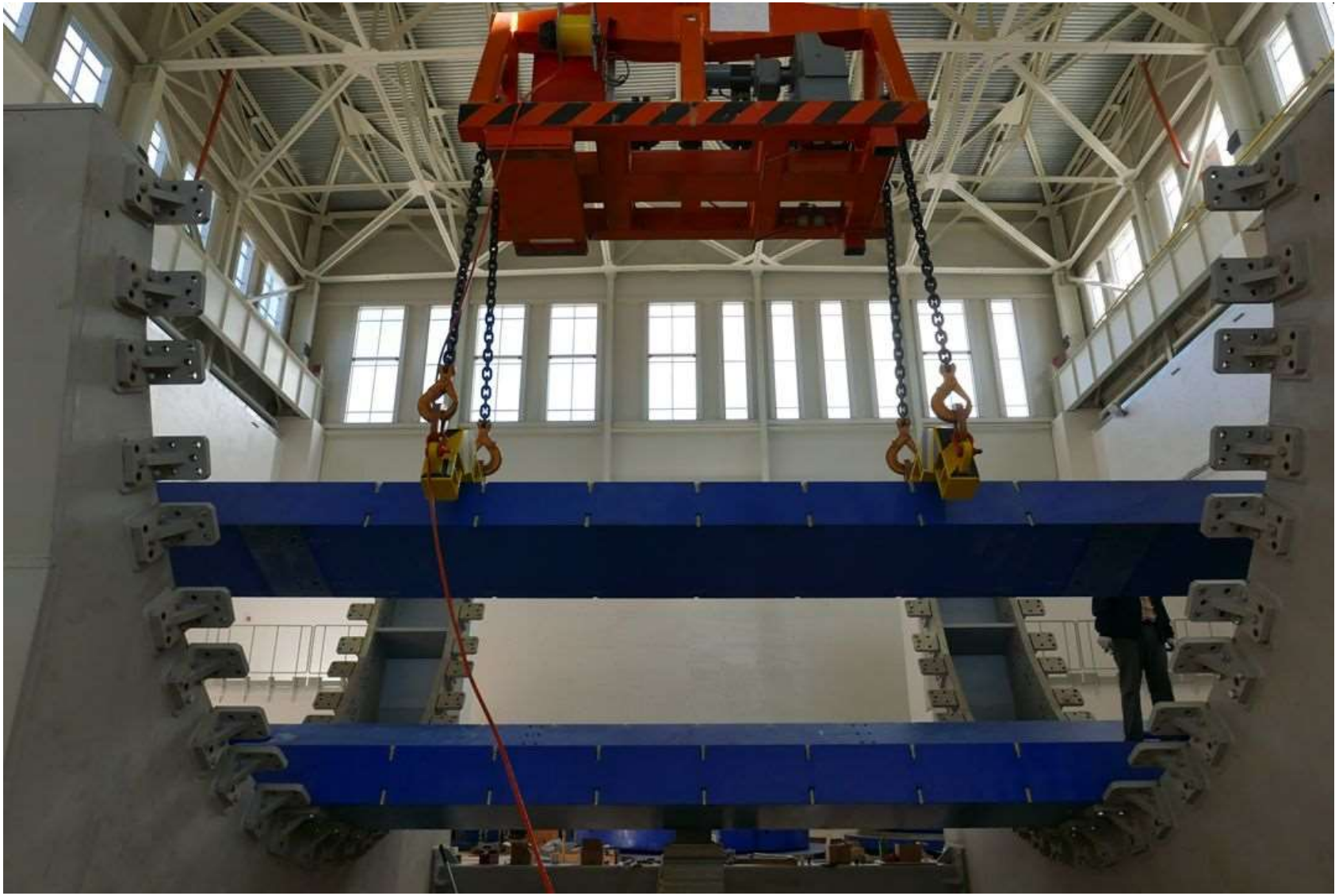
SC Solenoid in Genova

… in Saint-Petersburg

... River Volga

… transported to VBLHEP

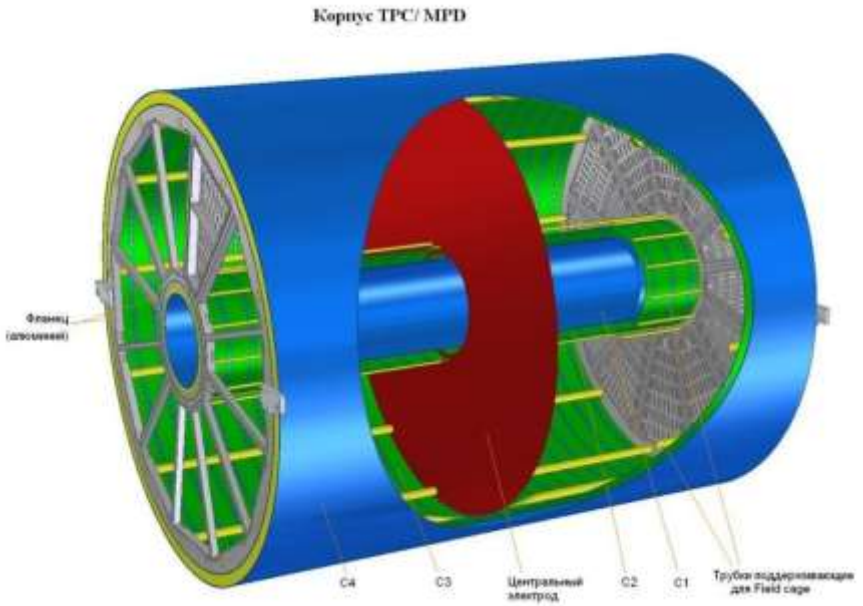
Magnetic yoke prepared for the solenoid location



MPD inner tracker

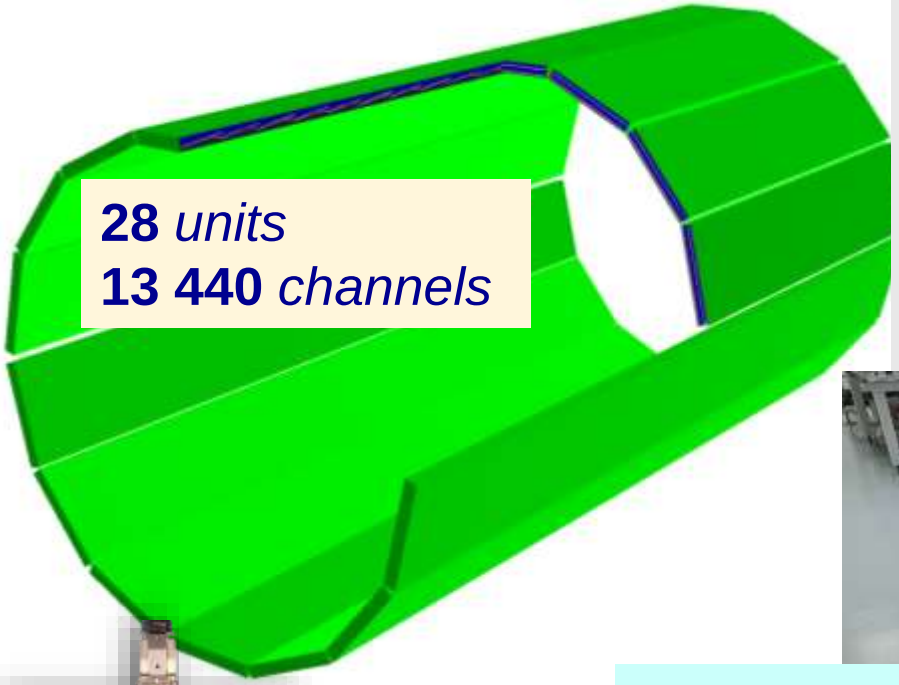
CREMLIN WP2 Working Meeting
„Exchange on Policy- and ESFRI-related Issues”, April 2016, Dubna

Time Projection Chamber (TPC)

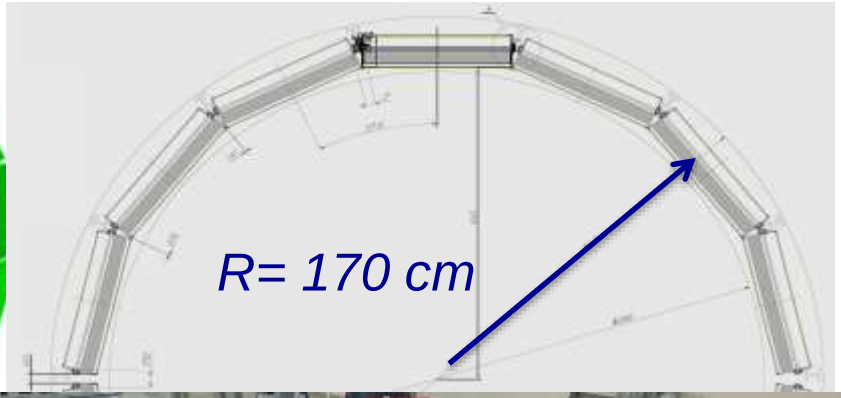


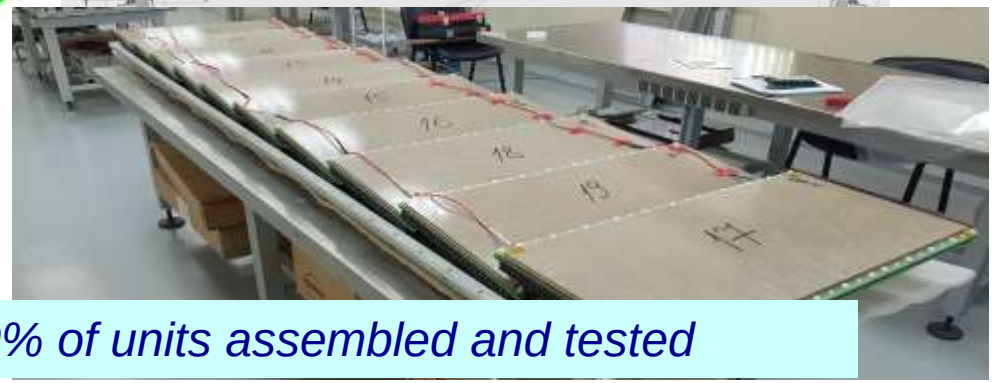
length	*340 см*
external R	*140 см*
internal R	*27см*
gas	*90% Ar+10% meth.*
Drift velocity	*5.45 см / мкс;*
Drift time	*< 30 мкс;*
N of chambers	*12 + 12*
N channels	*95232*
rate	*< 7 kHz (L= 10^{27})*

Time of Flight system (TOF)

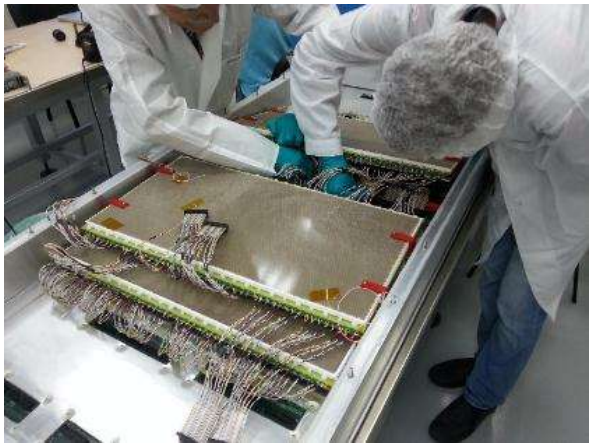


28 *units*
13 440 *channels*

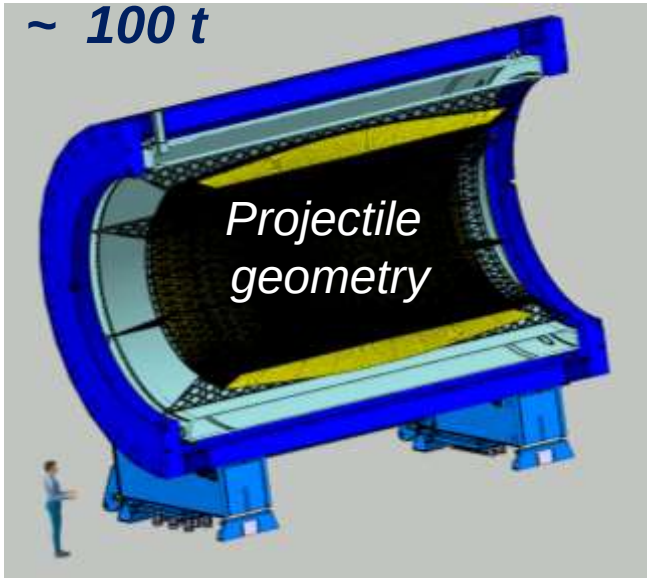


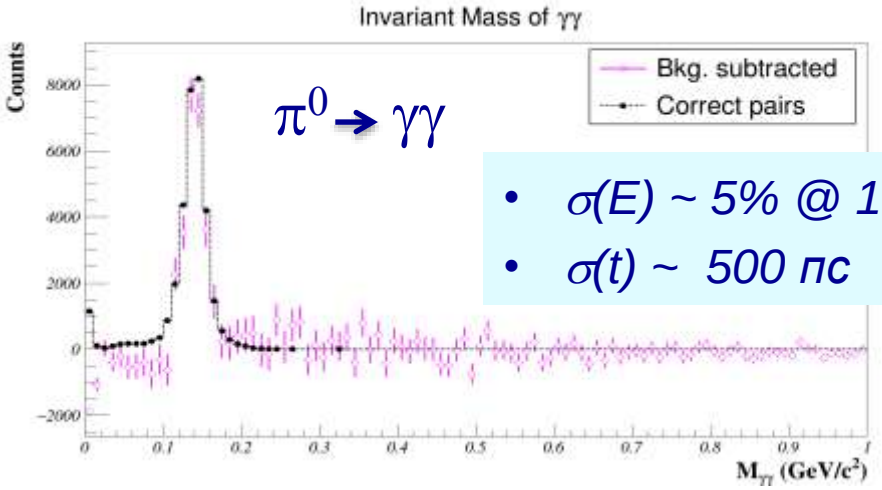


***20**% of units assembled and tested*

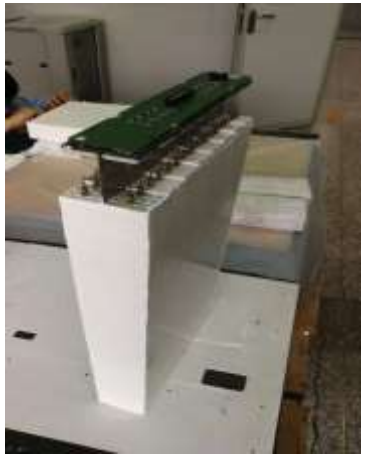


Electromagnetic calorimeter (ECal) system





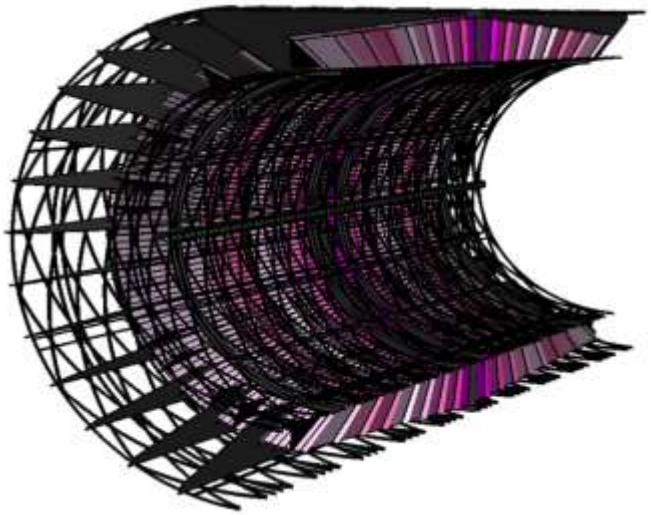
- $\sigma(E) \sim 5\%$ @ 1 ГэВ;
- $\sigma(t) \sim$ 500 пс



Protvino

Bejing

Support system



NICA accelerators

Main accelerator of the NICA complex is **the Nuclotron** –
superconducting ion synchrotron at magnetic rigidity of about 42 T·m
equipped with two injection chains: for heavy and for light ions.

Injection chain for heavy ions consists of:
the ion source (KRION-6N), heavy ion linear accelerator (HILac),
superconducting booster synchrotron (Booster) and required beam transport lines.

Injection chain for light ions includes:
Laser ion source (LIS), Source of polarized ions (SPI), Duoplasmatron,
RFQ accelerator as a foreinjector, Drift tube linac of Alvarec type (LU-20)
and required beam transport lines.

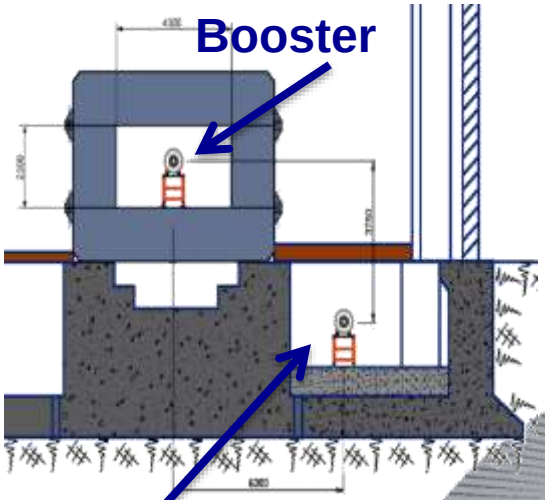
The collider experiments will be provided at two storage rings
with two interaction points (IP).

Heavy ion injection chain

KRION 6T
used in two runs

Heavy ion linear accelerator (HILAc)
Commissioned – October 2016

Booster



Electron cooler

injection

Reference section

Power supply

extraction

RF stations

Nuclotron

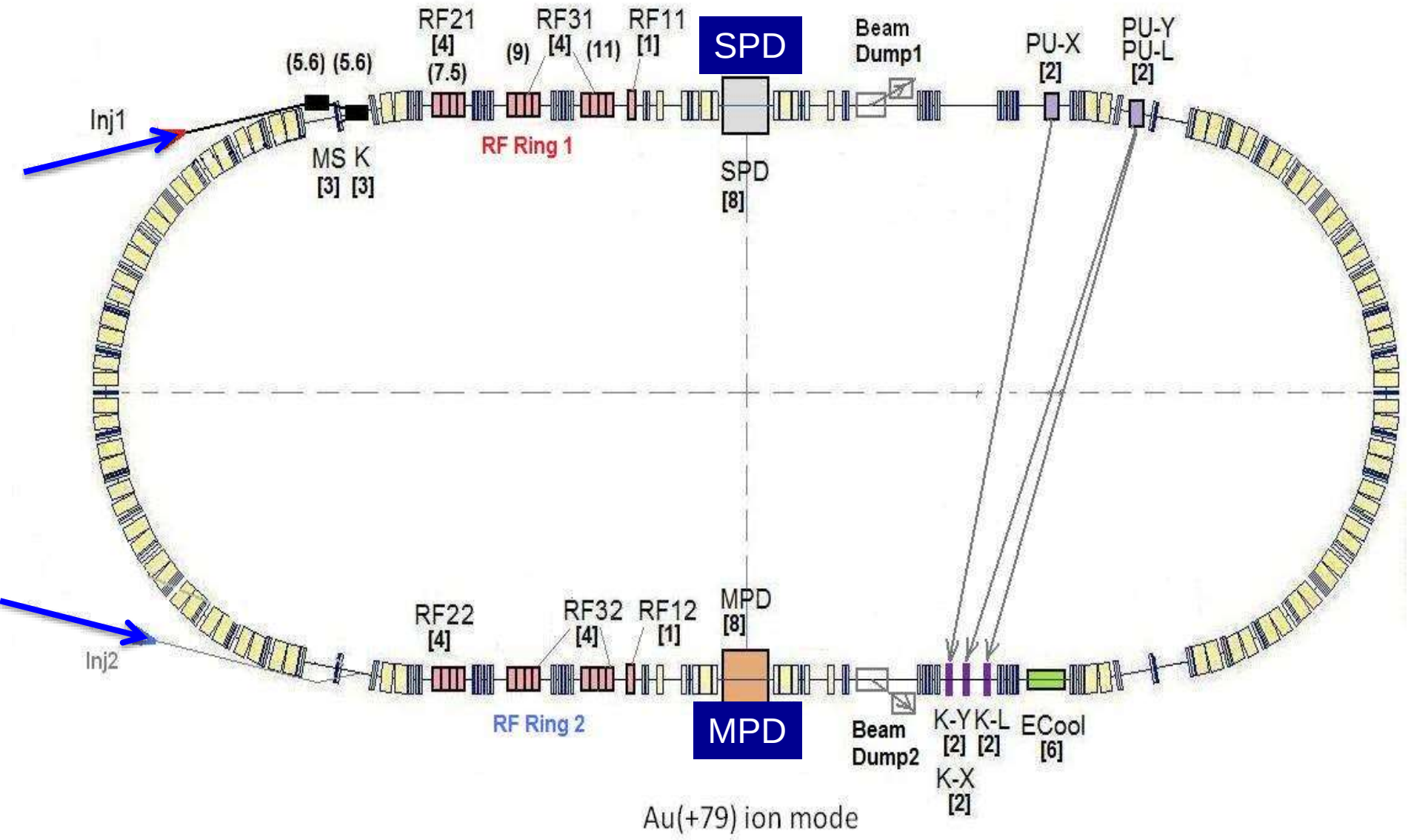
Booster

Official start of the commissioning

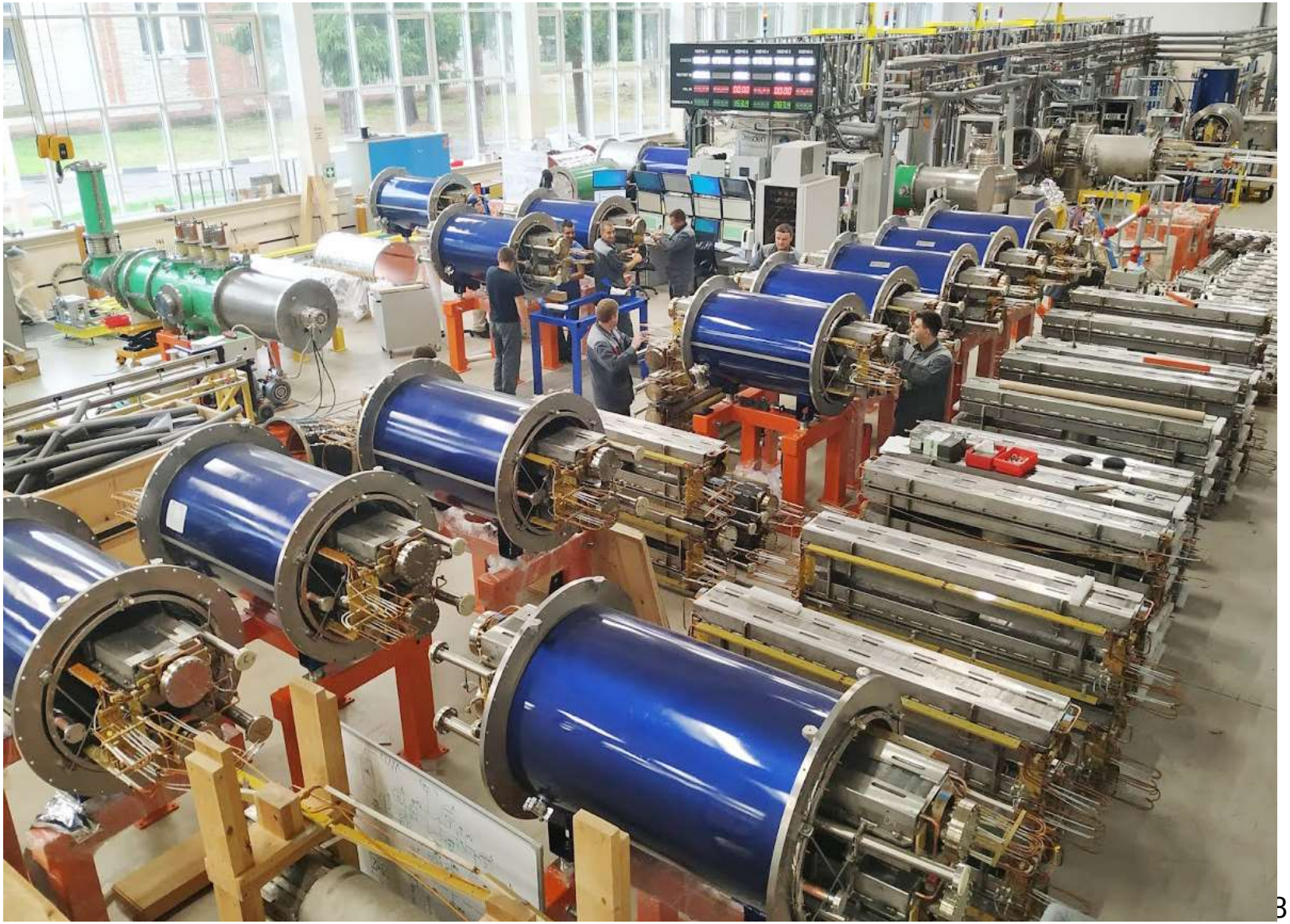
Booster

Cryo-magnetic system in assembly
16 November 2020 – start of technological run

NICA collider

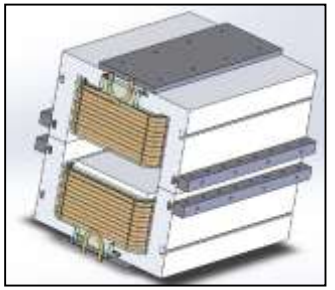


Serial production of the collider magnets



Nuclotron-collider Beam transport channel

Magnetic element	Number	Effective length, m	Max. magnetic field (gradient), T (T/m)
Long dipole	21	2	1.5
Short dipole	6	1.2	1.5
Quadrupole Q10	22	0.353	31
Quadrupole Q15	6	0.519	31
Steerer	33	0.466	0.114



29

Line for assembling and cryogenic testing of SC-magnets

Main production areas:

- Incoming inspection zone
- SC cable production hall
- SC coils production hall
- Area for assembling the magnets
- Area for the magnetic measurements under the room temperature
- Leakage test area
- Area for mounting the SC-magnets inside cryostats
- Cryogenic tests bench

450 magnets for NICA and FAIR projects

Official start up

28 November 2016

Collider building

Official start up of the construction 25 March 2016

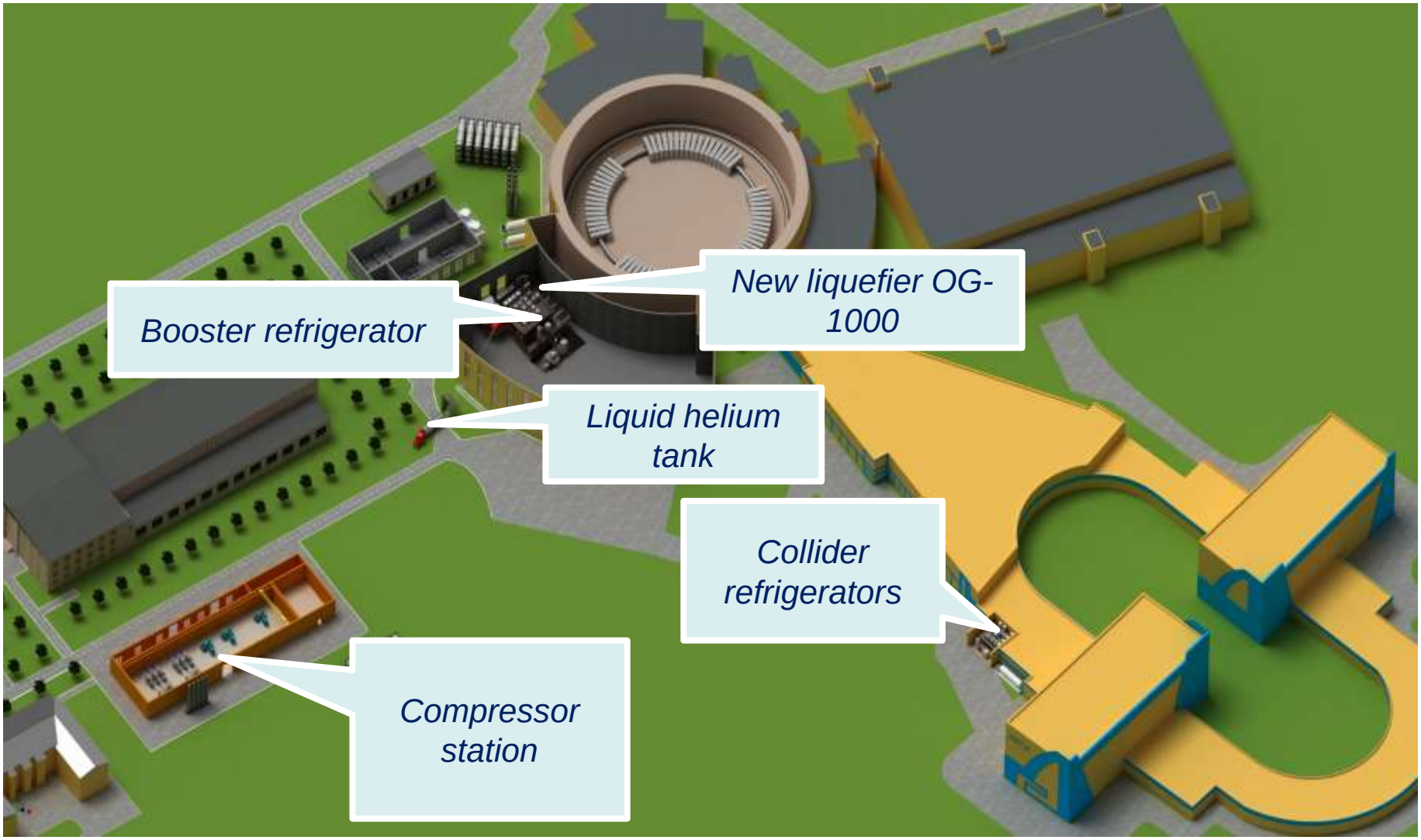
Collider building

2017

Collider building

http://nucloweb.jinr.ru/nucloserv/205corp.htm

NICA cryogenic complex



Total power 8 kW at 4.5 K

NICA cryogenic complex

New helium liquefier OG-1000
Put into operation – may 2016

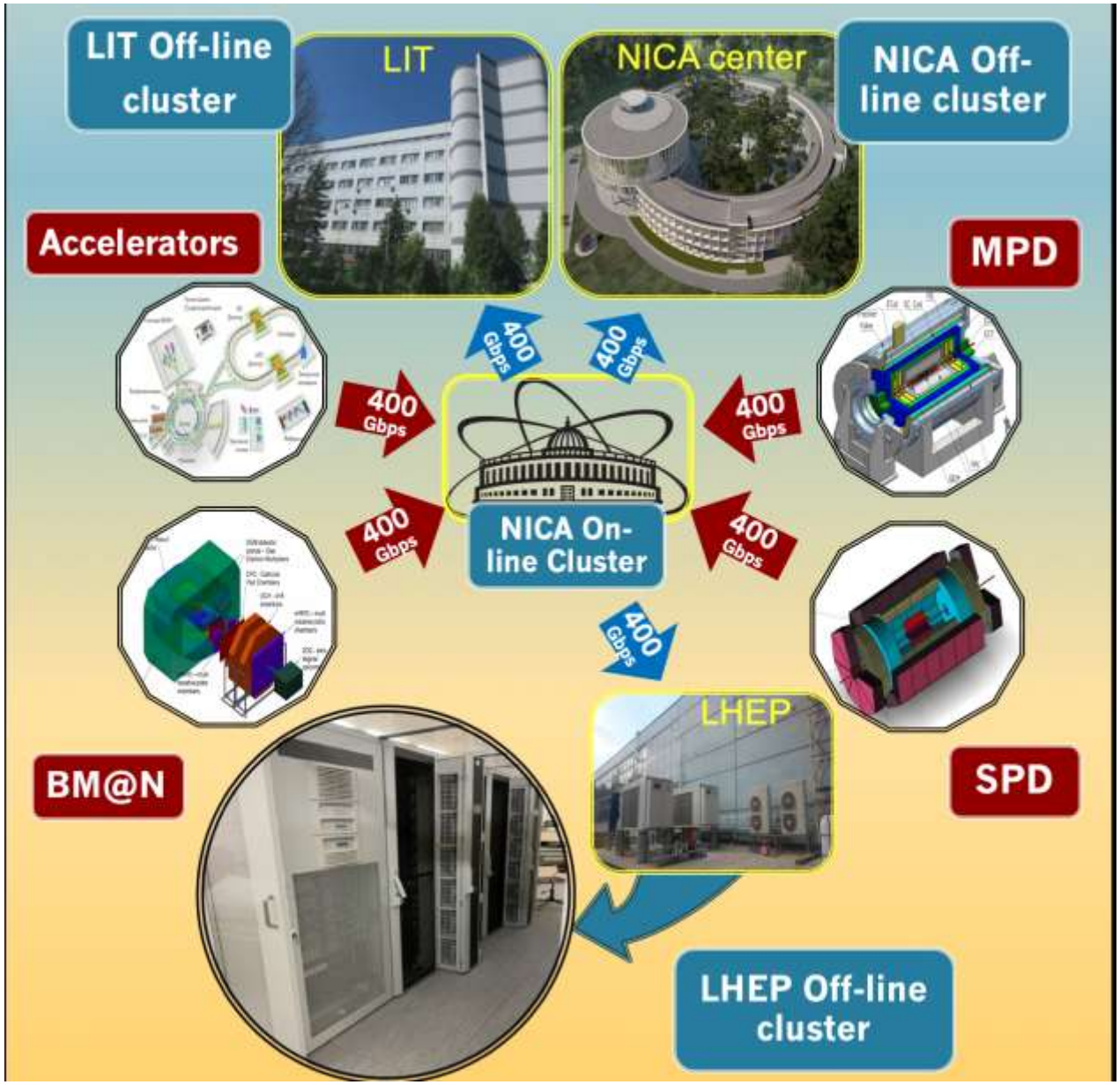
NICA innovation center

State expertize 2020.

NICA innovation center

- cluster of JINR computer center dedicated to collect and process the data from NICA detectors,
- 500 offices for scientists,
- laboratory rooms for preparation of experimental equipment and fast analysis of results,
- conference hall

NICA Network and Computing



LIT

Data storage:

- 2017: 1 PB RAW /year
- план: 10 PB RAW/year

Fast memory at supercomputer ***«Govorun»***

NICA Computing

LHEP off-line cluster -
put into operation
19 September 2019

Education program

JINR educational portal targets students and schoolchildren of the JINR Member States, young specialists and science teachers.
The portal hosts courses in the MOOC format on priority JINR activities.
The first courses have already been created and published:

- on the topics of the NICA megaproject,
- on heavy ions and the synthesis of new elements,
- fundamental and applied research of nanostructures and condensed matter using neutrons.

New video course: Megascience project NICA

We are pleased to present you **the first video course about megascience project NICA and collider technology**! This course consists of 8 sections and talks about scientific mega-projects, particle accelerators at JINR, structure and tasks of the NICA complex, factory of superconducting magnets and cryogenic complex.

The staff of the Veksler and Baldin Laboratory of High Energy Physics (Anatoly Sidorin, Sergey Kostromin, Anton Konstantinov, Sidorov Nikita, Marina Osmachko) and the Development and creation of educational programs department (Anna Komarova, Caren Rossouw, Oleg Smirnov) prepared this online course.

The course is available in both English and Russian.

https://edu.jinr.ru/

NICA milestones

2009
Start of the project
2013
Nuclotron modernization
2015
Technical project completion
2016
Start of the collider building construction
2018
BM@N I

Plans:

2020
Completion of the Booster commissioning
2021
BM@N II
2022
Creation of the collider in starting configuration permitting to provide experiments with colliding ion beams up to Bi^{+83}
at mean luminosity of $L = 5 \cdot 10^{25}$ см$^{-2}$ с$^{-1}$ in the energy range $\sqrt{s_{NN}} = 8 - 11$ GeV/u

Thank your for attention