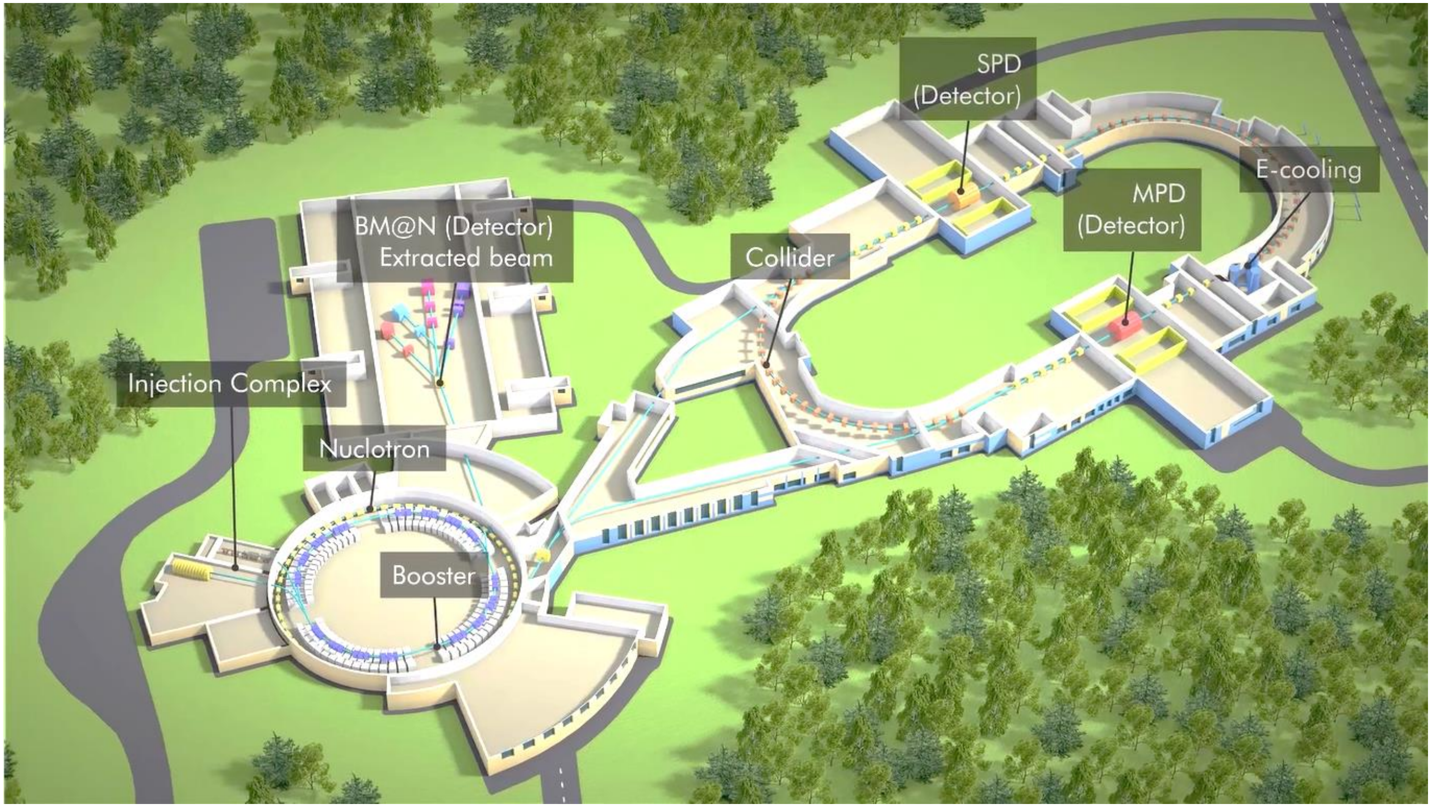
COOL'2017

18-22 September 2017

Gustav-Stresemann-Institut, Bonn

The NICA Project: Three Stages and Three Coolers

I.Meshkov, G.Trubnikov for NICA Team



Three stages of the NICA project: status and tasks

Outline

Introduction: NICA project goals

1. Stage I: Experiment “The Baryonic Matter at Nuclotron”

2. Stage II : Search for The Mixed Phase and New Physics In Heavy Ions’ Collisions at NICA Collider

3. Stage II-a: The basic configuration of the NICA complex

    3.1. Status of The NICA civil construction (11.05.2017)

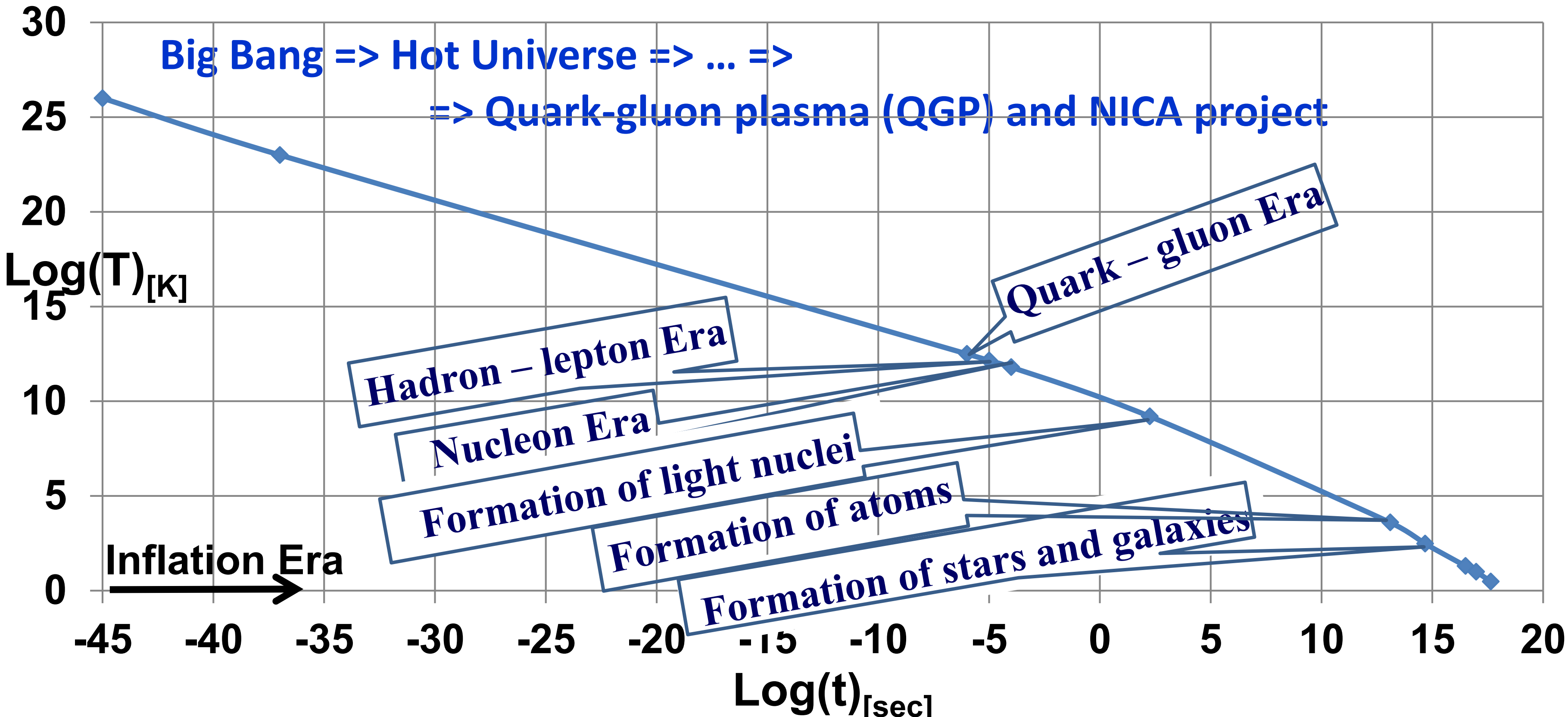
4. Stage II-b: The project (full) configuration of the NICA complex

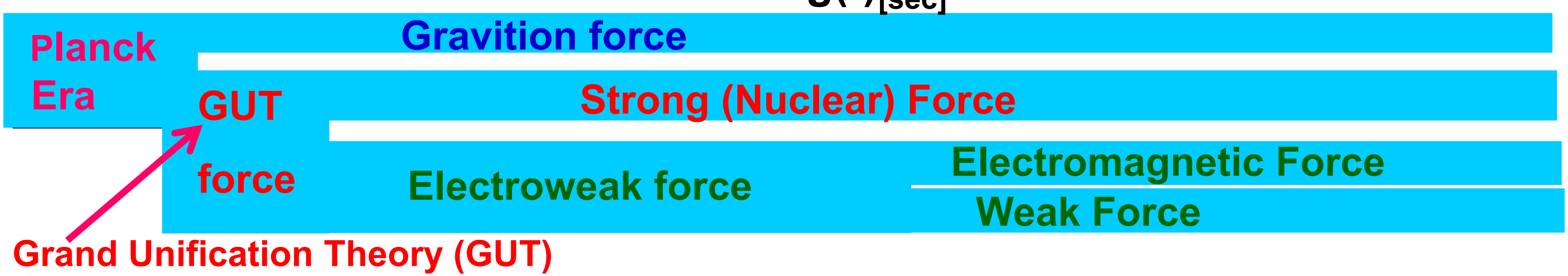
5. Stage III: Polarized Beams’ Mode of The Collider

6. NICA Milestones

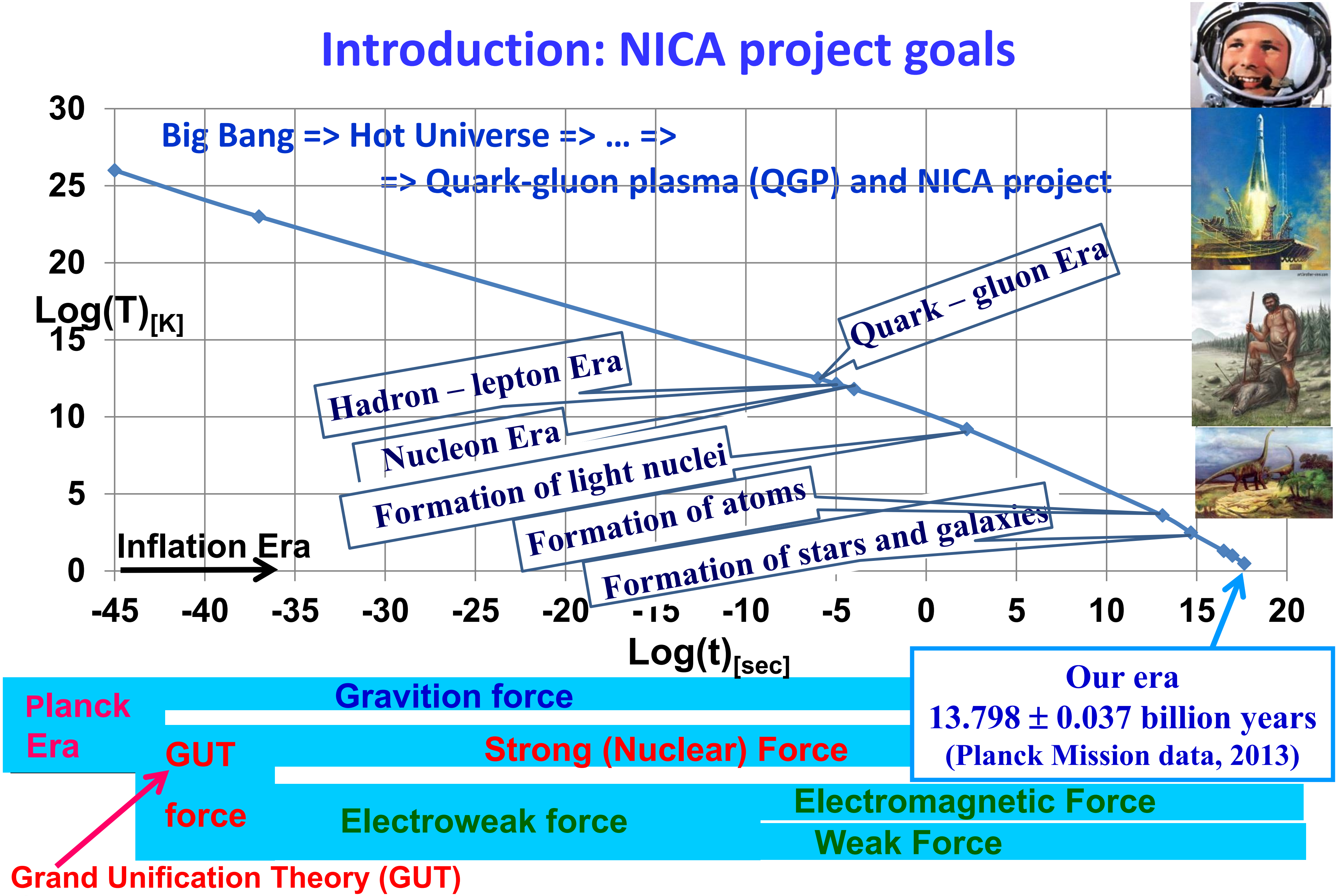
7. Instead Summary: NICA Megaproject

Introduction: NICA project goals





Introduction: NICA project goals



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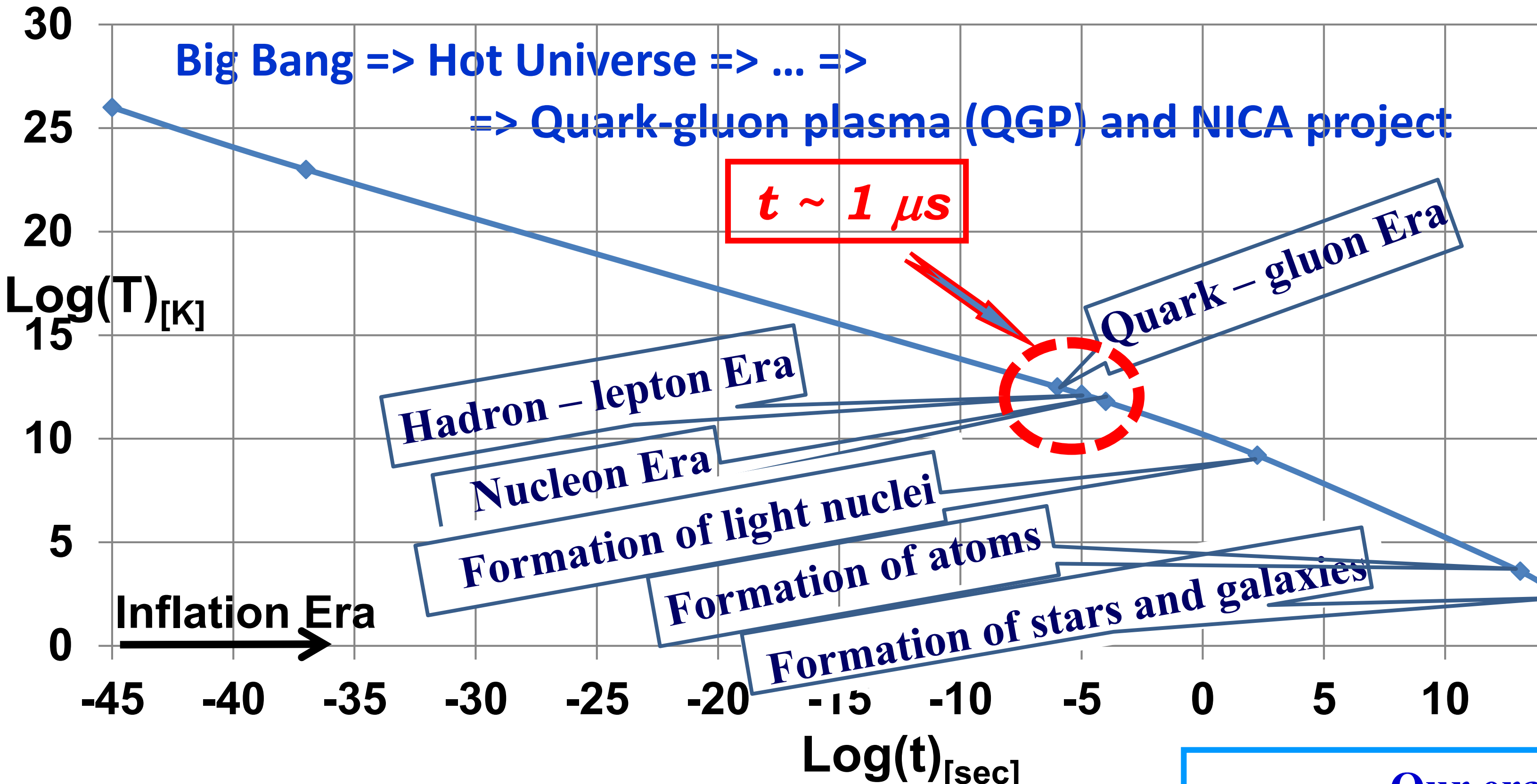
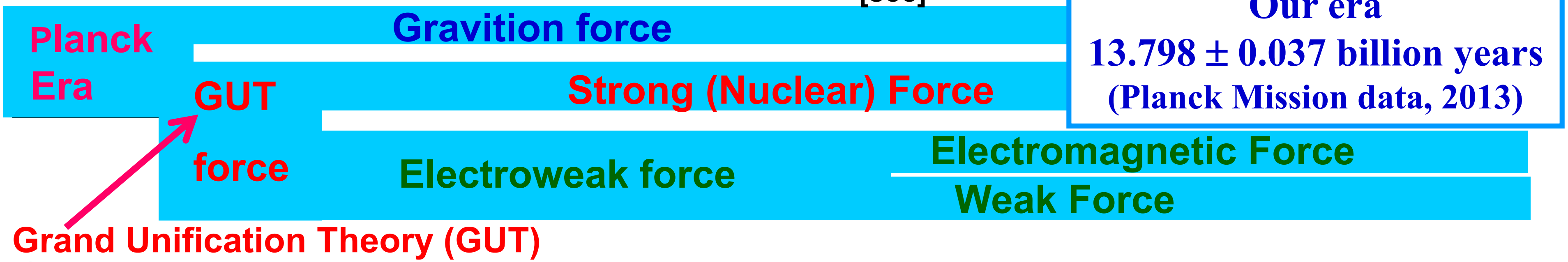
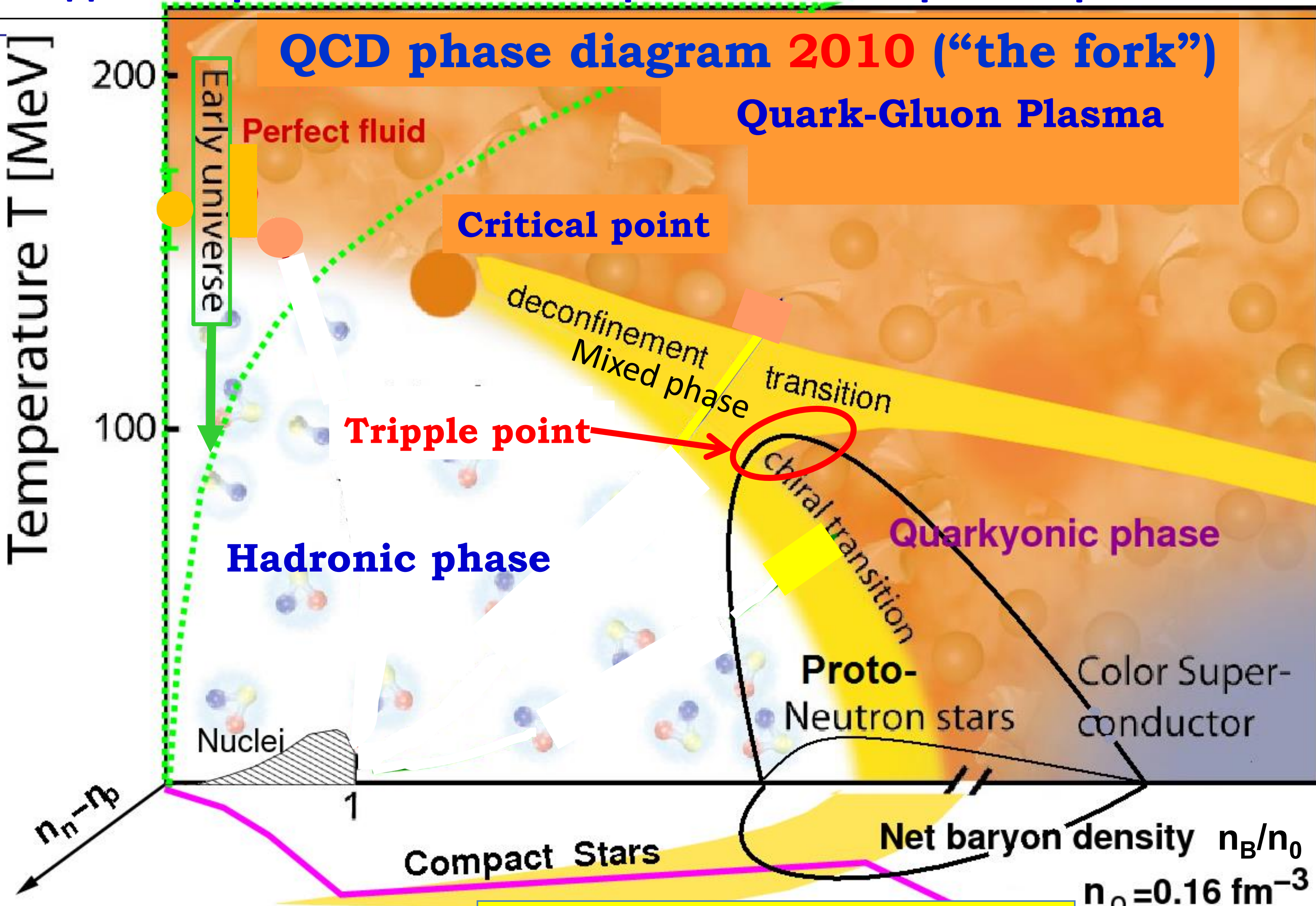


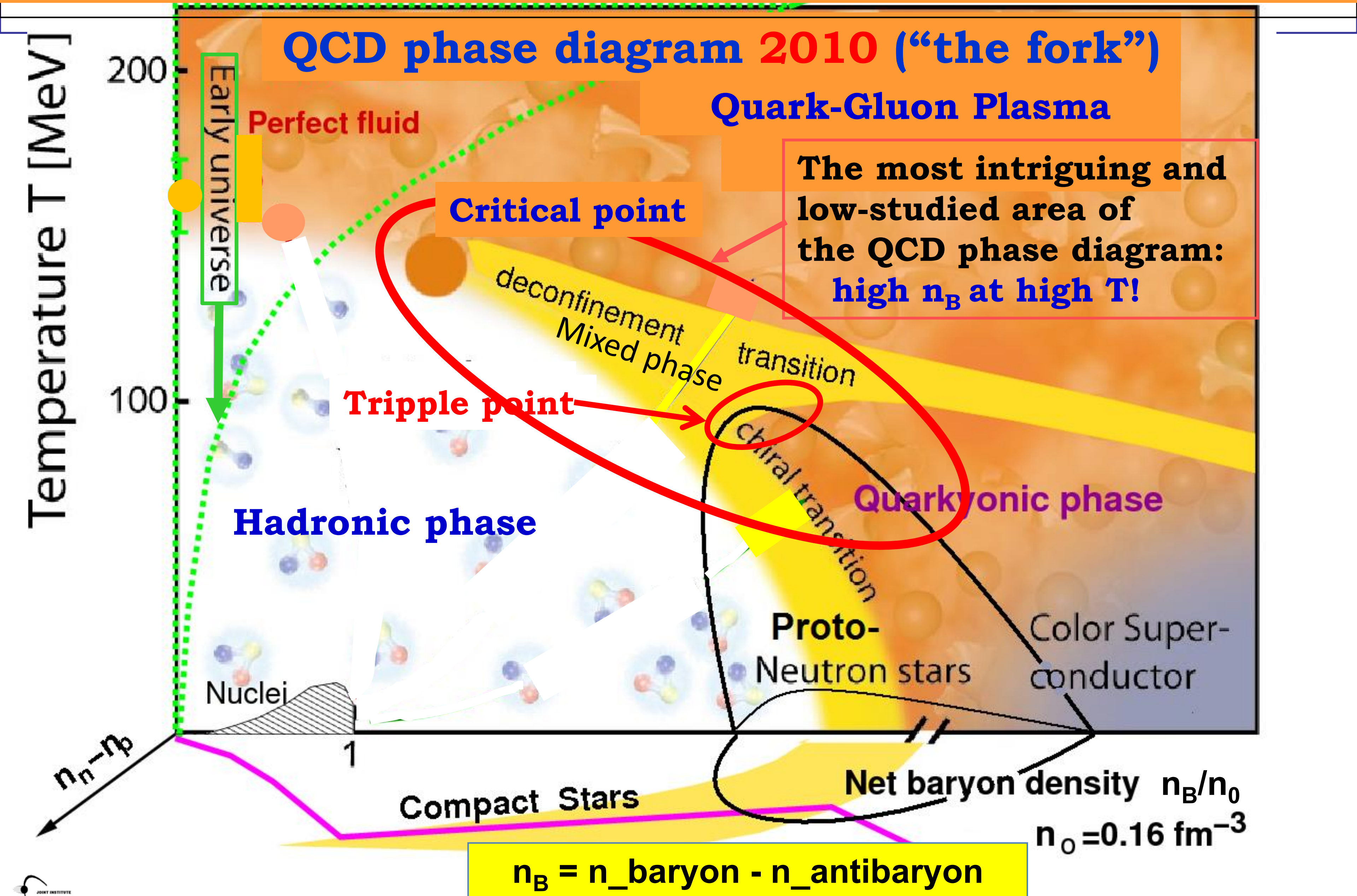


Введение: физика плотной барионной материи и проект NICA



n_B = n_baryon - n_antibaryon

Nuclei Collision and Phase Trajectories in T-n_B space



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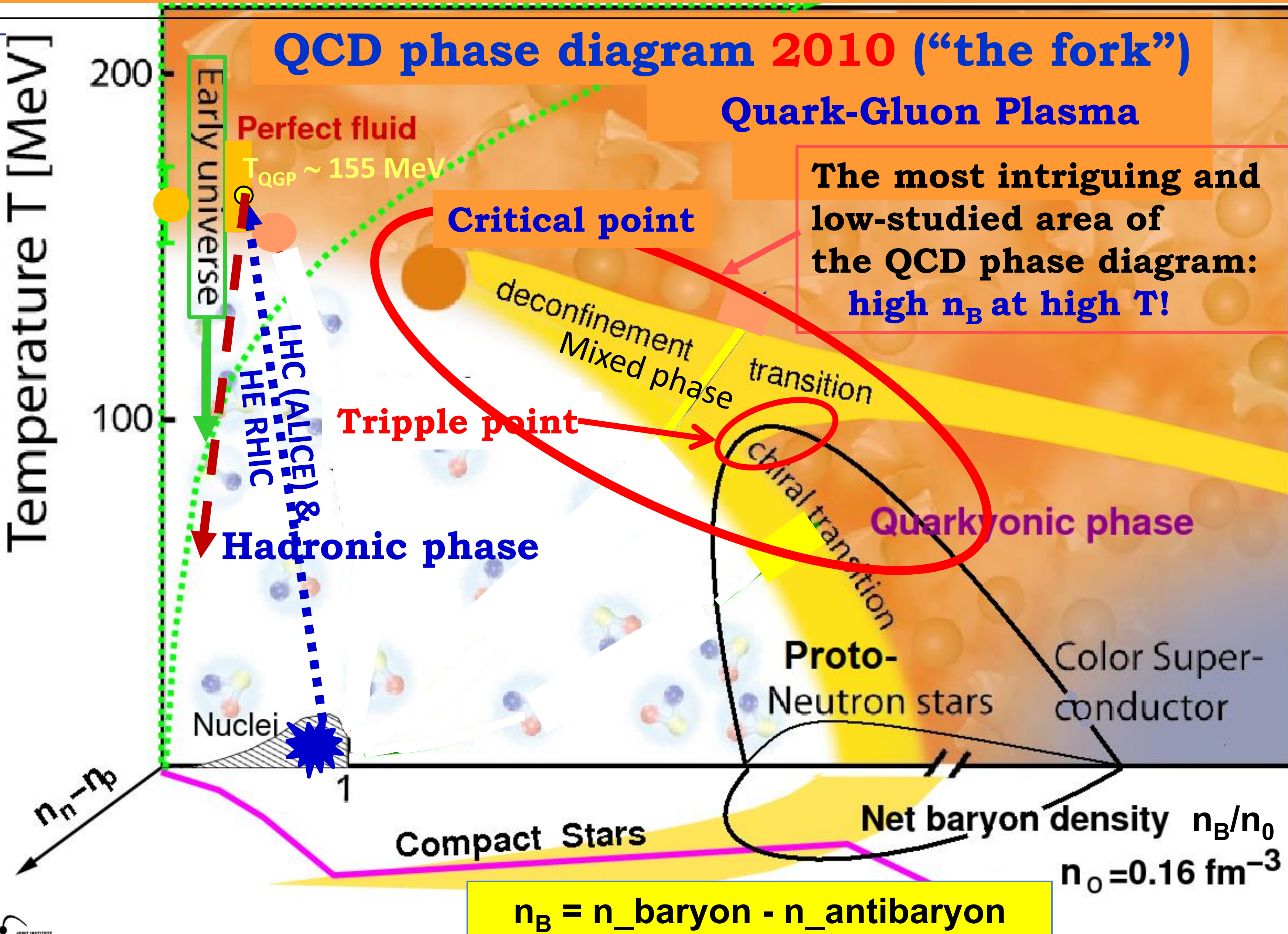

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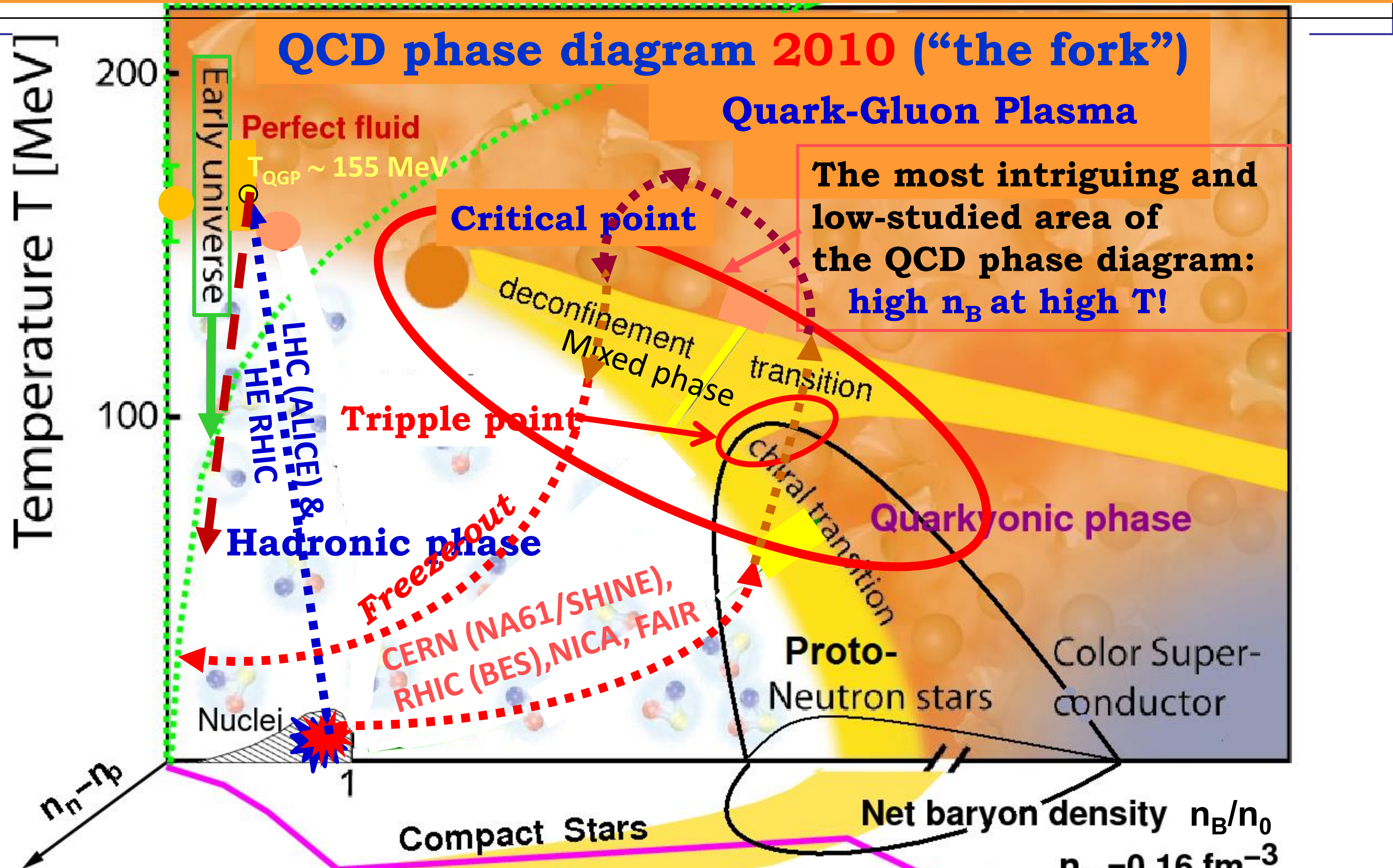

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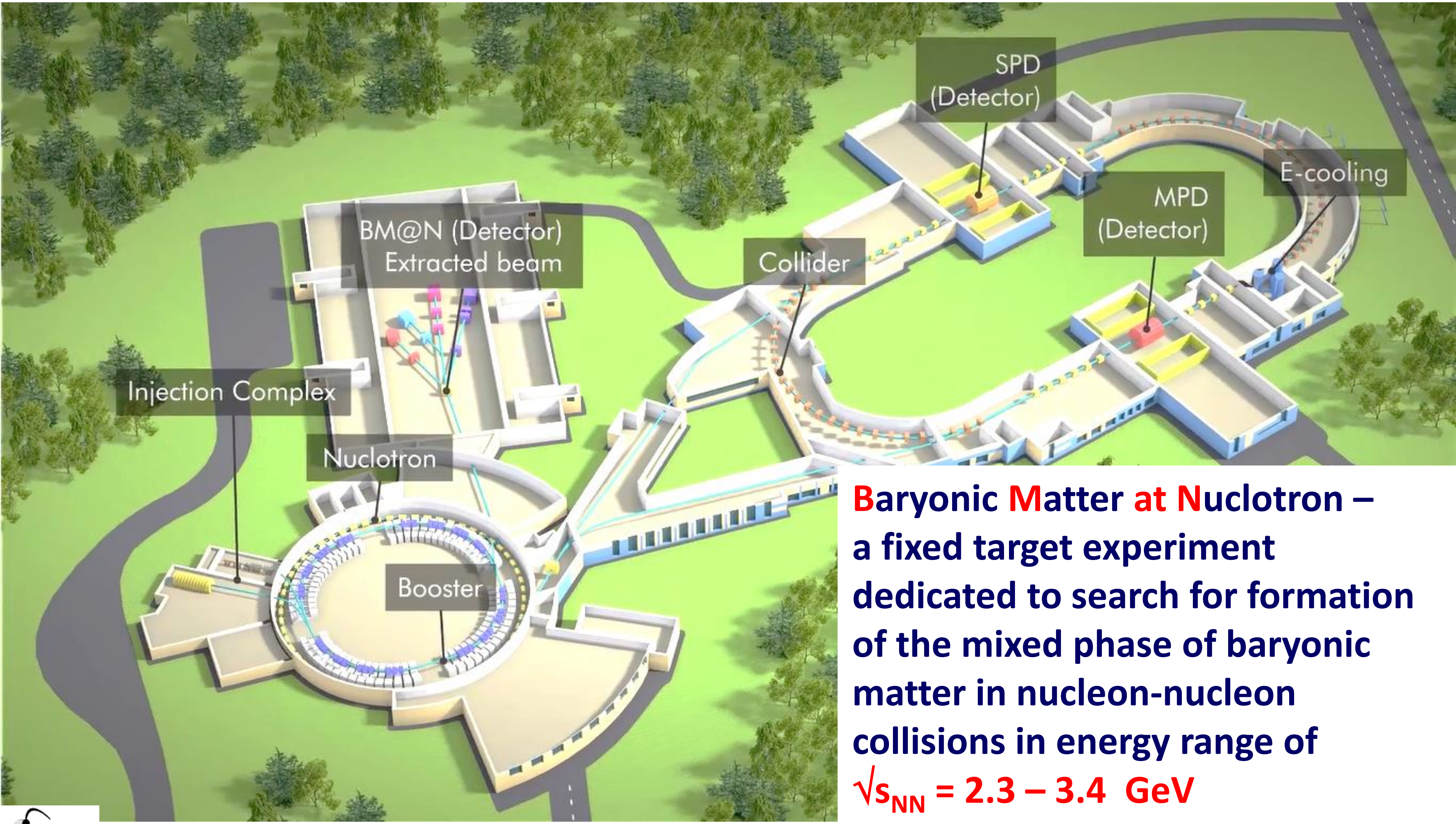
NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"

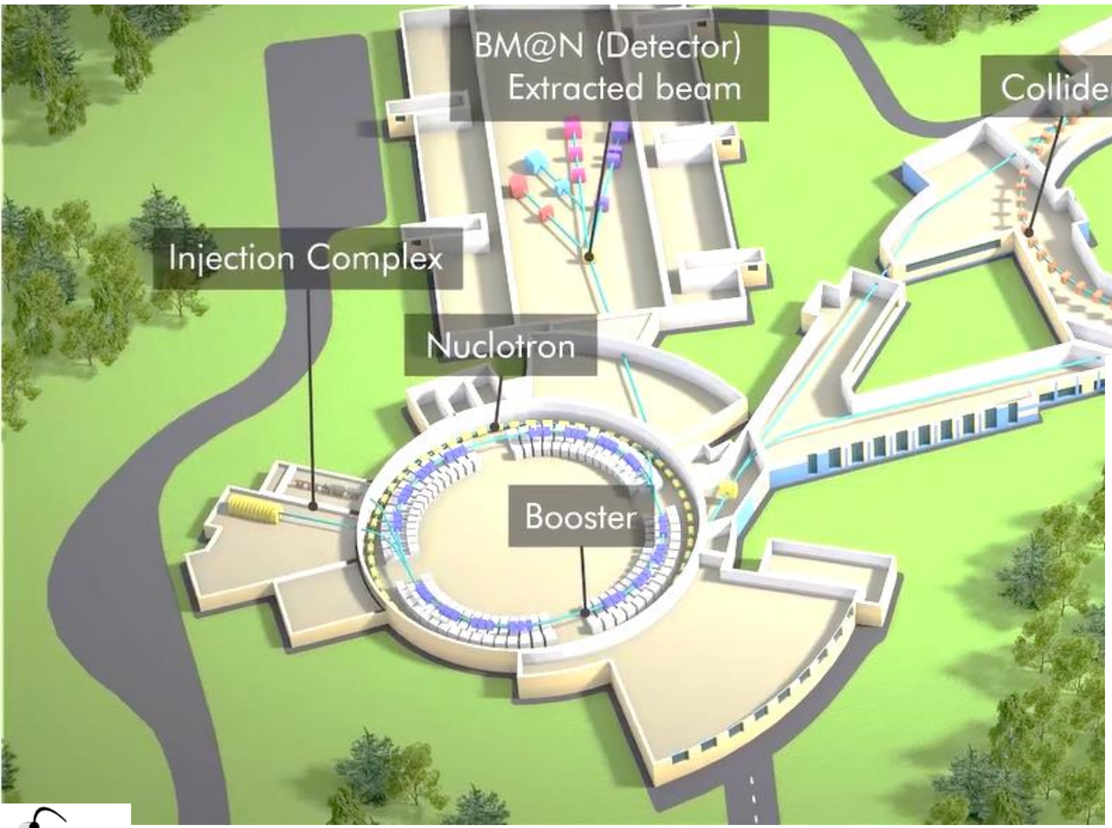


Baryonic Matter at Nuclotron – a fixed target experiment dedicated to search for formation of the mixed phase of baryonic matter in nucleon-nucleon collisions in energy range of $\sqrt{s_{NN}} = 2.3 - 3.4$ GeV

NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"

We need for full scale BM@N commissioning in 2019 to have in operation:

- ❑ **Injection complex: KRION, HILAc, LU20**
- ❑ **The Booster**
- ❑ **Beam Transfer Line Booster – Nuclotron (*under development at BINP*)**
- ❑ **Nuclotron upgraded**
- ❑ **BM@N Detector setup**



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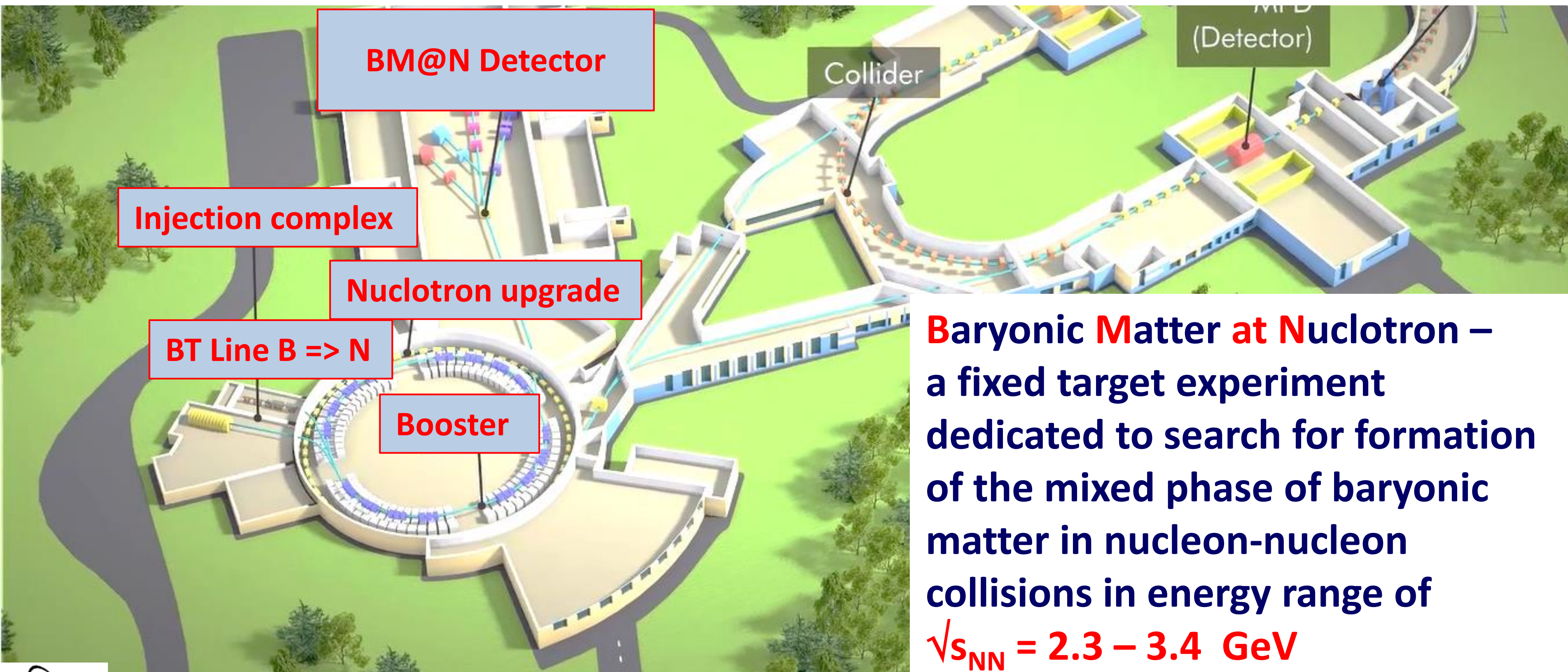

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NICA Stage I: Experiment “The Baryonic Matter at Nuclotron”

Linac HILac (3.2MeV/u) ← ESIS KRION

Linac LU-20 (5MeV/u) ← Ion sources

Booster (25 Tm)
1(2-3) single-turn injection,
storage of $(2 \div 4)\times10^9$ ions,
acceleration up to 100 MeV/u,
electron cooling, acceleration
up to 573 MeV/u

Stripping (80%)
$^{197}Au^{31+} \Rightarrow {}^{197}Au^{79+}$

Nuclotron (45 Tm)
injection of one
bunch
of $\leq 2\times10^9$ ions,
acceleration up to
1 - 4.5 GeV/u

Slow resonance extraction (slides #14, 15)

Baryonic Matter @ Nuclotron
BM@N: NICA – Stage I

$\sqrt{s}$ = 2.3 – 3.4 GeV/u (Au × Au)

Why do we need the Booster:

1) To provide a good vacuum condition ~ 2x10 pTorr
2) To avoid a space charge problem at beam injection into Nuclotron;
3) The main goal - to “strip” the ions up to “bare” state for acceleration the ions (nuclei!) in Nuclotron up to maximum kinetic energy E_{max} = 4.5 GeV/amu.

NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"

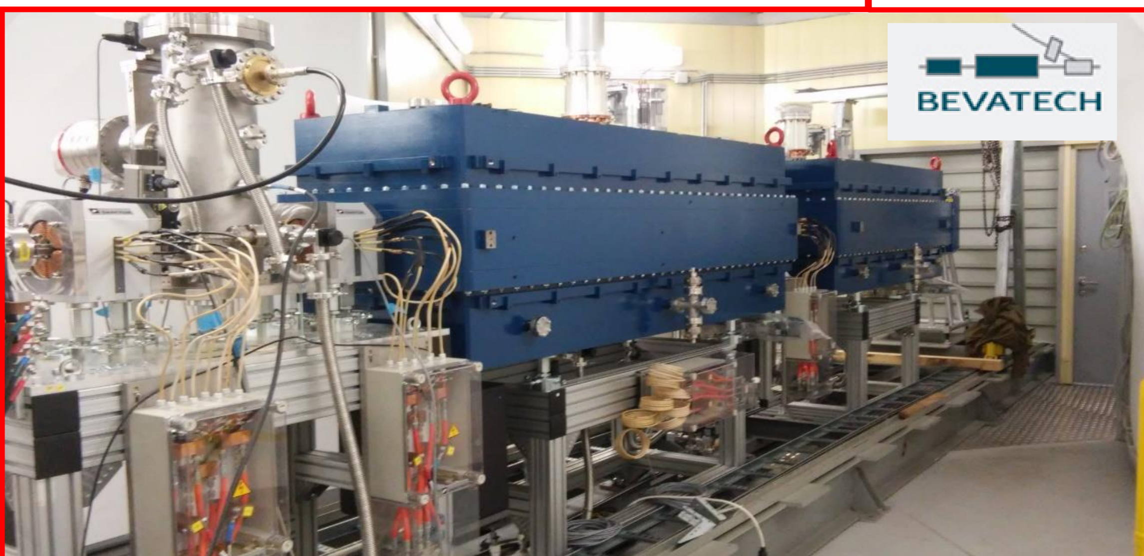
Injection complex

Heavy ion source: Krion-6T ESIS

B= 5.4T reached. Test Au beams produced:
- Au^{30+} ÷ $Au32^{32+}$, $6*10^8$, $T_{ionization}$= 20 ms for
- Au^{31+} => repetition rate 50 Hz.
To be tested at Nuclotron this October

p↑ и d↑ Source of Polarized Ions (SPI)

Oct.-Nov. 2016 - Very successful run:
Protons from SPI accelerated in Nuclotron.
Recovering of the spin physics experimental program at JINR!

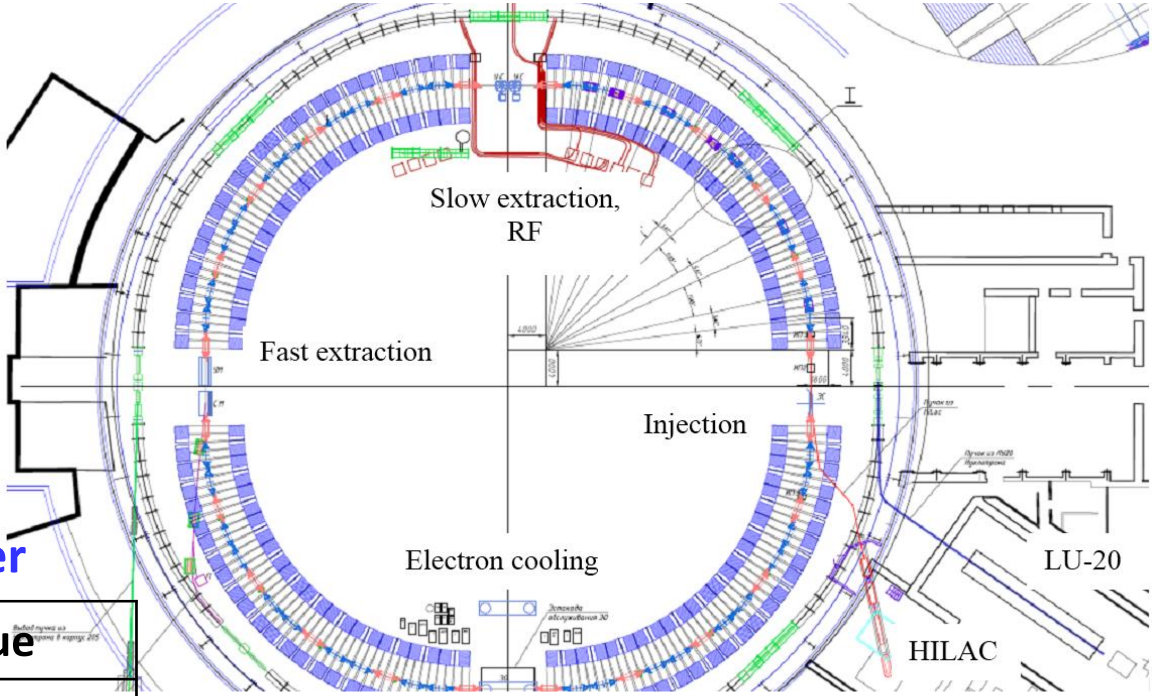


Heavy Ion Linear Acccelerator (HILAc) commissioned at VBLHEP (2016)

3.2 MeV/u
Au^{31+}

NICA Stage I: Experiment “The Baryonic Matter at Nuclotron”

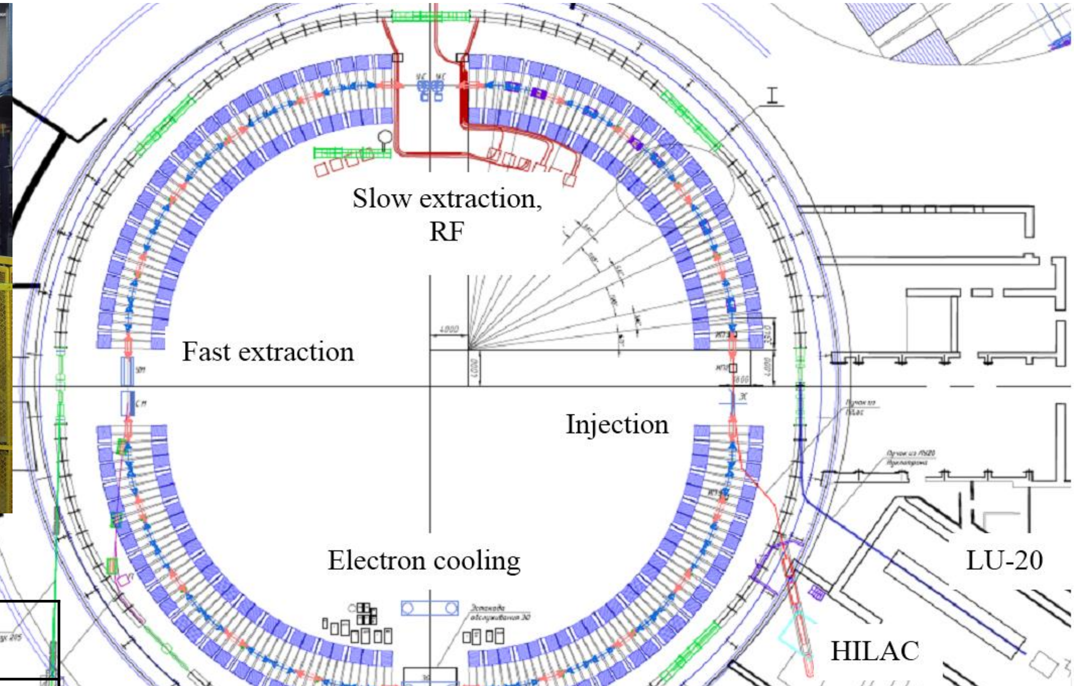
Booster



Main Parameters of NICA Booster

Parameter	Value
Ions	p => $^{197}Au^{31+}$
Circumference, m	211
Max. magnetic rigidity, *T·m*	25
Injection energy, *MeV/u*	3.2
Extraction energy, *MeV/u*	578 ($^{197}Au^{31+}$)
Max. magnetic field, *T*	1.8
Vacuum pressure, *pTor*	10.0

Booster



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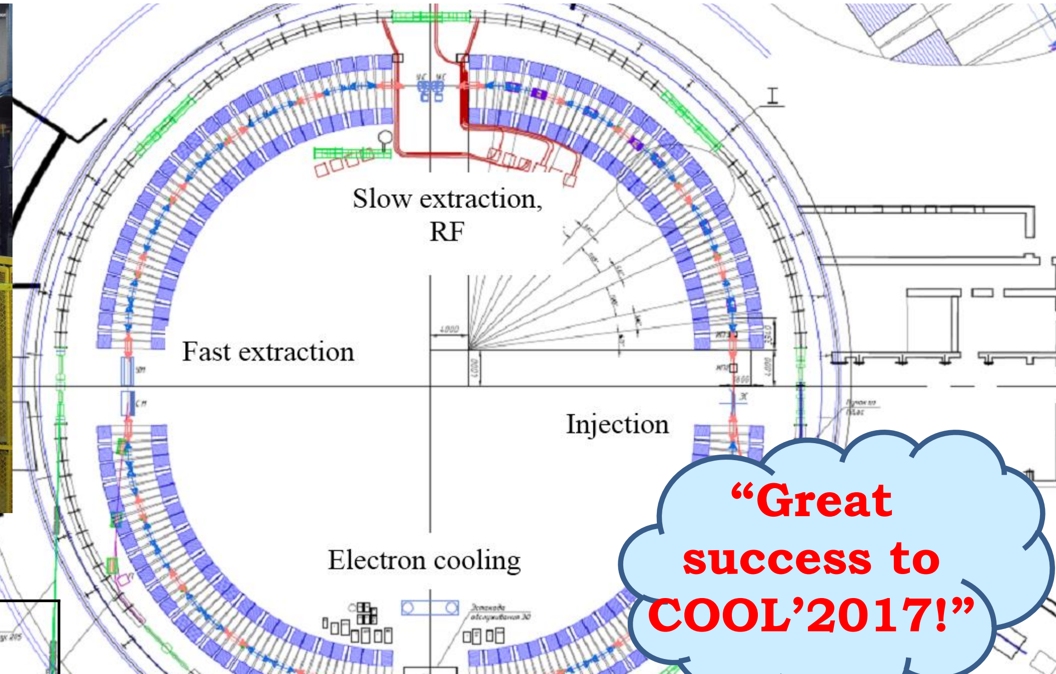

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"Great success to COOL'2017!"

G.Khodzhibagiyan
S.Kostromin

Booster

Plan and status of the Booster magnets’ fabrication & testing

Magnet	Total number	Fabricated & Tested 02.01.2017	Plan/ Tested 12.09.2017
Dipole	40	7	28/25
Quadrupole	48	4	20/6

G.Khodzhibagiyan
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NICA Stage I: Experiment “The Baryonic Matter at Nuclotron”

Booster

Electron cooler for the Booster

Designed, fabricated and presently under commissioning by BINP Team

Vasily Parkhomchuk…

Parameter	Value
Ions to be cooled	p => $^{197}Au^{31+}$
Electron energy, *keV*	1.5 – 50
Beam current, *Amp*	0.2 – 1.0
Cooling section length, *m*	1.9
Electron energy variation, $\Delta E/E$	$\le 1\cdot 10^{-5}$
Beam current stability, $\Delta I/I$	$\le 1\cdot 10^{-4}$
Beam current losses, $\delta I/I$	$\le 3\cdot 10^{-5}$
Solenoid magnetic field, *T*	0.1 – 0.2
Field ripples, $\Delta B/B$ on 15 cm	$\le 3\cdot 10^{-5}$

Why do we need an electron cooler for the Booster:

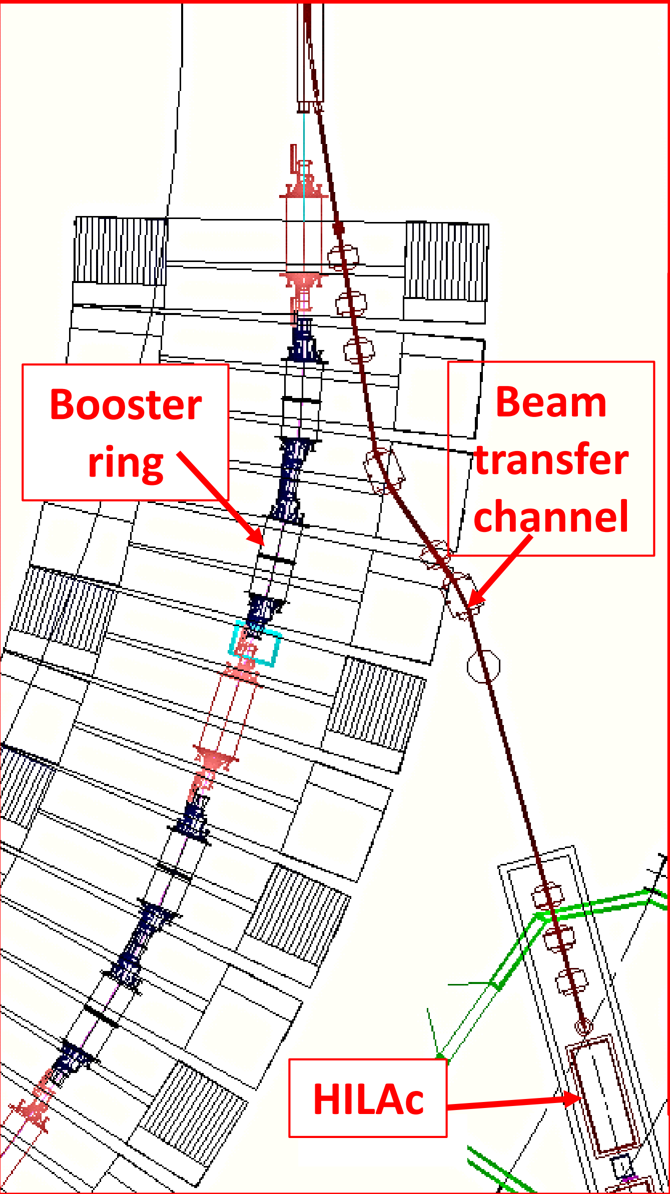
1) To provide a multiturn or multicycle (*3 pulses at 10 Hz repetition*) injection;
2) To form ion bunches of a small 6D emittance (*Wait for continuation until slide # 15 – slow resonance extraction.*)

Details have been presented in the the talk of Alexander Bublei (Tuesday, 9:00)

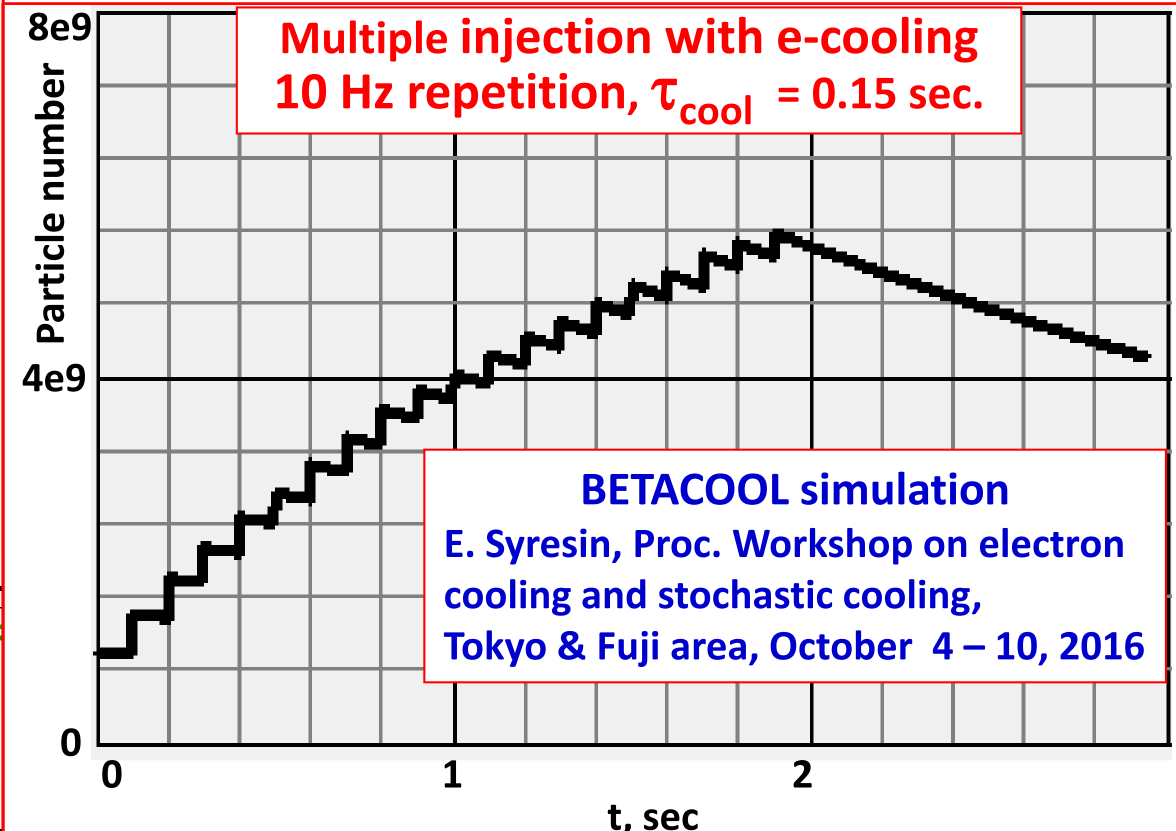
…and his coolers’ construction team

Booster

Why do we need an electron cooler for the Booster



The beam injection methods:
- single-turn
- multiturn with e-cooling
- multiple with e-cooling



Booster

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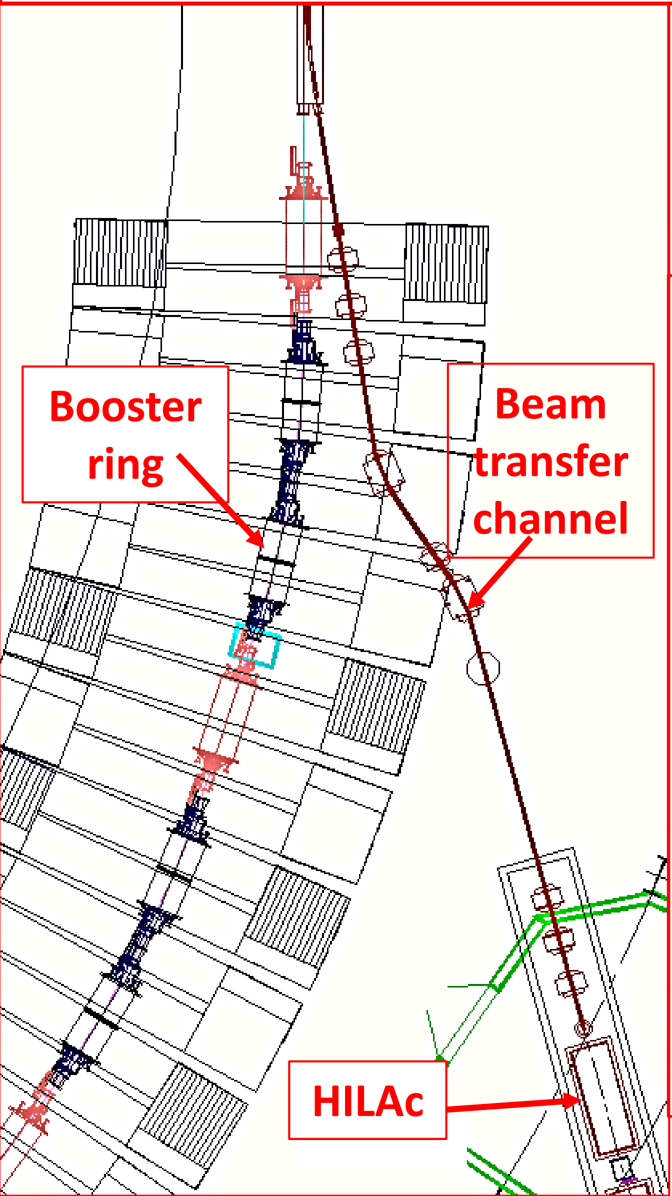

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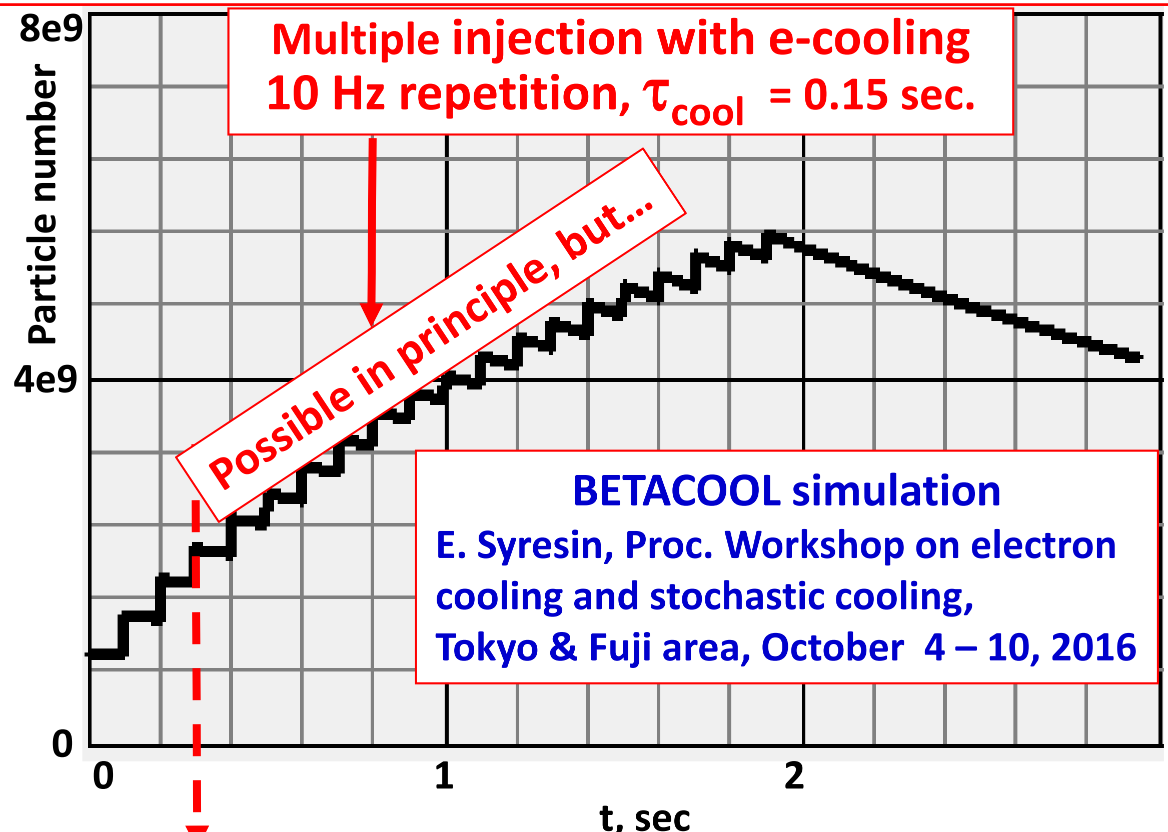
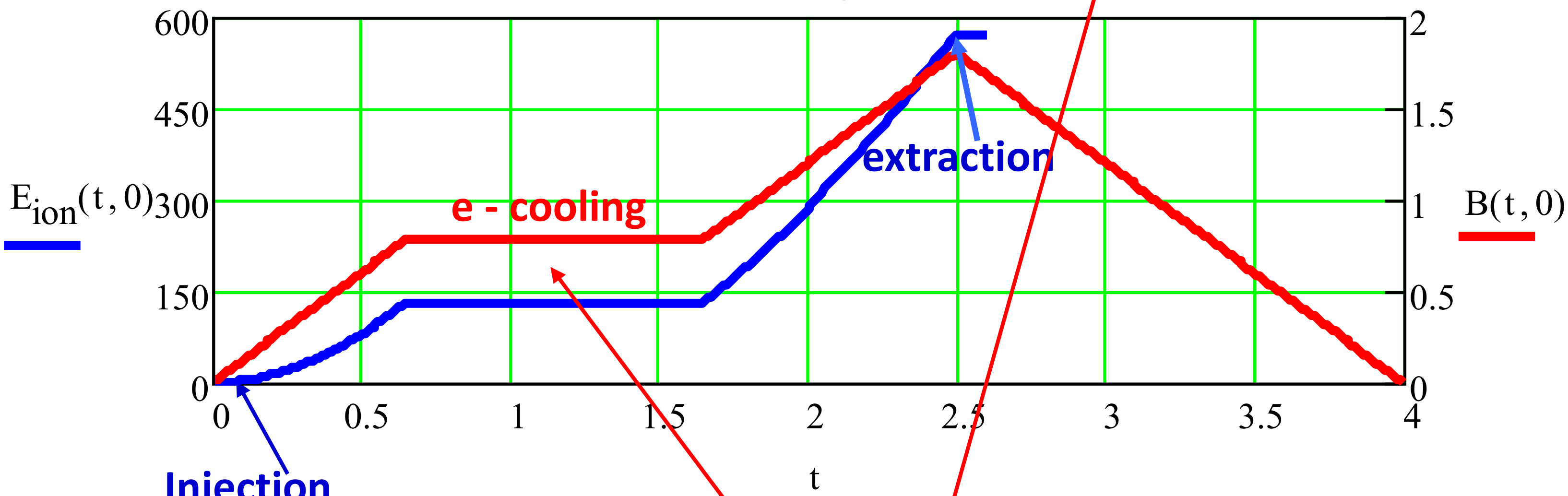


…3 cycles only: limited by the HILAc quads heating

Booster

Application of electron cooling, ions $^{197}Au^{31+}$

Booster cycle

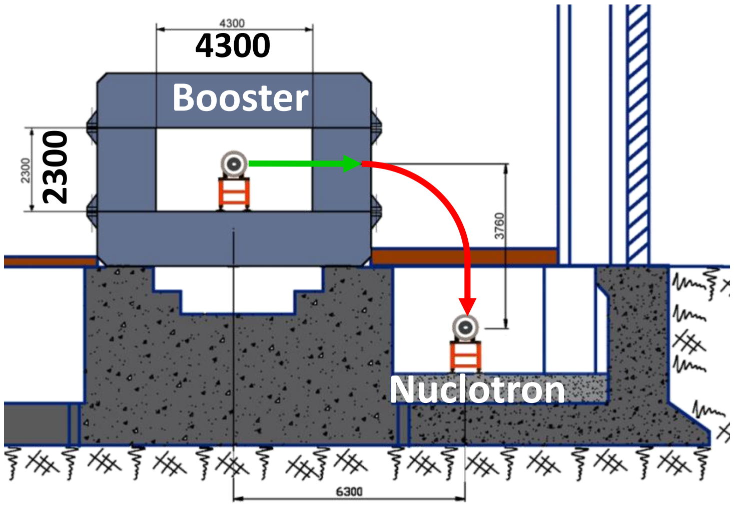


E_{ion} = 3.2 MeV/u,
I_e = 0.3 A,
τ_{cool} = 0.16 s

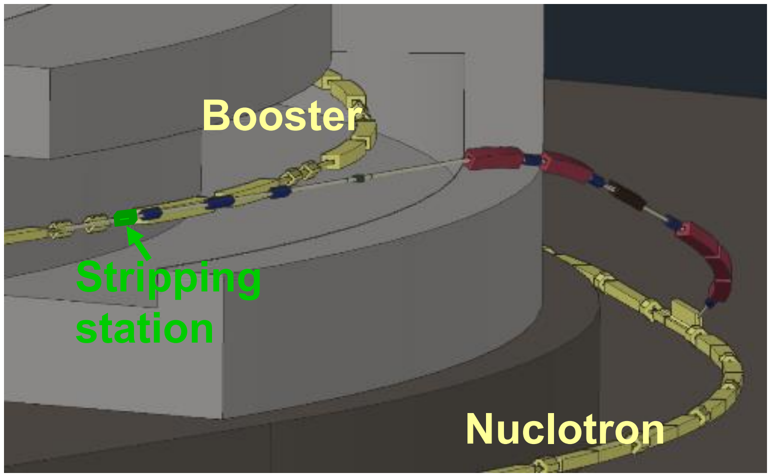
E_{ion} = 90 MeV/u,
I_e = 1 A, a_e = 0.5 cm
τ_{cool} = 0.27 s

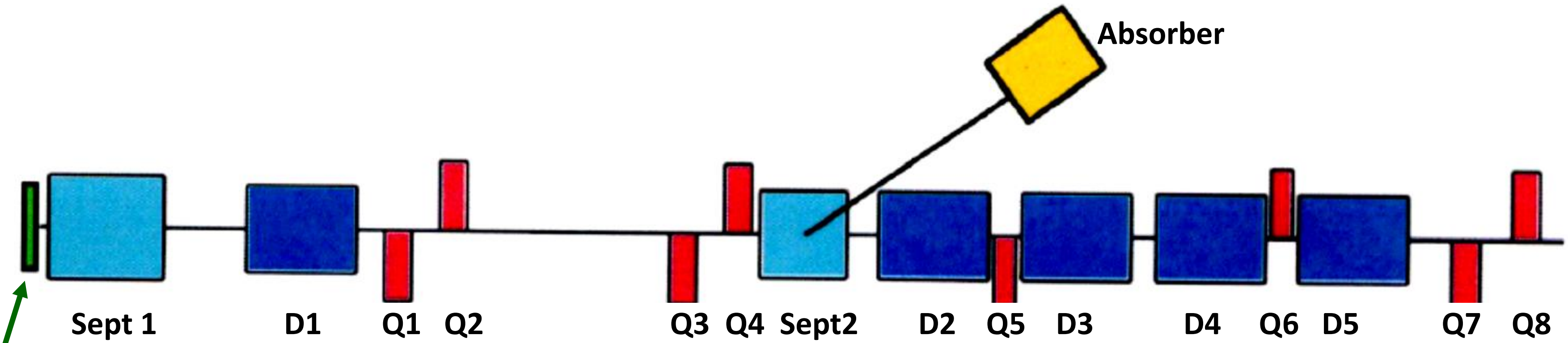
$$\tau_{cool} = -\frac{1}{\gamma A_{ion} m_{nucleon}} \cdot \int_{\Delta_{tr}}^{0.1\Delta_{tr}} \frac{dV_{tr}}{F_{VVP}(V_{tr} = V_{ion})}, \quad \Delta_{tr} = \sqrt{\frac{T_{e\perp}}{m_e}}$$

Beam Transfer from The Booster to The Nuclotron



Under design, fabrication and further mounting/commissioning by BINP Team

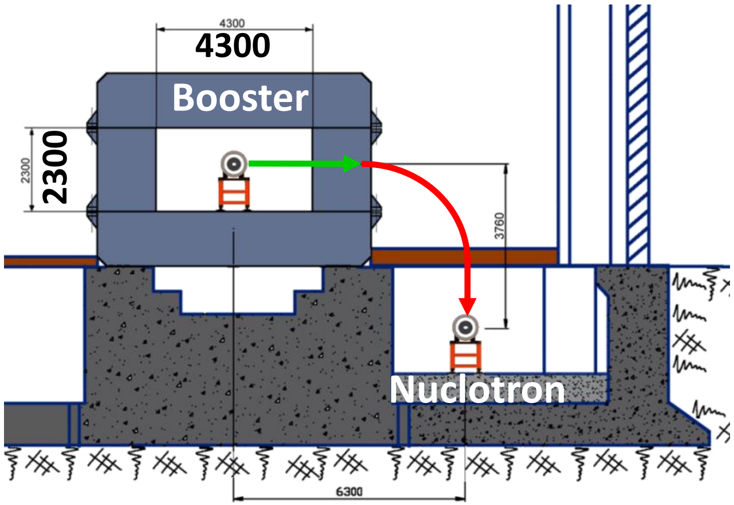


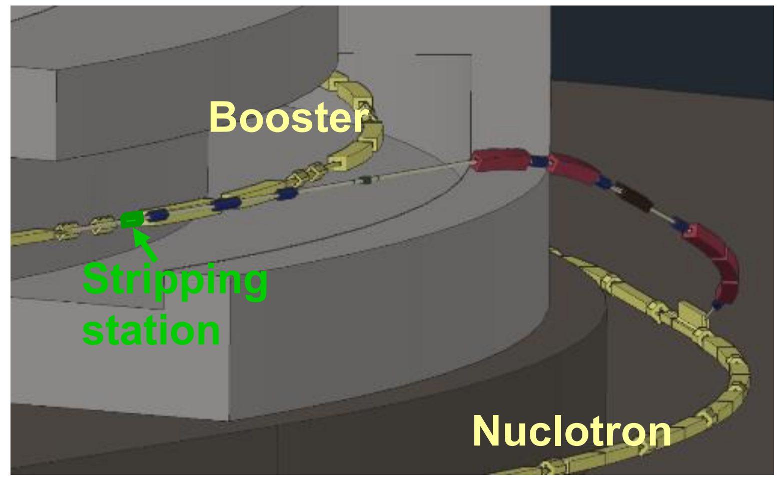


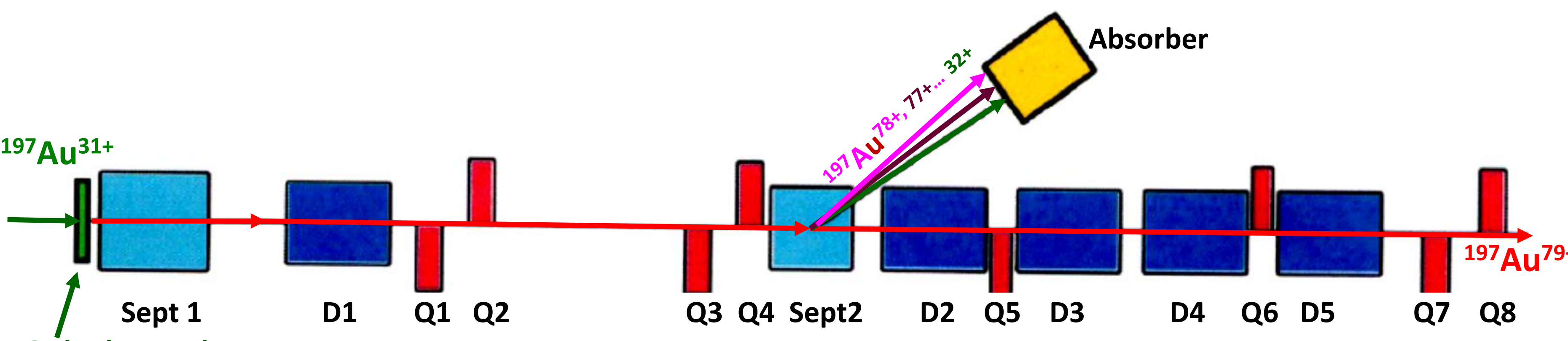
Lattice of the BTC from The Booster to The Nuclotron *A.Tuzikov, (NICA Team)*

Beam Transfer from The Booster to The Nuclotron

Under design, fabrication and further mounting/commissioning by BINP Team







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Beam Transfer from The Booster to The Nuclotron

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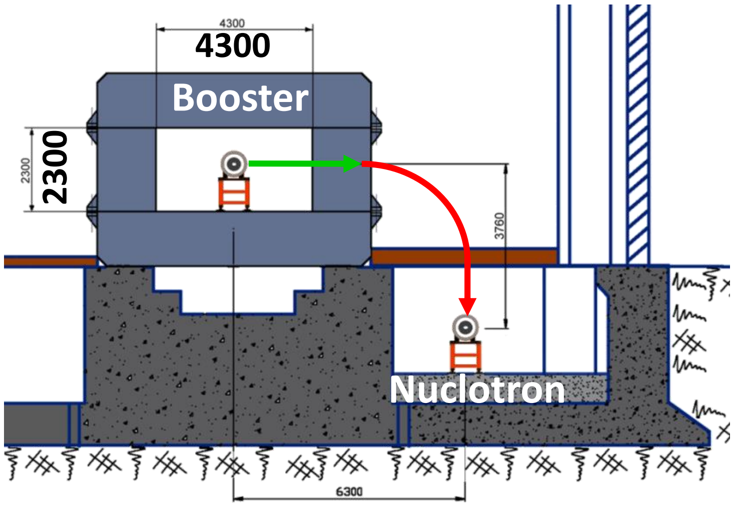
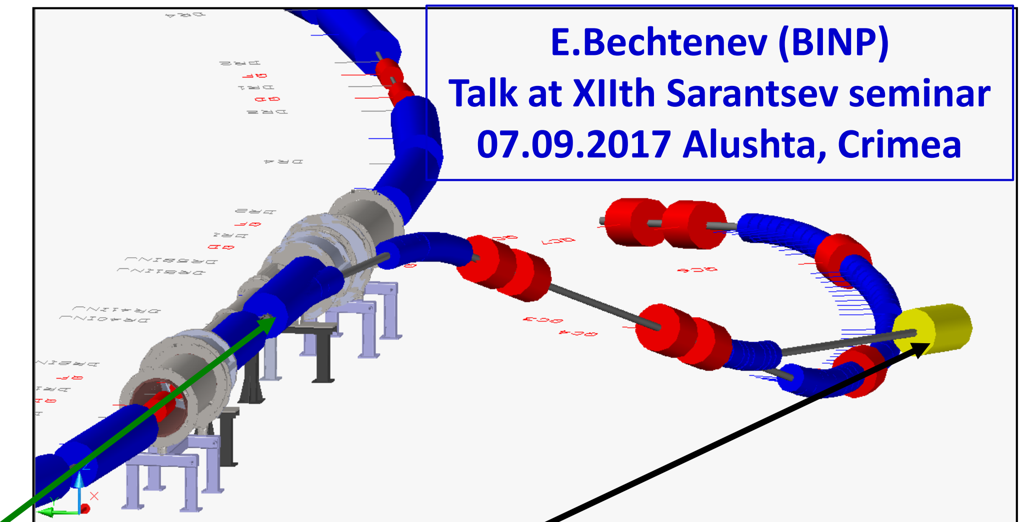
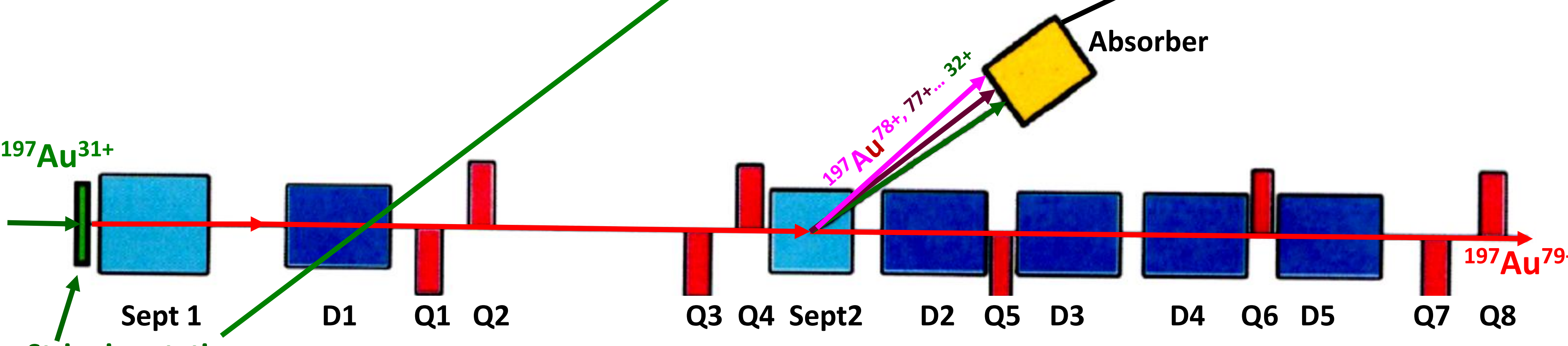


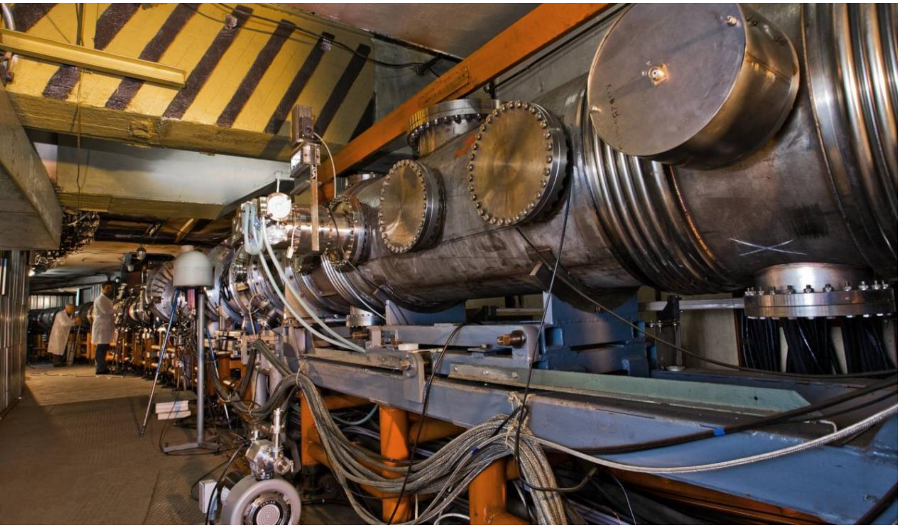


E.Bechtenev (BINP)
Talk at XIIth Sarantsev seminar
07.09.2017 Alushta, Crimea



Lattice of the BTC from The Booster to The Nuclotron *A.Tuzikov, (NICA Team)*

Nuclotron Upgrade



Nuclotron is SC synchrotron accelerating ions and delivering presently ion beams:

deuterons E_{max} = 4.8 GeV/u (B = 1.7 T)

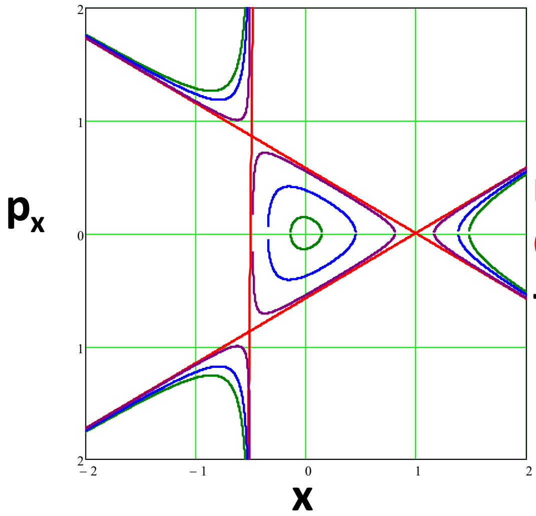
$^{124}Xe^{42+}$ E_{max} = 3.0 GeV/u (B = 1.7 T).

The Nuclotron upgrade tasks for *heavy ion* mode:

- Acceleration of $^{197}Au^{79+}$ up to 4.5 GeV/u
- Injection system for $^{197}Au^{79+}$ transferred from the Booster at 600 MeV/u
- Slow extraction system for $^{197}Au^{79+}$ at 1 ÷ 4.5 GeV/u (the next slide)
- Upgrade of control system (synchronization!)

NICA Stage I: Experiment “The Baryonic Matter at Nuclotron”

Slow Resonance Extraction



Phase trajectories in vicinity of a resonance $(Q_x)_{res}$ = n + 1/3*)

red lines - boundary of the resonance separatrix,

Colour curves - particle phase trajectories at different values of the resonance detuning:

$$\delta = Q_x - Q_{res}$$

p_x, x, δ – *in arbitrary units!*

$\cdot 2 \cdot \pi \cdot n)$

Philip J. Bryant et al., Preprint CERN ps-99-010 (1999)
E.Levichev, Lectures on Part. Nonlinear Dynamics in Cyclic Accelerators (in Rus.), Novosibirsk State Tech. University, 2009

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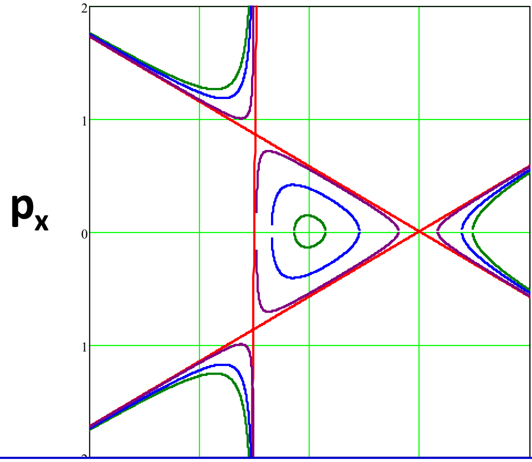

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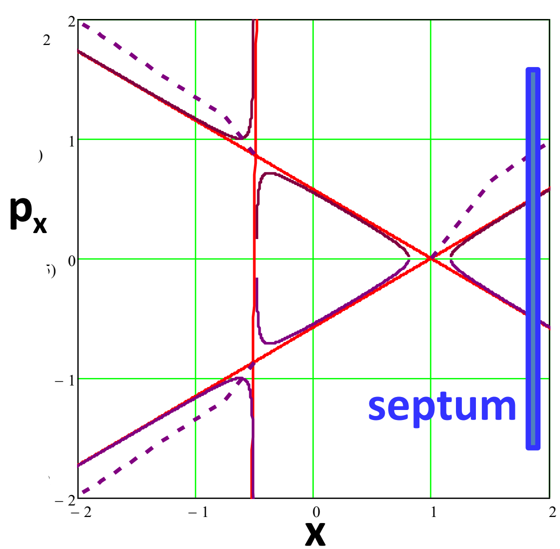
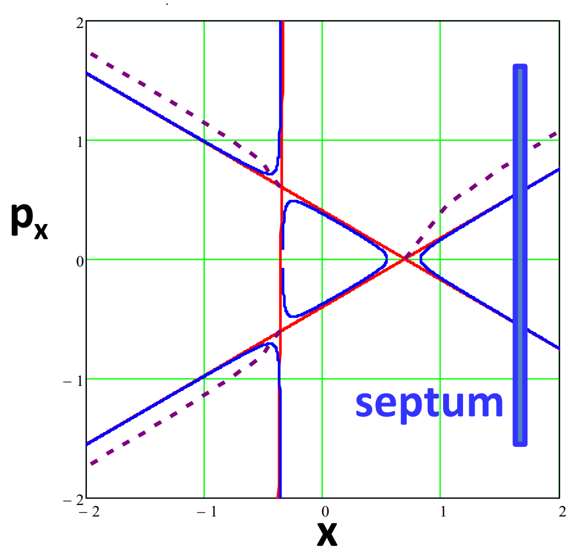
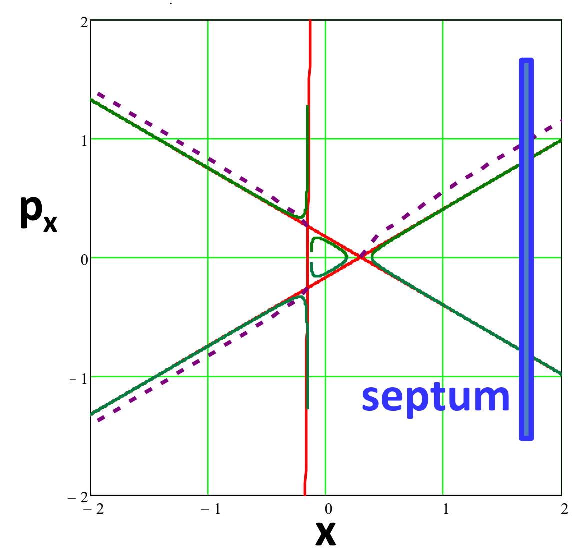
Phase trajectories in vicinity of a resonance $(Q_x)_{res}$ = n + 1/3 at slow variation of the detuning δ

Dark red dashed curves– trajectories of particles leaving a symmetric separatrix







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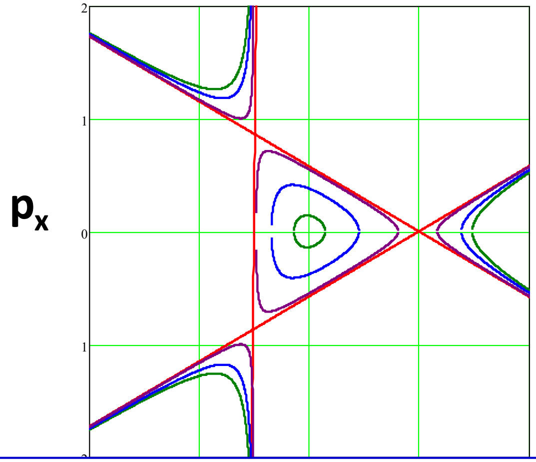

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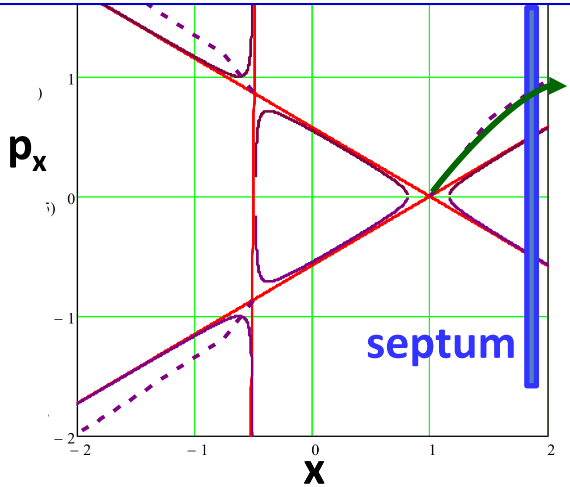
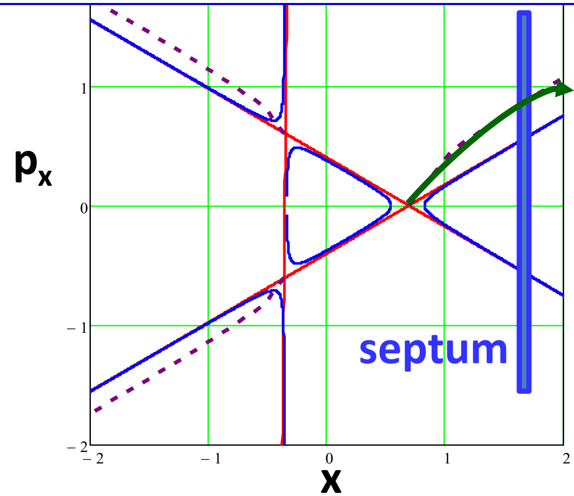
p_x, x, δ – *in arbitrary units!*

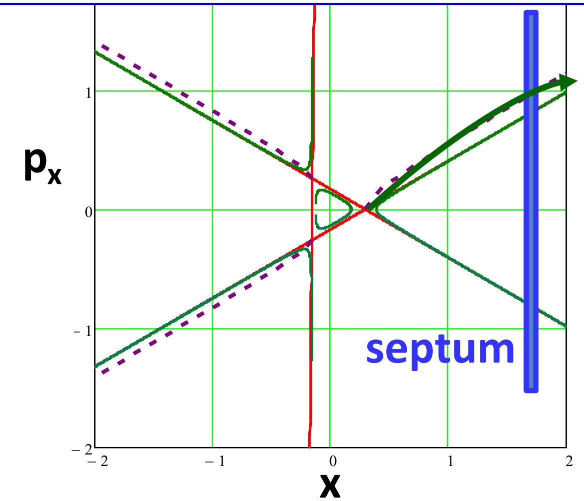
Phase trajectories in vicinity of a resonance $(Q_x)_{res}$ = n + 1/3 at slow variation of the detuning δ

Dark red dashed curves– trajectories of particles leaving a symmetric separatrix

Green solid curves– trajectories of the particles leaving the separatrix, which is especially deformed, at δ(t) variation in time







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NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"
Slow Resonance Extraction

The dream of experimenters is to have at a slow particle extraction
as long as possible an extracted particles' flux of constant intensity

$$J(\delta) = \frac{dN}{d\delta} \cdot \frac{d\delta}{dt}$$

For this purpose one needs to have a proper dependence on time of the function

$$\delta(t) = Q_x(t) - Q_{res} \,.$$

The *numerical simulation* of particle dynamics at slow resonant extraction shows that one can have *a constant flux of extracted particles* and *increase the extraction time* reducing the beam emittance.

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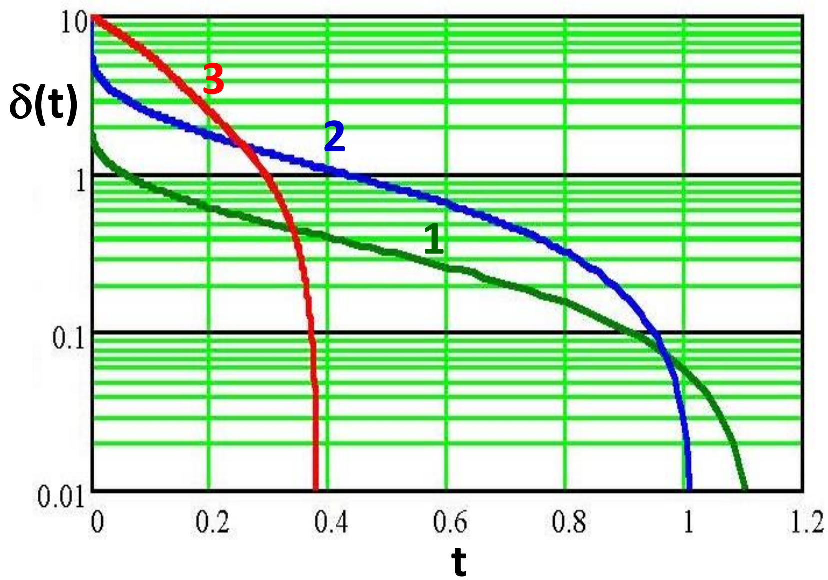
For this purpose one needs to have a proper dependence on time of the function

$$\delta(t) = Q_x(t) - Q_{res}\ .$$

The *numerical simulation* of particle dynamics at slow resonant extraction shows that one can have *a constant flux of extracted particles* and *increase the extraction time* reducing the beam emittance.

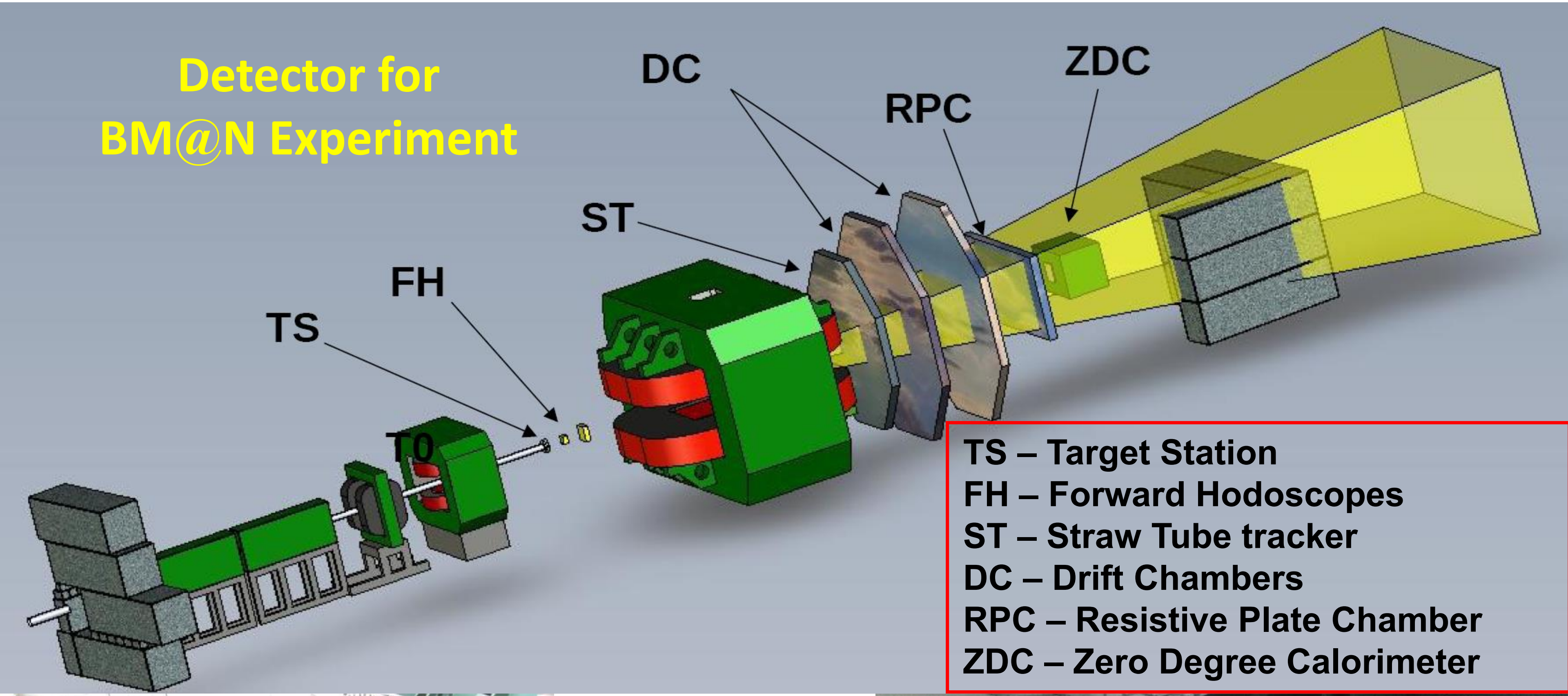
Dependence of δ(t) on time at *constant particle flux J(δ)* (arb. units) at slow resonant extraction of Gaussian beam at different values of the beam emittances: $\sigma_x = \sigma_p =$ = 0.1 (1), 0.3 (2), 1.0 (3) (arb. units).

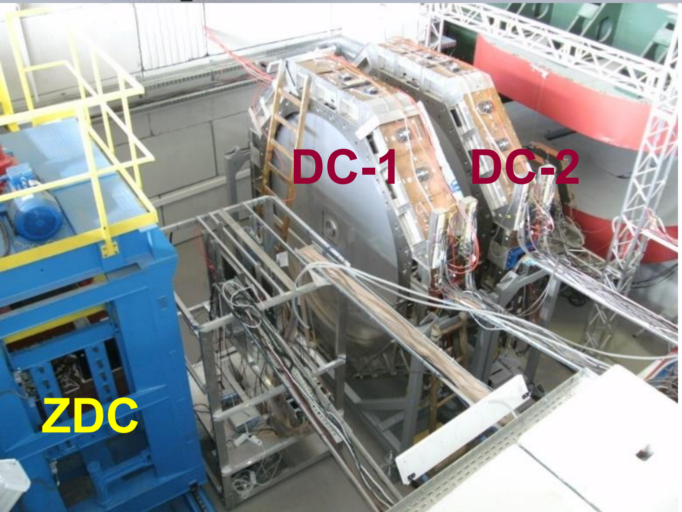


One can conclude:
Electron cooling allows us to control in wider range the intensity of the extracted ion flux.

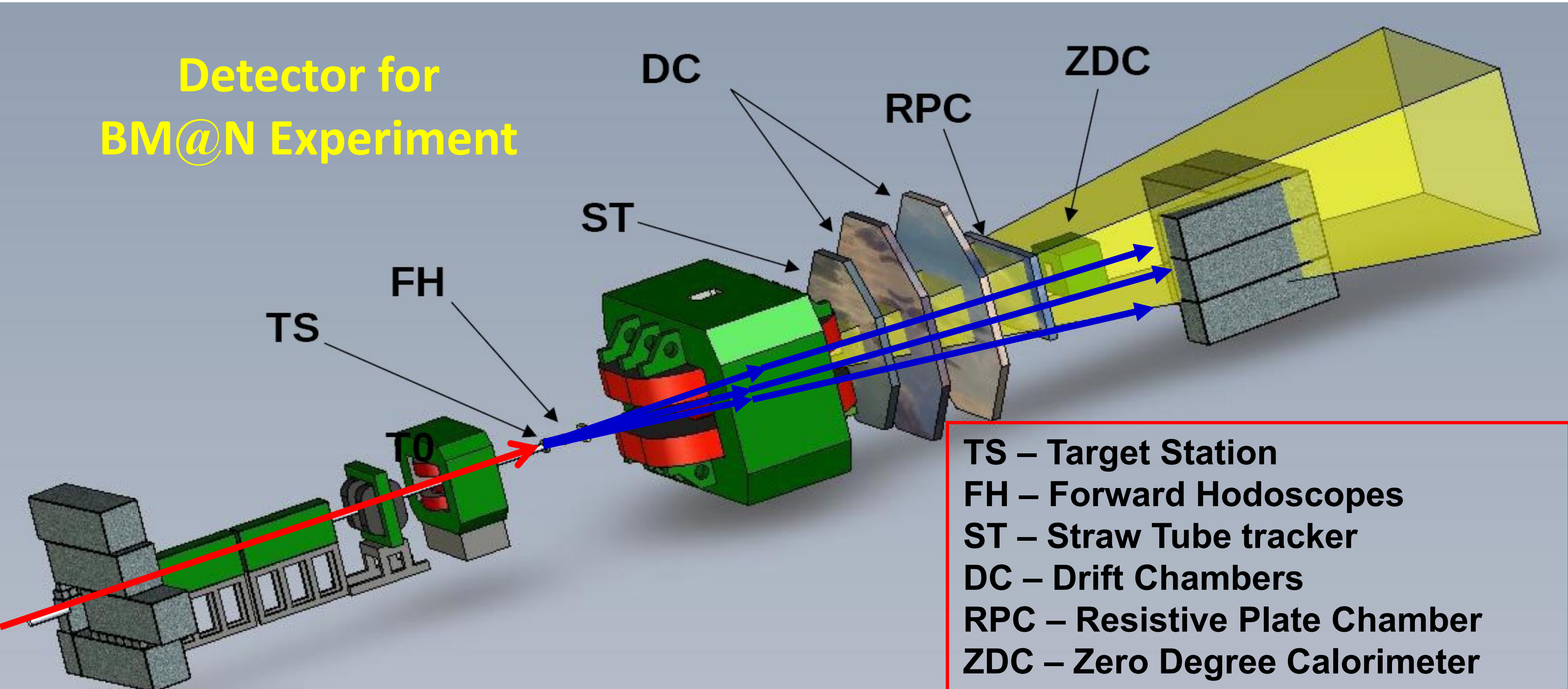
Here the tune dependence on time δ(t) is described with a function obtained by numerical simulation .
Details of these simulations will be published later.

NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"

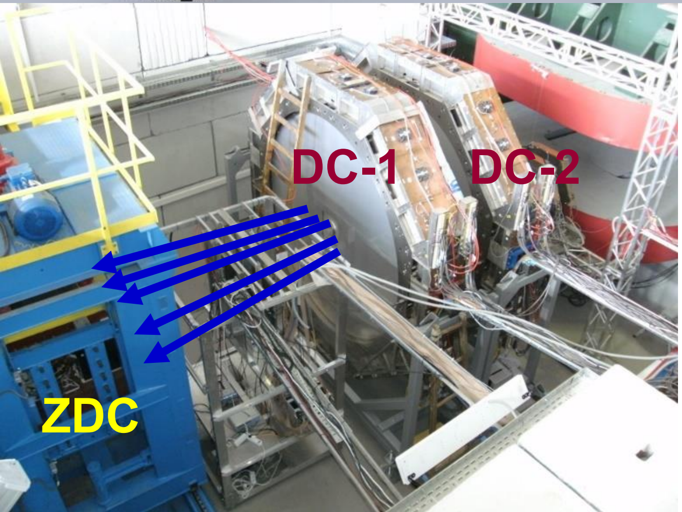




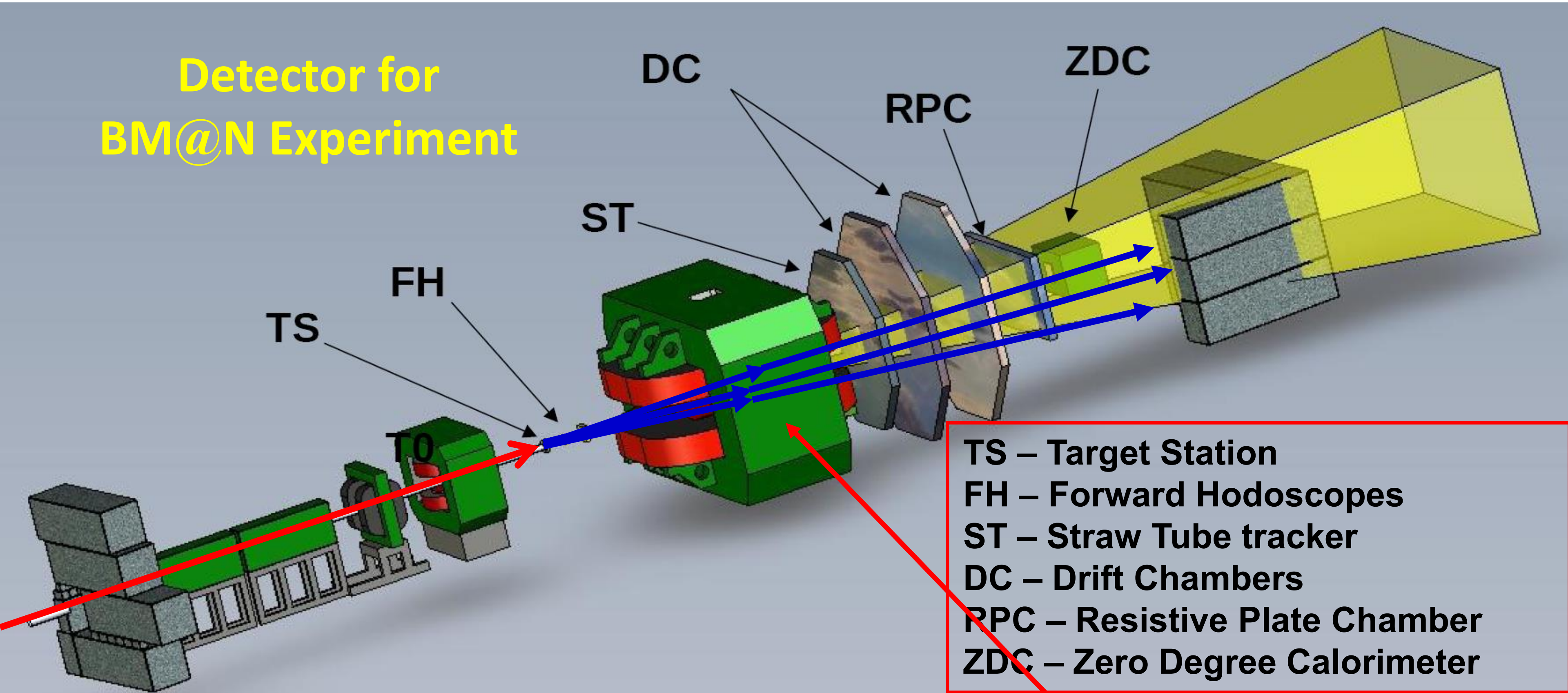
NICA Stage I: Experiment "The Baryonic Matter at Nuclotron"

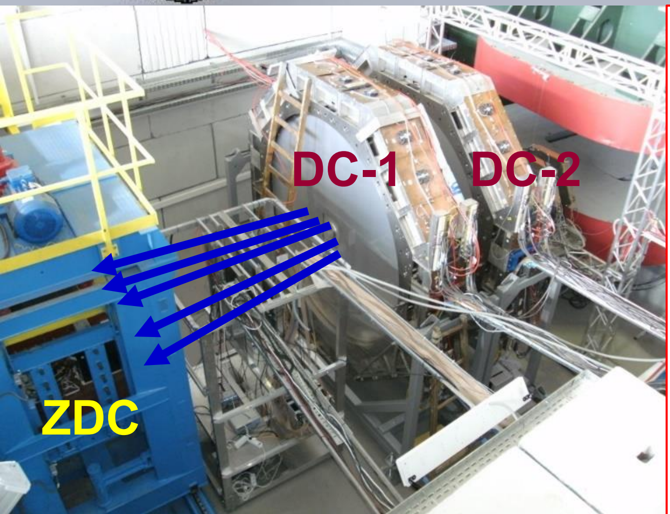


- TS – Target Station
- FH – Forward Hodoscopes
- ST – Straw Tube tracker
- DC – Drift Chambers
- RPC – Resistive Plate Chamber
- ZDC – Zero Degree Calorimeter



NICA Stage I: Experiment “The Baryonic Matter at Nuclotron”

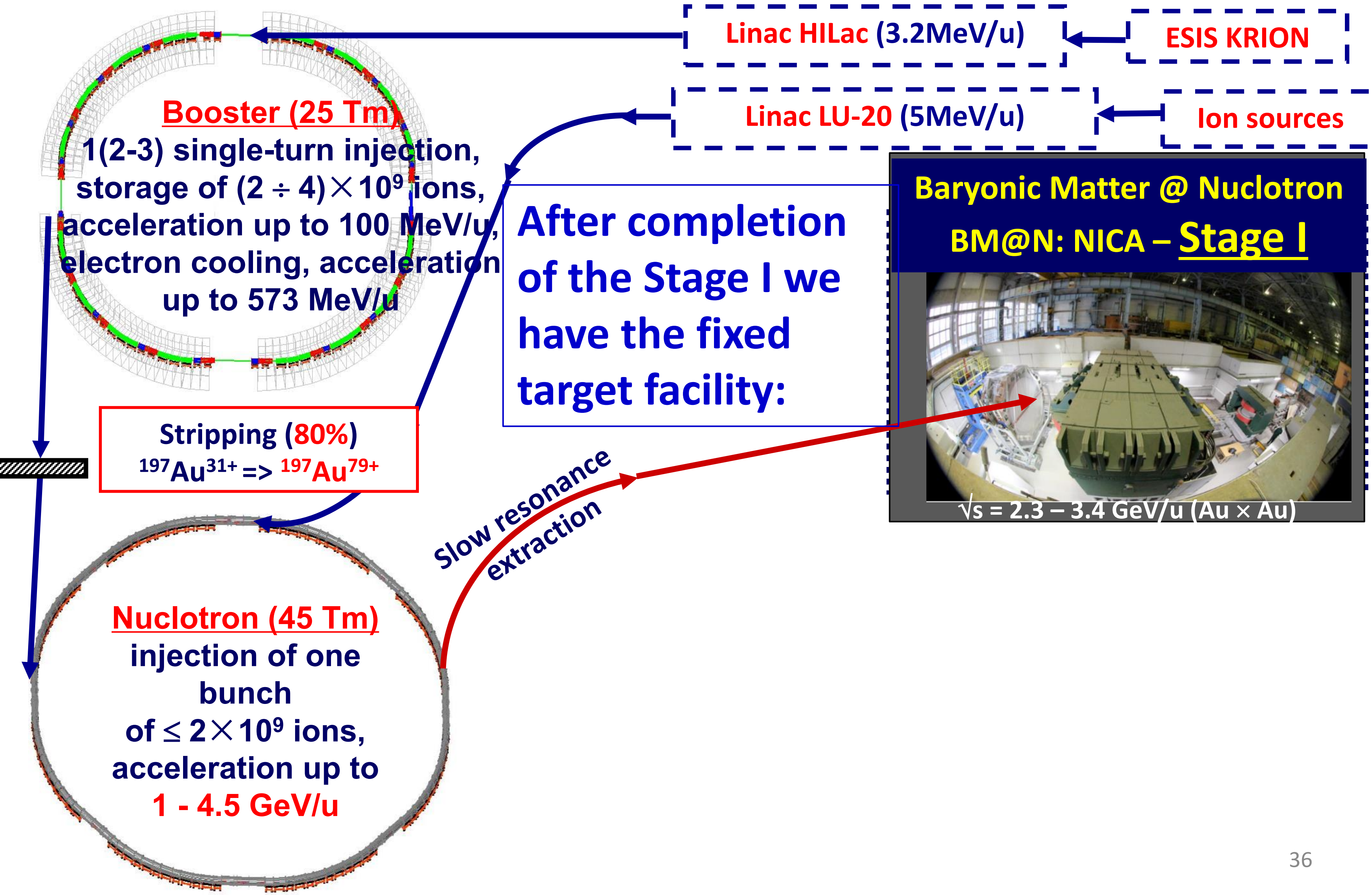




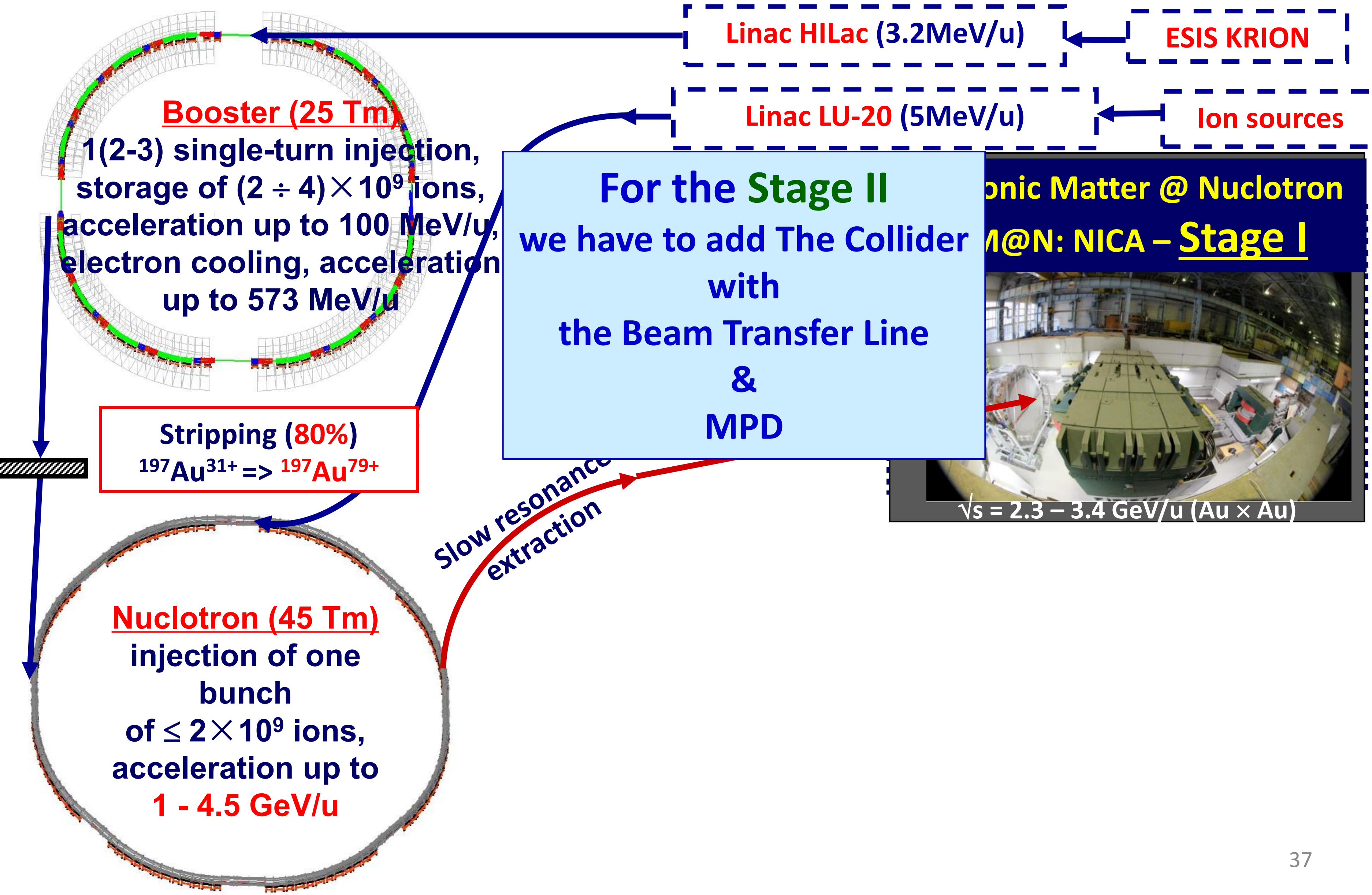
June 2016:

Commissioning at the Nuclotron beam subdetector located inside analyzing magnet

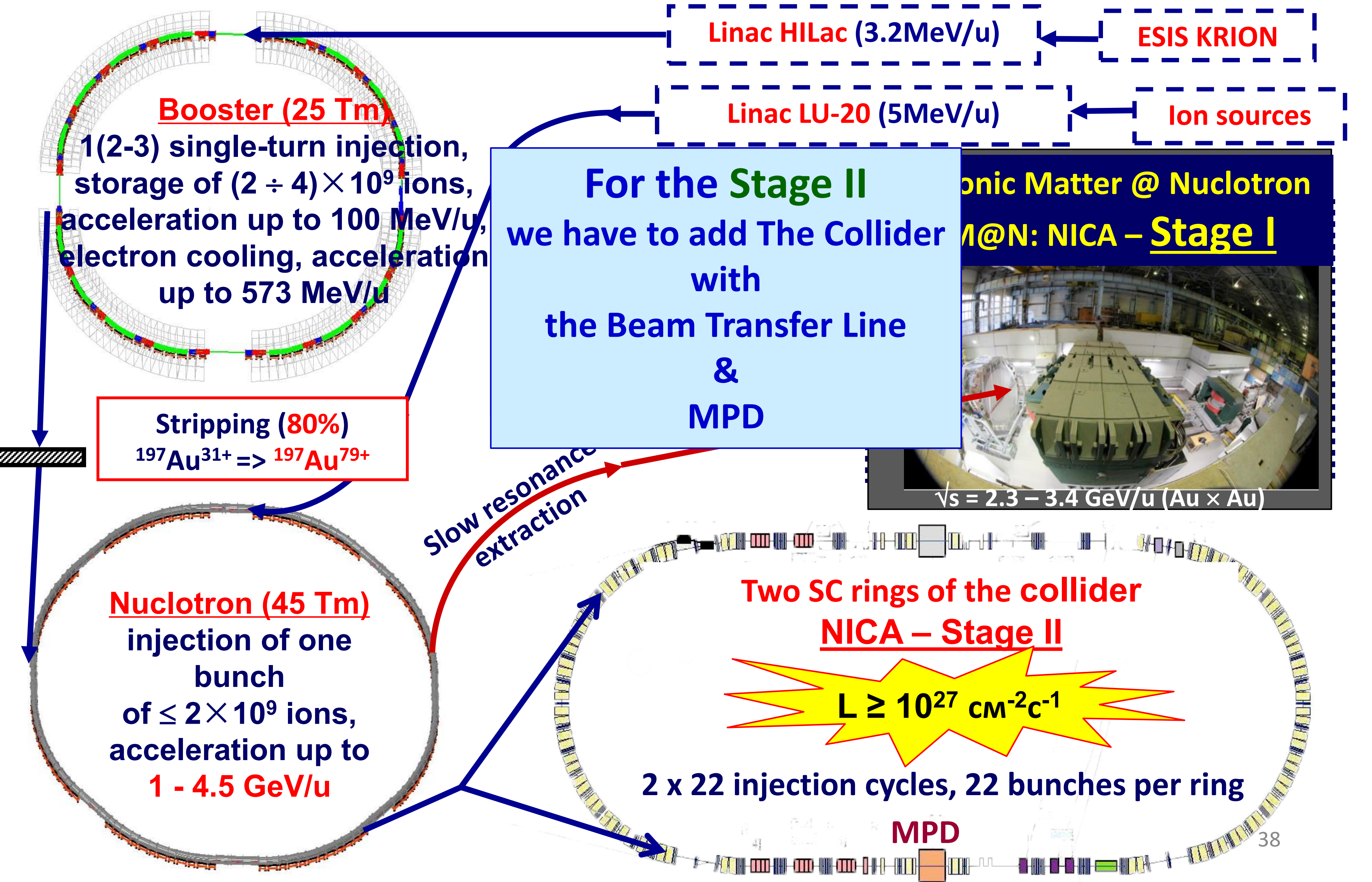
NICA Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider



NICA Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider



NICA Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider



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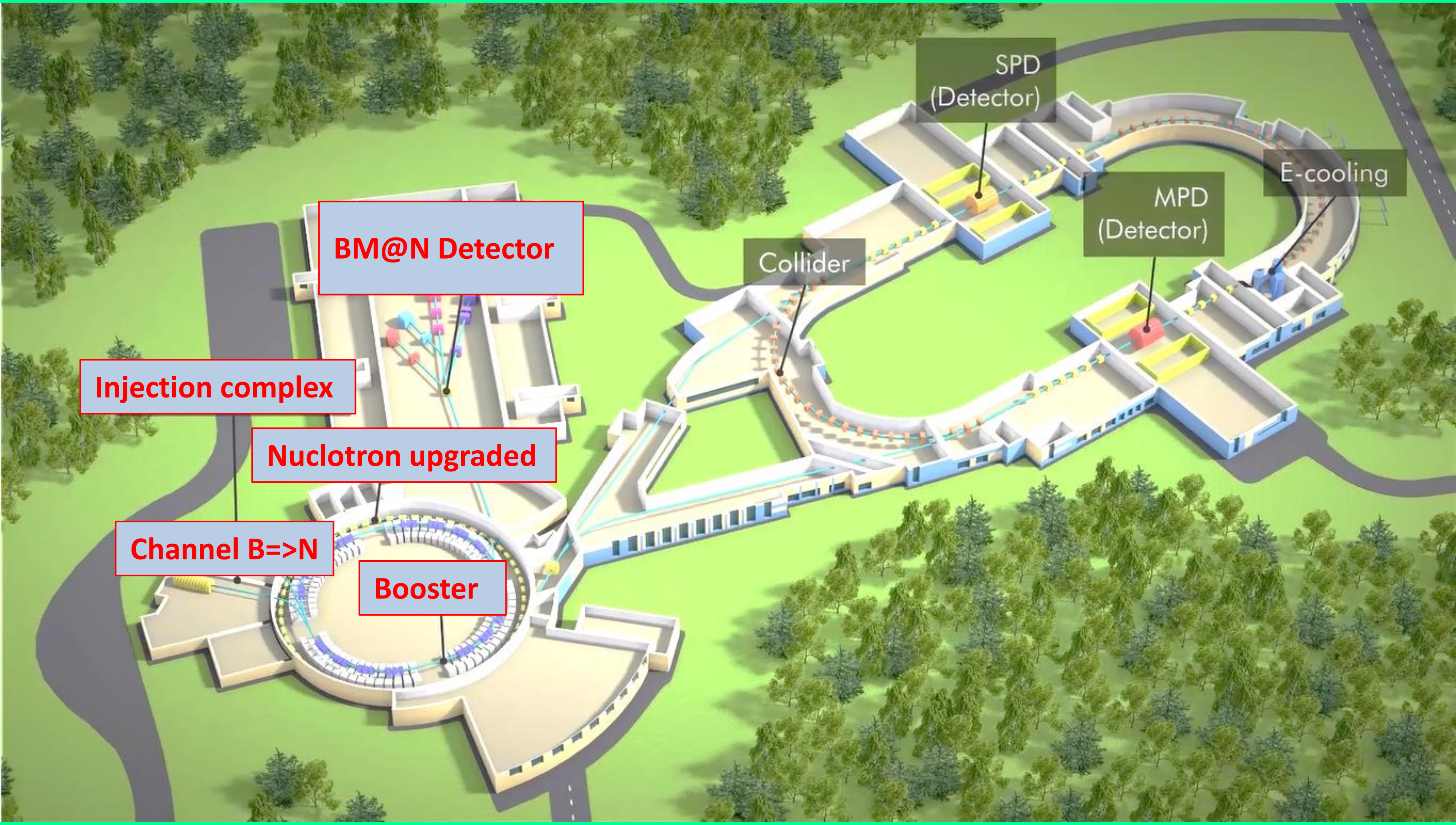

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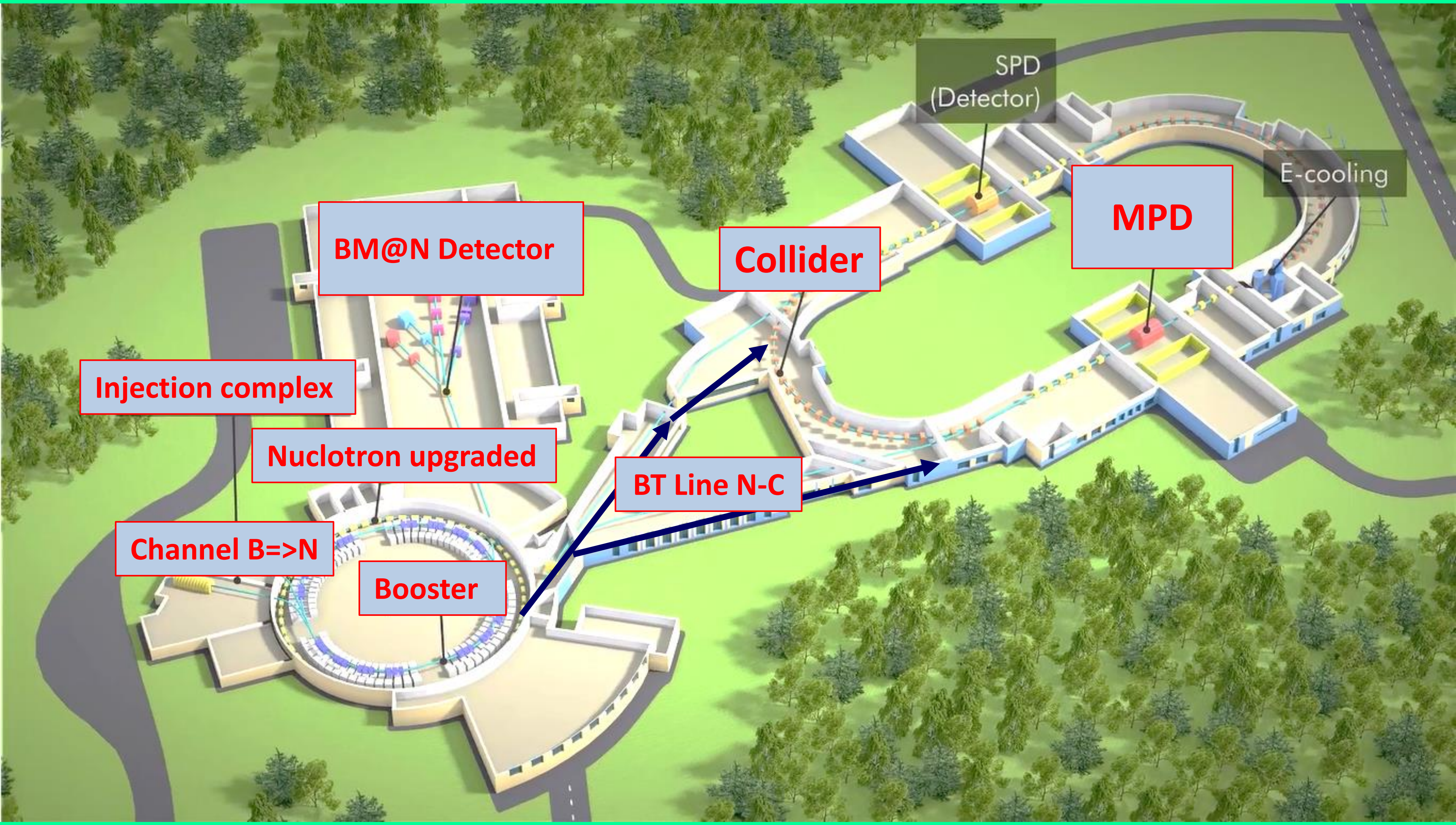
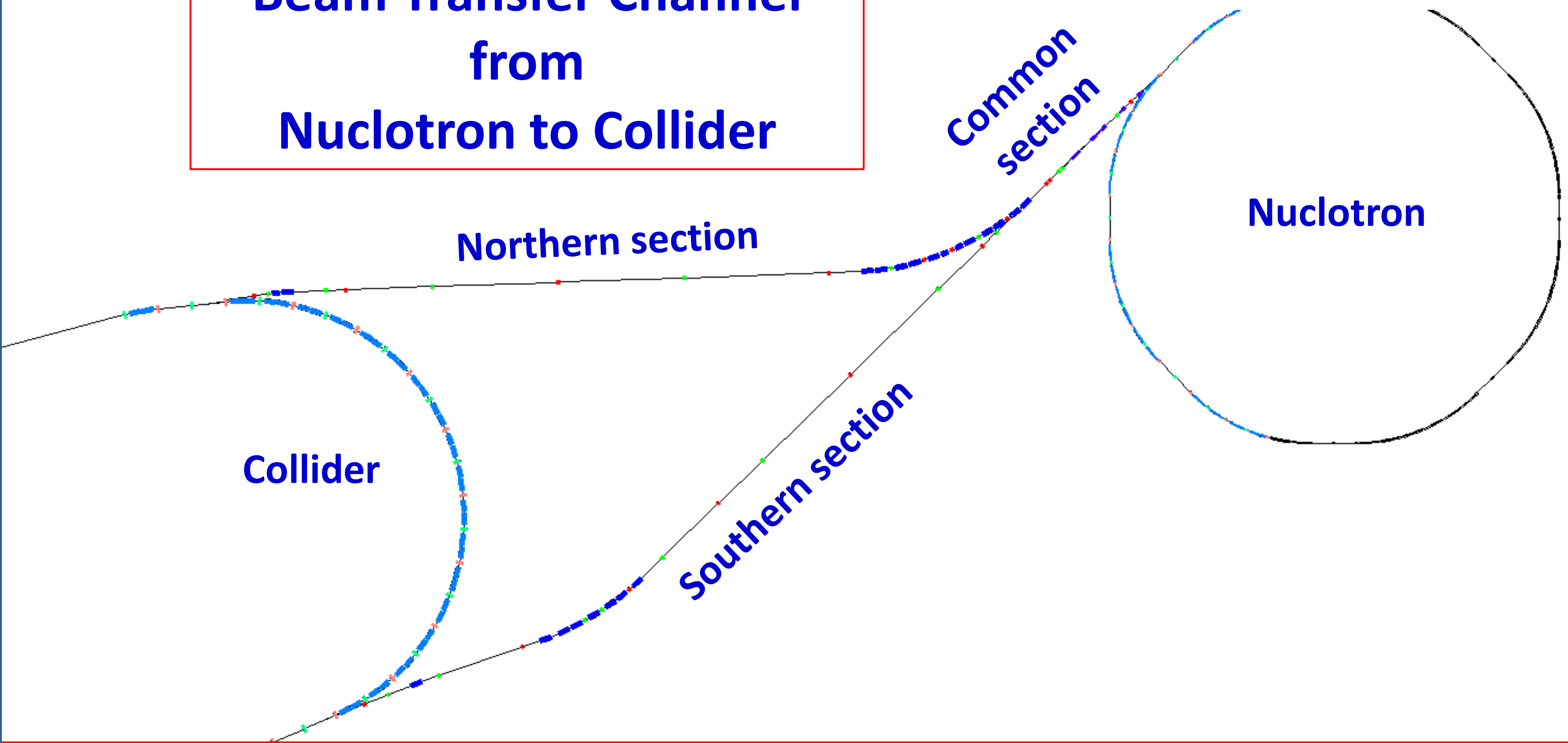


Beam Transfer Channel from Nuclotron to Collider

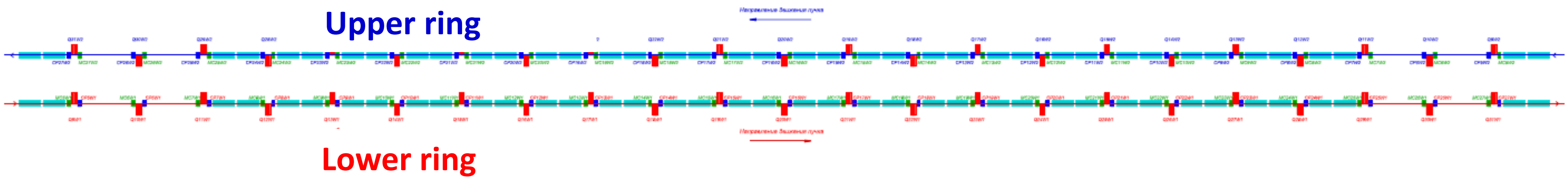


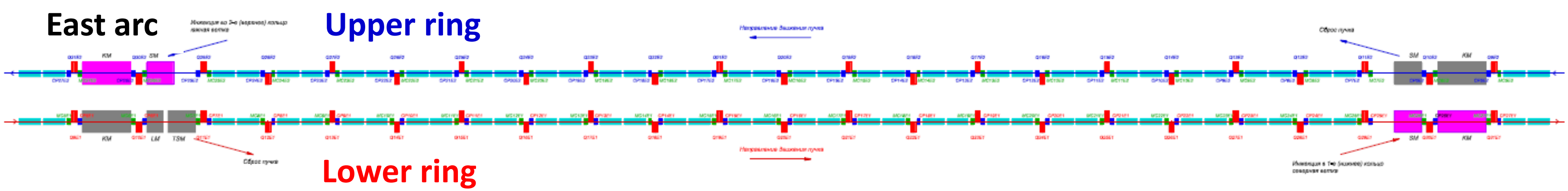
Conceptual design (channel lattice, parameters of elements, etc.) –
- Alexei Tuzikov and NICA team

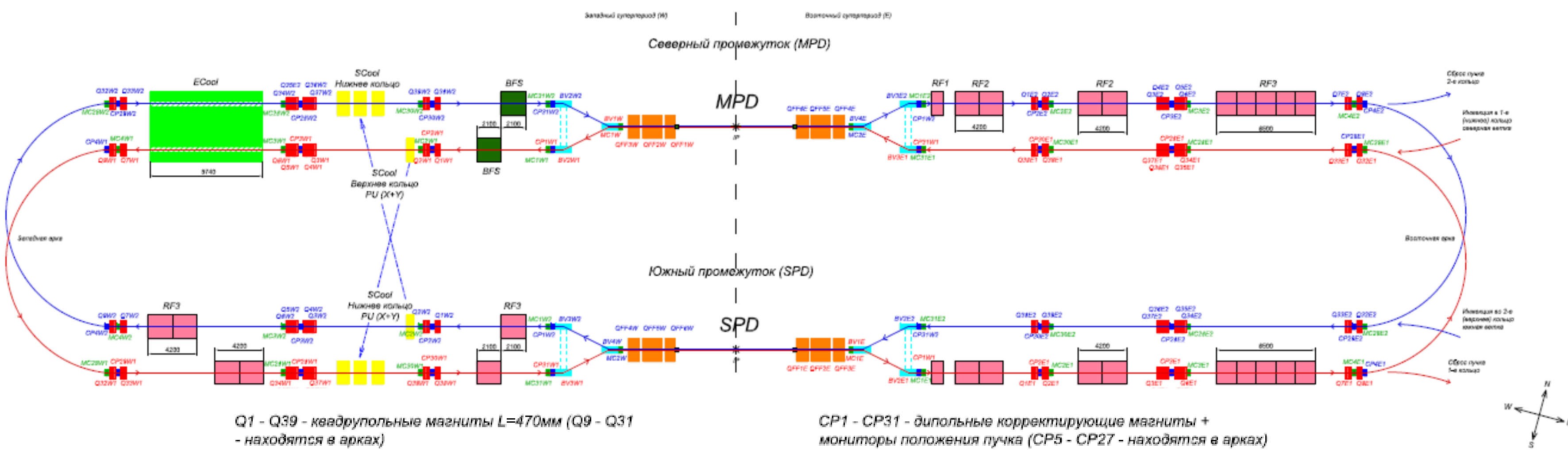
Technical project, working design, fabrication, mounting and commissioning –
- SigmaPhi C° (France)

Collider rings composition

S.Kostromin, O. Kozlov







Q1 - Q39 - квадрупольные магниты L=470мм (Q9 - Q31 - находятся в арках)
QFF1 - QFF6 - квадрупольные магниты финальной фокусировки пучков
BV1 - BV4 - дипольные магниты вертикального сведения / разведения пучков
MC1 - MC31 - мультипольные корректирующие магниты (MC5 - MC27 - находятся в арках, MC1, MC2 - общие для обоих пучков)

CP1 - CP31 - дипольные корректирующие магниты + мониторы положения пучка (CP5 - CP27 - находятся в арках)
ECool - система электронного охлаждения
RF1 - ВЧ-система 1
RF2 - ВЧ-система 2
RF3 - ВЧ-система 3
BFS - система коррекции когерентных колебаний пучка
Scool - кикеры системы стохастического охлаждения
Scool PU (X+Y) - монитор положения пучка системы стохастического охлаждения

Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider

G.Khodzhibagiyan
S.Kostromin

NICA Collider Magnets

Characteristics	Dipole	Lens
Number of magnets	80+8*	86+12**
Max. magnetic field (gradient)	1.8 T	23.1 T/m
Effective magnetic length	1.94 m	0.47 m
Beam pipe aperture (h/v)	120 mm / 70 mm	
Distance between beams	320 mm	

8* - dipoles of two beams' convergence, 12** - Final Focus lenses

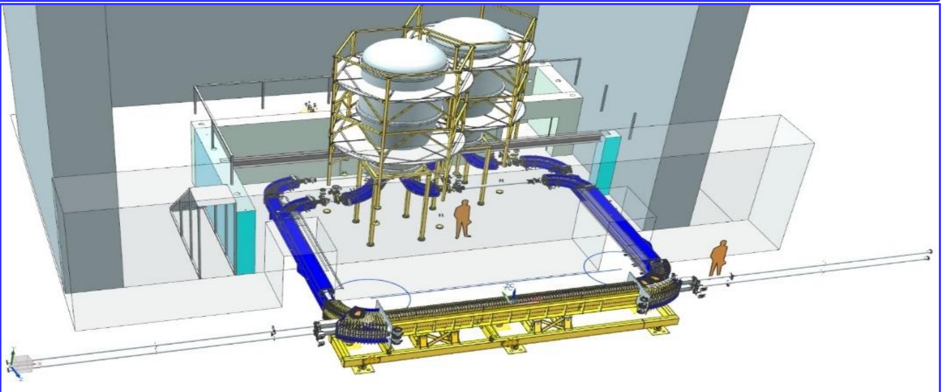
"Cold" test at T = 4.5 K

Serial dipole magnet and quad lens doublet for Booster

Preserial "twin" dipole magnet for Collider

Cooling Systems of The NICA Collider Magnets, Ions $^{197}Au^{79+}$

HV Electron Cooler for NICA Collider
Stage of design and prototyping at BINP



Main parameters

Parameter	Value
Electron energy, MeV Energy instability, $\Delta E/E$	0.2 – 2.5 $\leq 1\cdot 10^{-4}$
Electron beam current, A	0.1 – 1.0
Cooling section length, m	6.0
Solenoid magnetic field, T Field inhomogeneity, $\Delta B/B$	0.05 – 0.2 $\leq 1\cdot 10^{-5}$

Cooling Systems of The NICA Collider Magnets, Ions $^{197}Au^{79+}$

HV Electron Cooler for NICA Collider
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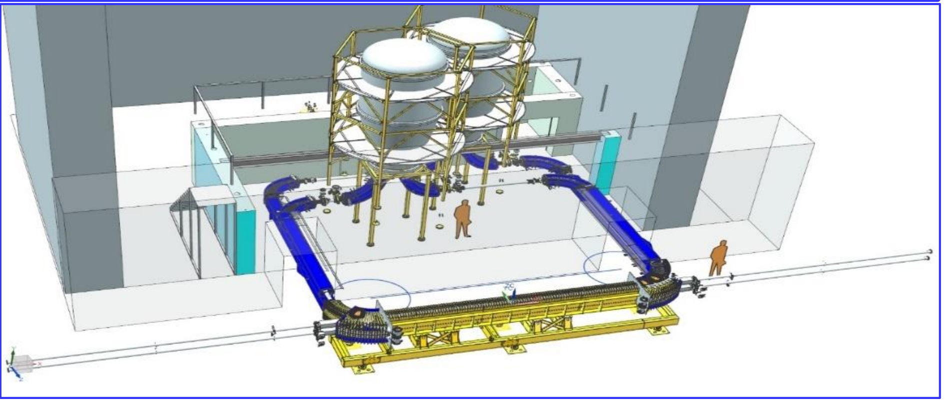

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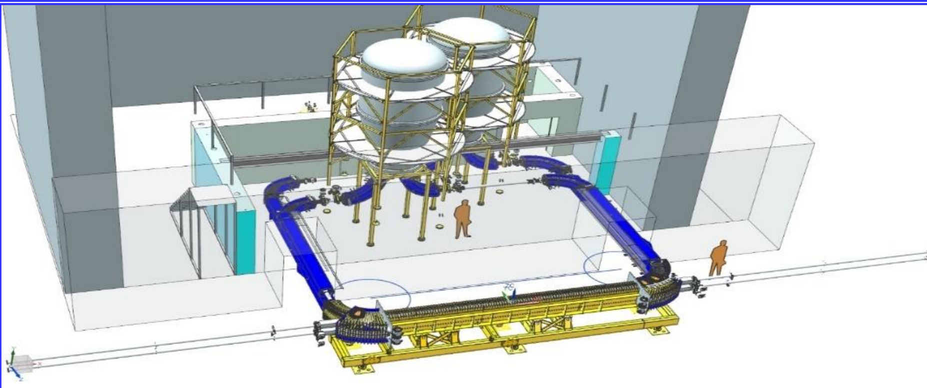
Details have been presented in the the talk of Vladimir Reva (Tuesday, 11:30)

Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider

Cooling Systems of The NICA Collider Magnets, Ions $^{197}Au^{79+}$

HV Electron Cooler for NICA Collider
Stage of design and prototyping at BINP



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Stochastic Cooling System for NICA Collider
Stage of design and prototyping at JINR (?)

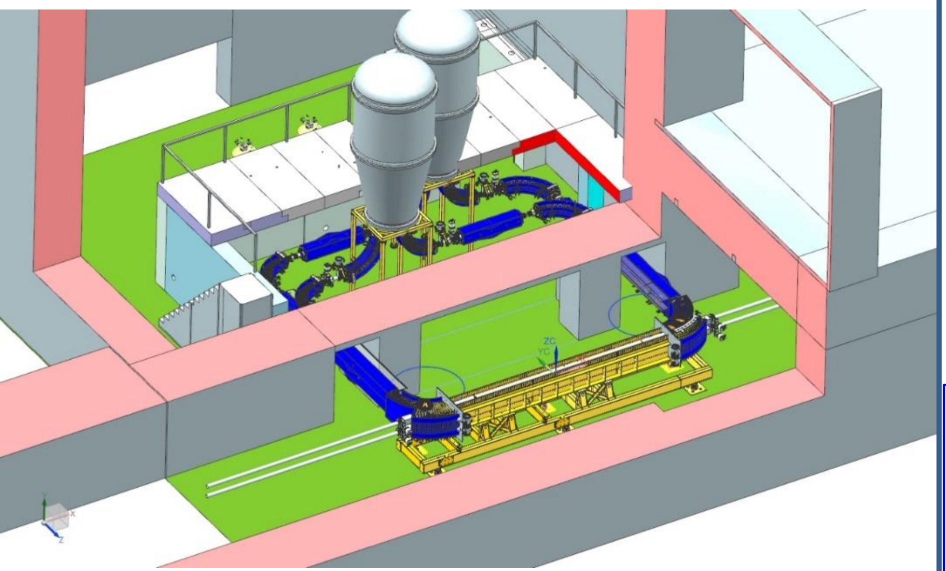
Facility configuration	Stage IIa (basic)	Stage IIb (final)
Energy range 3-4,5 GeV/u		
Bandwidth 2-4 GHz		
RMS bunch length, m	1,2	0,6
Coolling system	Longitudinal only	3-D
Method for long. cooling	Filter	Palmer
Optimal gain, dB	69	91
Equipment losses, dB	67	37
Total gain, dB	136	128

Cooling Systems of The NICA Collider Magnets, Ions $^{197}Au^{79+}$

HV Electron Cooler for NICA Collider
Stage of design and prototyping at BINP

Stage IIb (final)

HV Electron cooler built in the NICA Collider tunnel…



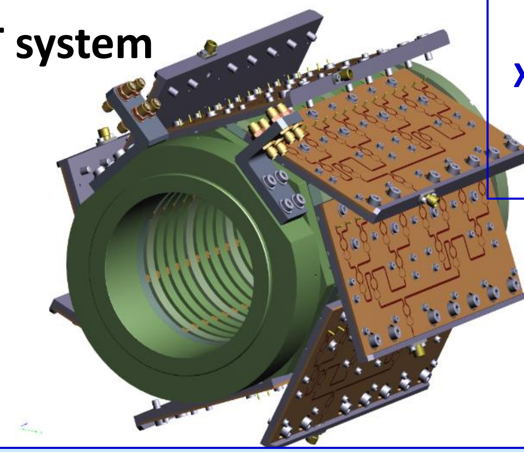
…in 2021 hopefully (Stage IIb – final)

Stochastic Cooling System for NICA Collider
Stage of design and prototyping at JINR

FZJ Ring-slot couplers will be used as Pickups & Kickers:

I.Gorelyshev (JINR)
Talk at
XII Sarantsev seminar
05.09.2017
Alushta, Crimea

RS-LT system



G.Trubnikov,
A.Sidorin,
R.Stassen,
I.Gorelyshev

Stage IIa – basic configuration:

1 PU station and 1 kicker per ring

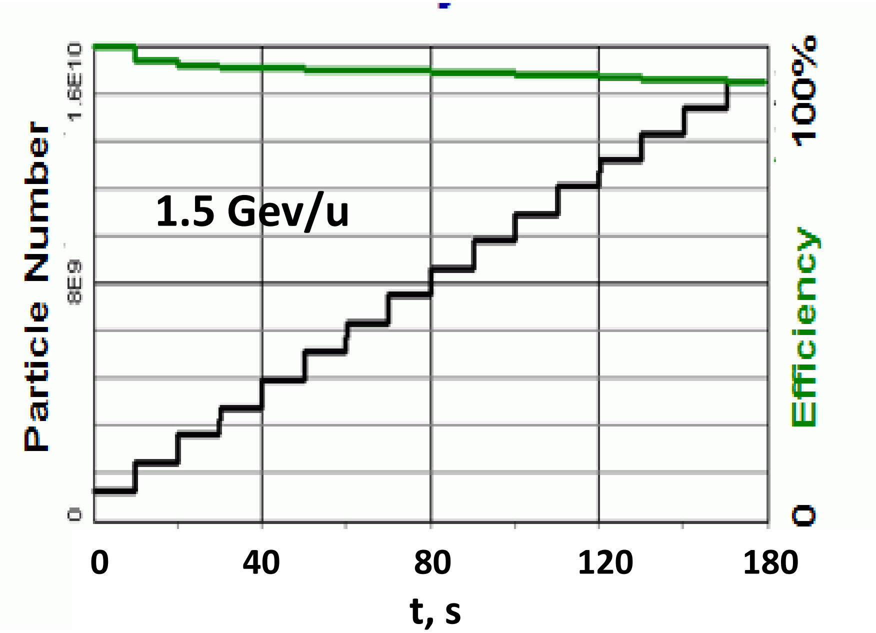
Stage IIb – final configuration:

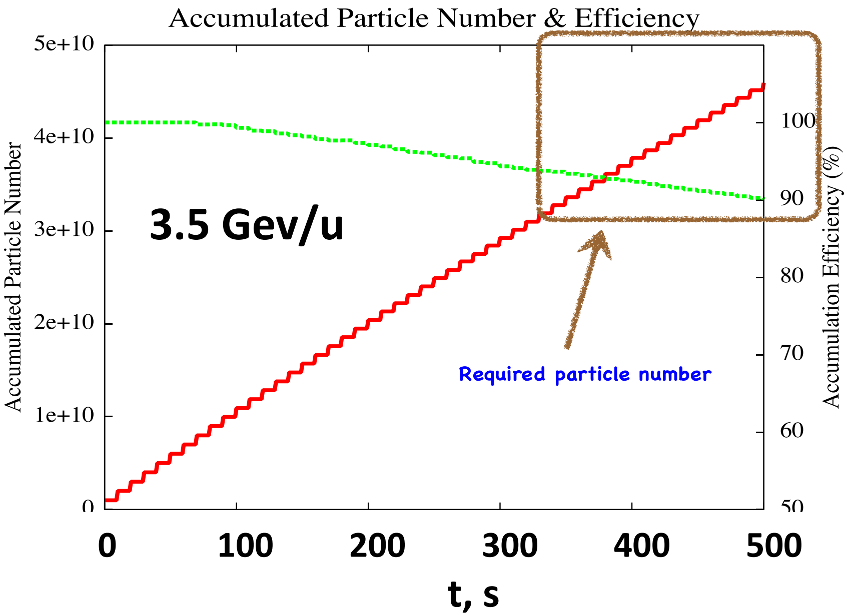
3 PU stations and 2 kickers per ring (1 kicker combines x- ans s- co-ordinates)

Ion Storage in Collider Rings with Barrier Bucket Technique

BETACOOL simulation with electron cooling: E=1.5 GeV/u

Simulation of stochastic cooling: E= 3.5 GeV/u





Accumulation process and its efficiency

E < 3 GeV/u:

Stacking with Electron cooling

Storage time corresponds to 200 s at ion energy 1-2.5 GeV/u

A.Smirnov, E.Syresin, 2016

4.5 > E > 3 GeV/u:

Stacking with Stochastic cooling

T.Katayama, 2009

Project Luminosity of The NICA Collider and Strategy of Its Achievement and Maintenance

1. Efficient scheme of ion storage and formation of short bunches of the intensity up to 1e9 ions $^{197}Au^{79+}$.
2. Vacuum in the Collider of the order of 10 pTorr providing ion beam lifetime ~ 10 h.
3. Compensation of ion beam space charge and suppression of intrabeam scattering (IBS) by means of electron and stochastic cooling application:

   E_{kin} = 1 – 3 GeV/u – electron cooling only,

   E_{kin} = 3 – 4.5 GeV/u – 3D both stochastic and electron cooling.
4. Suppression of coherent instabilities using feedback system.

All these measures allow us to form ion bunches of the r.m.s. length of 0.6 m that provides the Collider project luminosity.

RF Gymnastics in The Collider

Step 1: **Cooling and stacking with RF1 barrier voltage (< 5 kV). Accumulation efficiency ~ 95%, about 44 - 100 injection pulses (22-50 to each ring) every 5 sec. Total accumulation time ≤ 10 min.**

Ion momentum spread is limited by microwave instability.

Steps 2-3. Formation of the short ion bunches at presence of cooling:

RF-2 (100 kV, 4 resonators) => RF-3 (1MV, 8 resonators).

From coasting beam to => 22nd harmonics => 66th harmonics

V_{RF} & ion bunches , arb. units

Phase, arb. units

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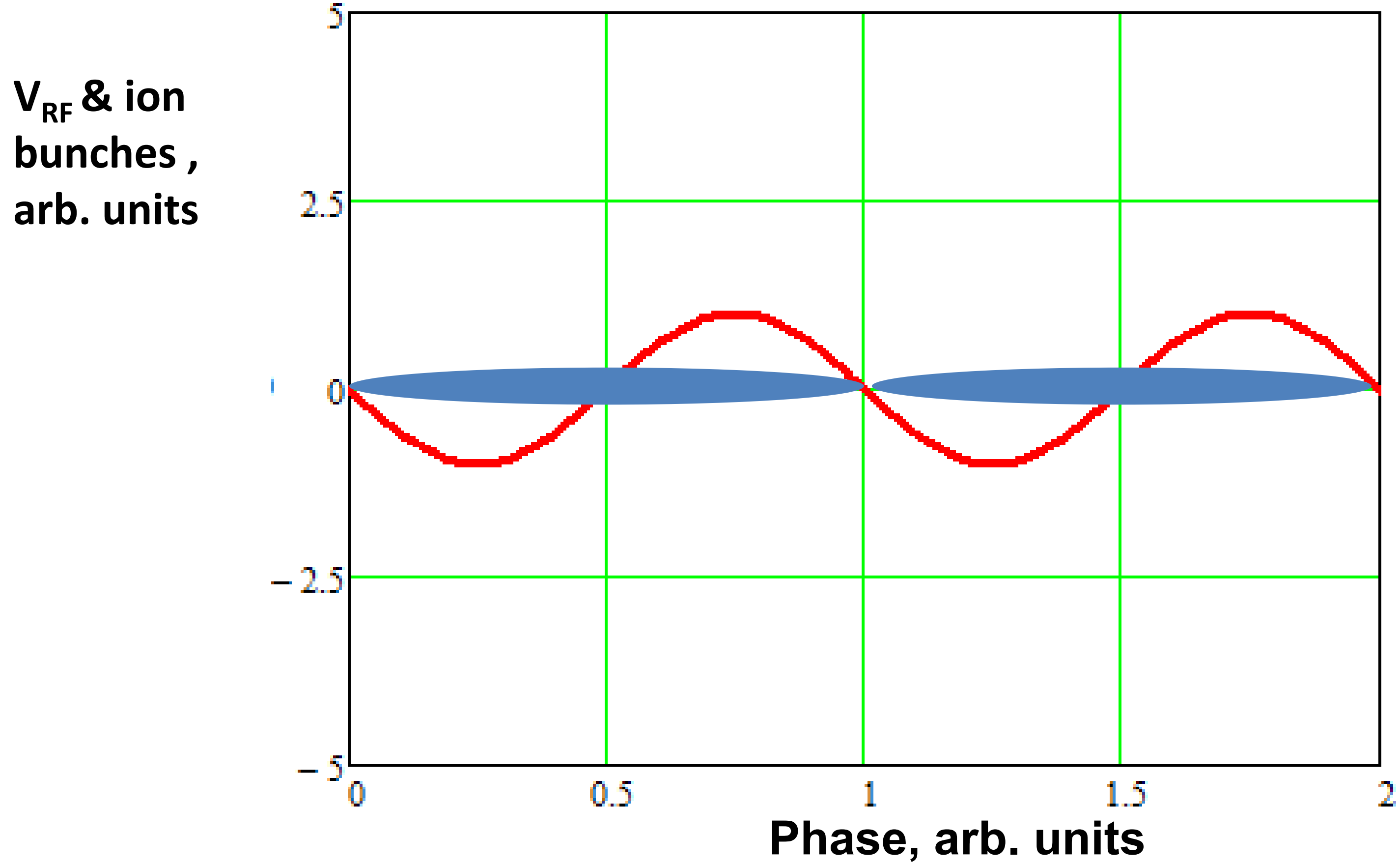

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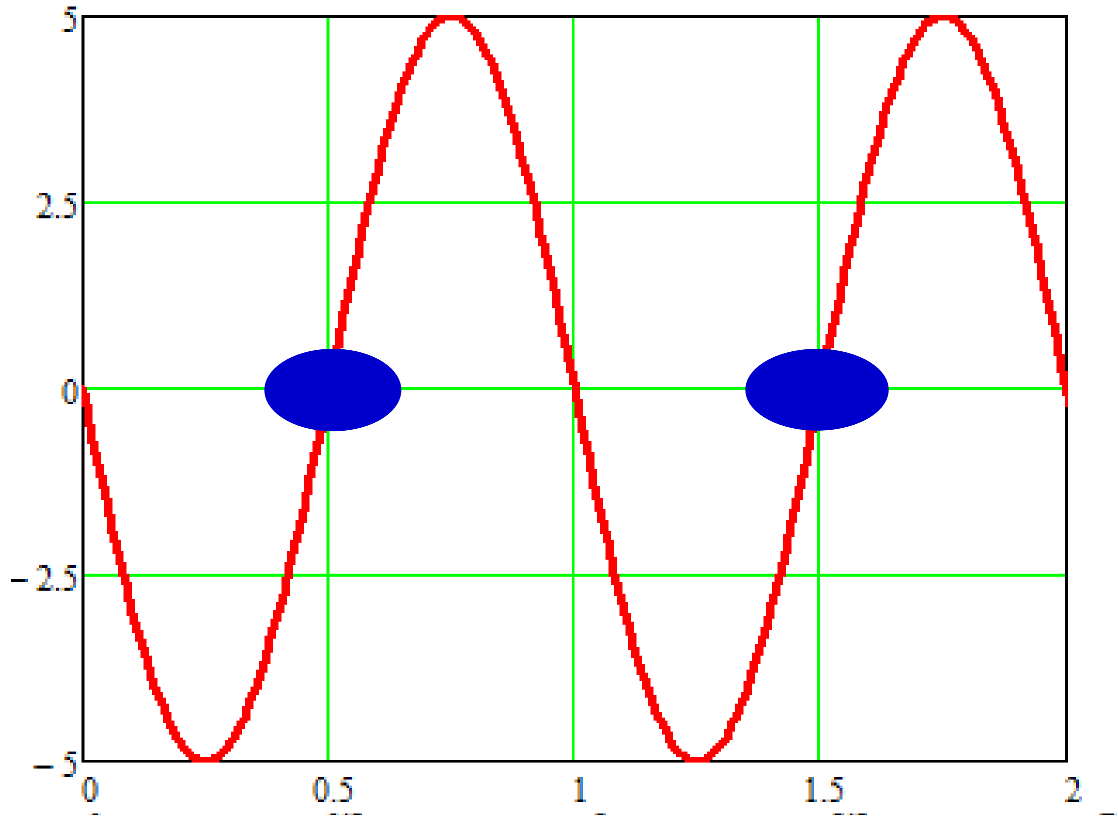

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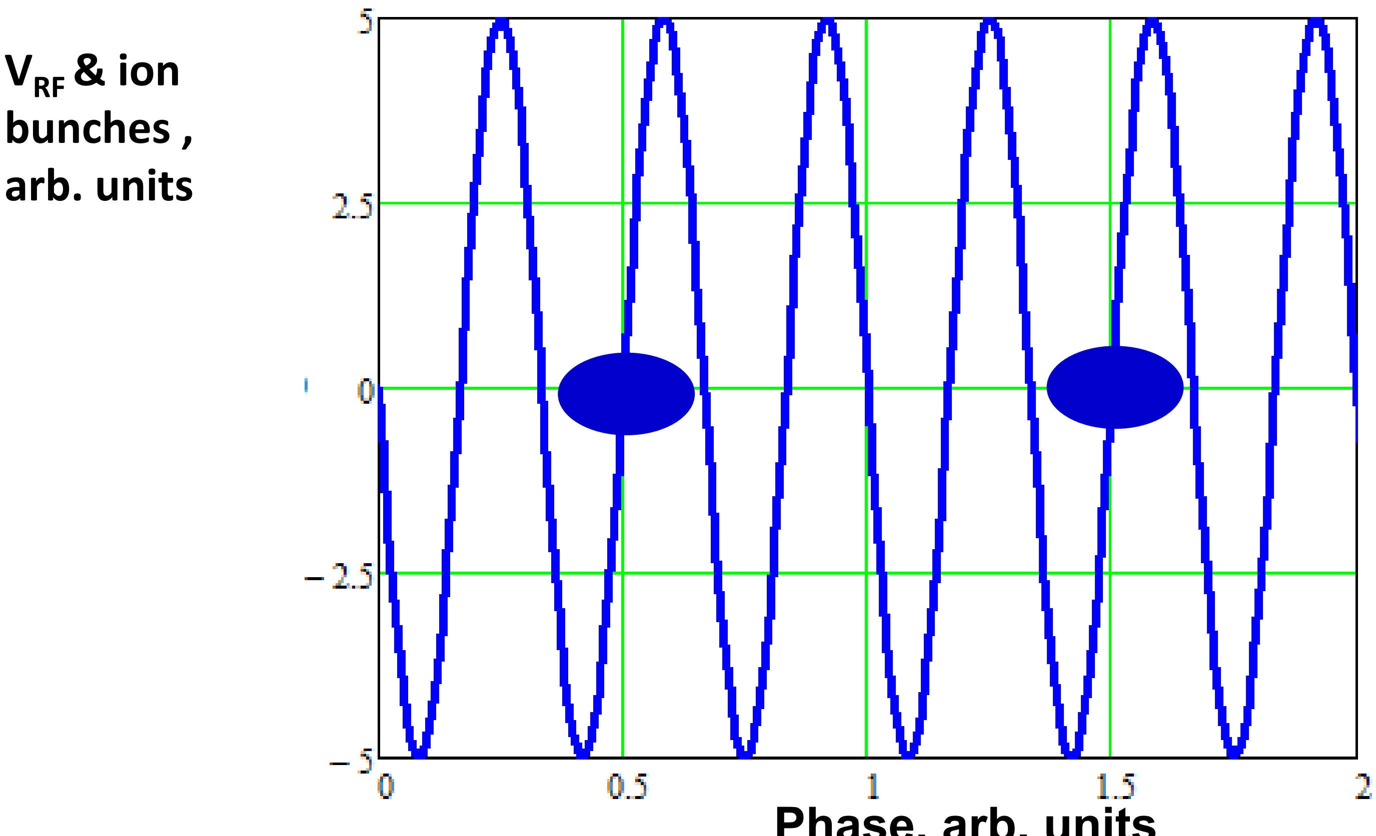

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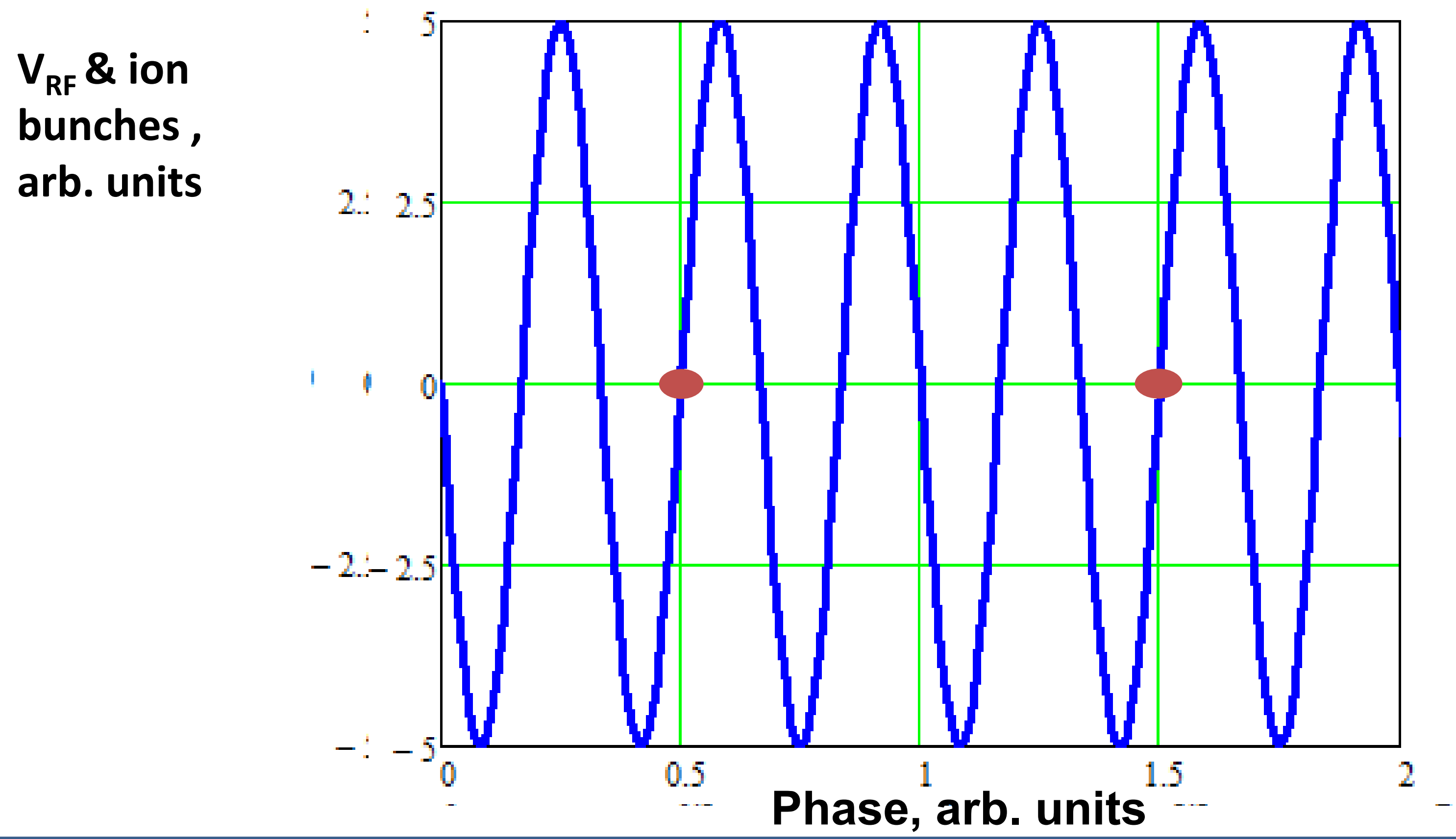
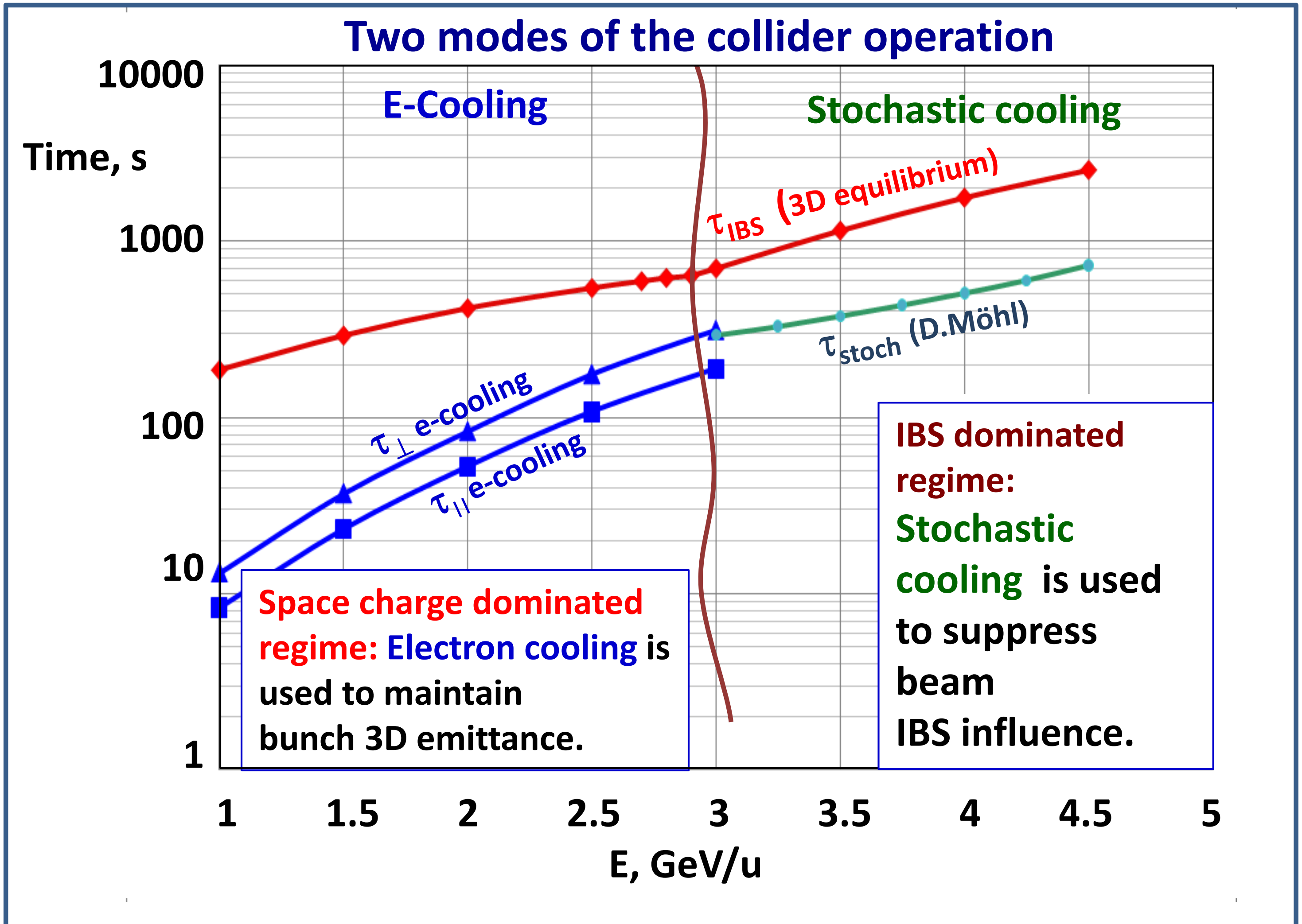


Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider

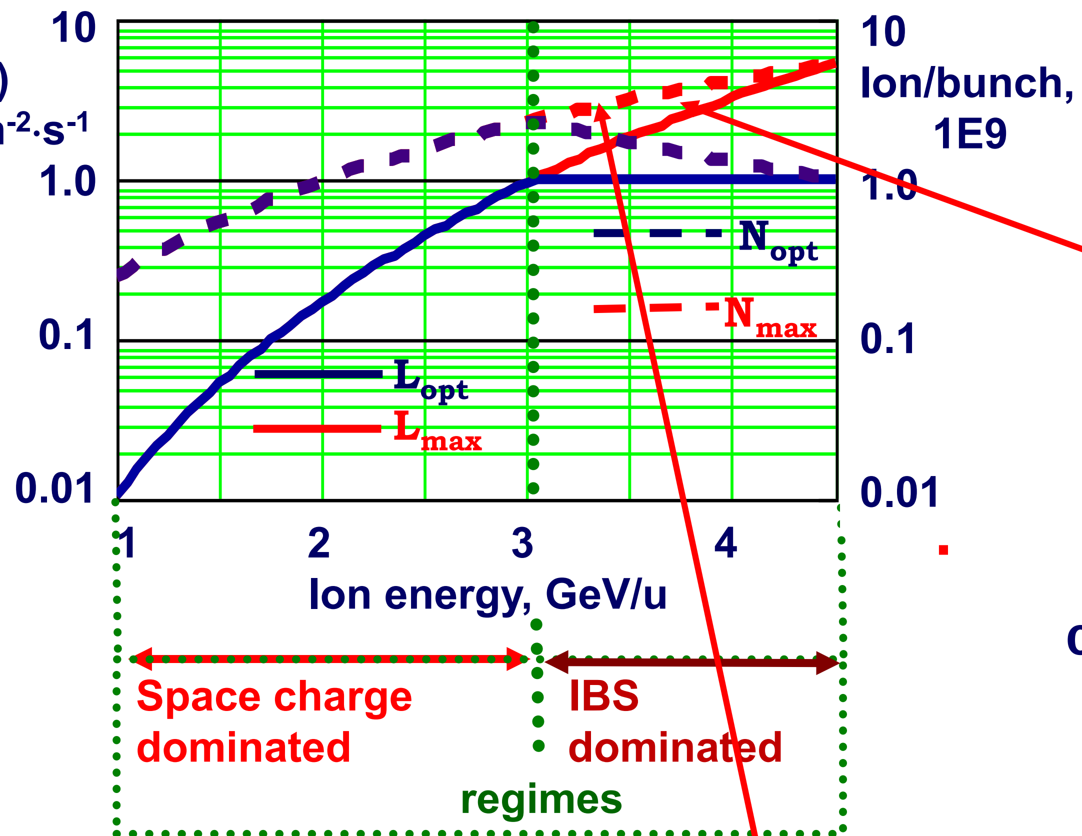
Beam Maintenance in Collider Rings with Cooling Technique



Space charge dominated mode ($\Delta Q \leq 0.05$)	IBS dominated mode
ε and dp/p are optimized independently. The bunch relaxation? is suppressed by cooling. Luminosity is limited by space charge effects	ε and dp/p are "equi-partitioned", either fast bunch relaxation. Luminosity can be obtained at small $\Delta Q<0.05$

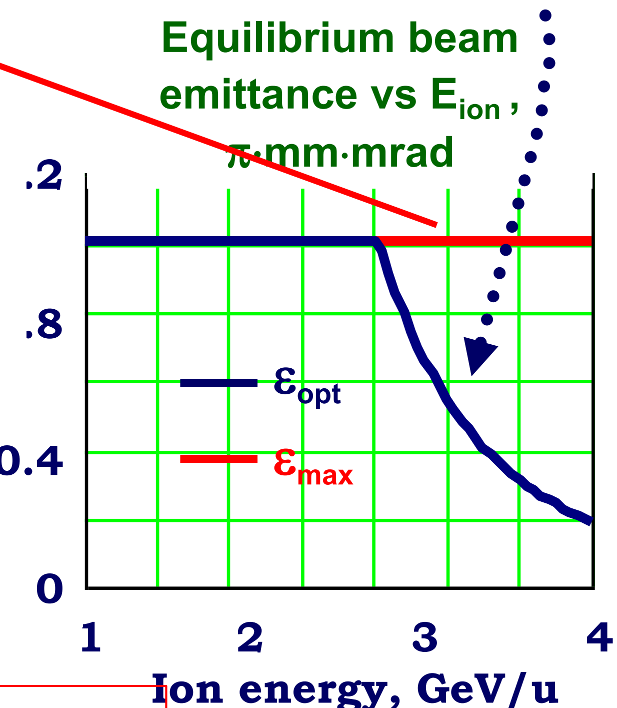
Beam Maintenance in Collider Rings with Cooling Technique

Two Operation Regimes and Collider Luminosity



Electron and stochastic cooling application!

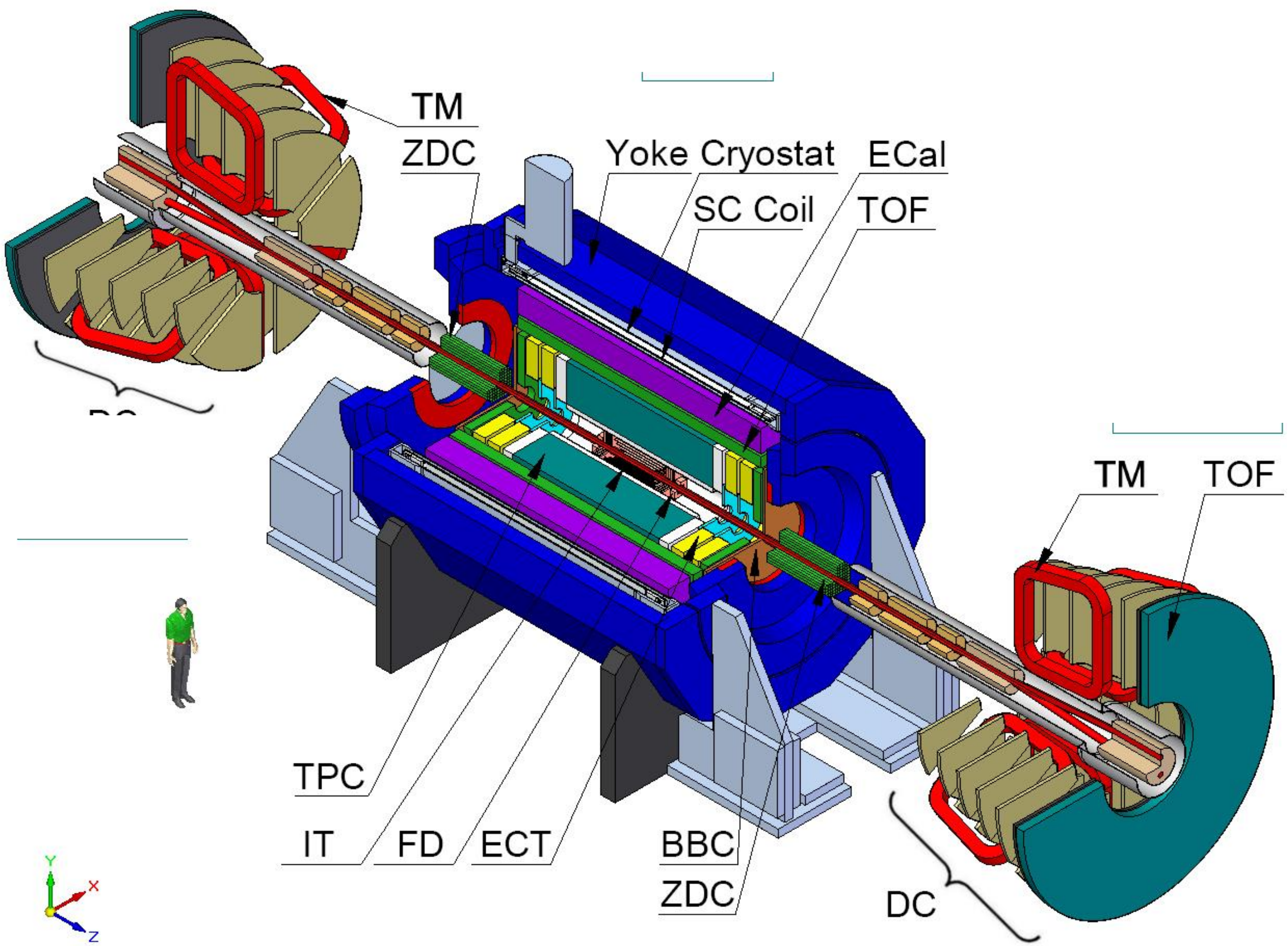
Emittance reduction with energy:



One can increase luminosity if... we can have at injection and storage more ions!

MultiPurpose Detector (MPD)

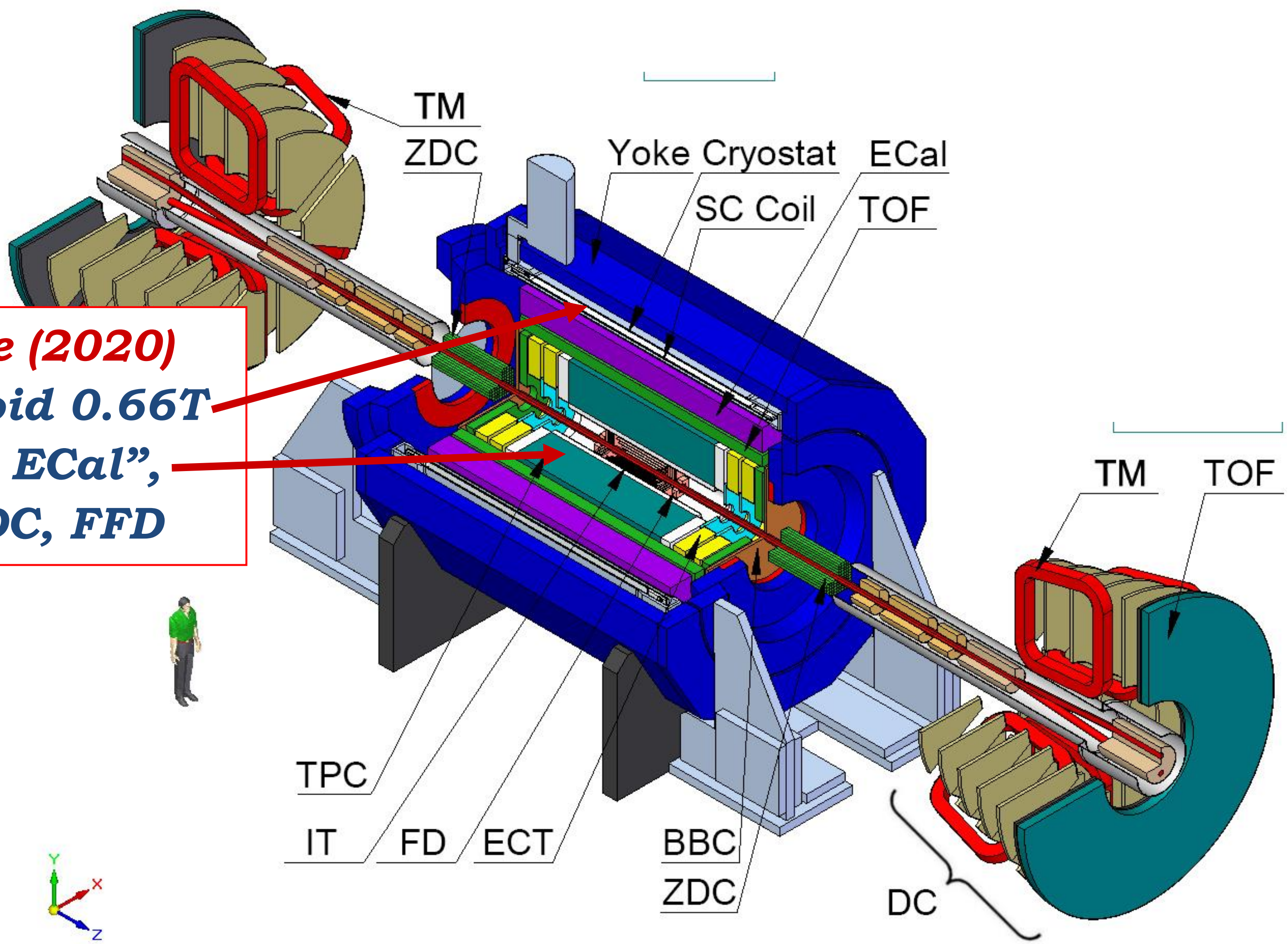
3 stages of The MPD Construction and Commissioning



MultiPurpose Detector (MPD)

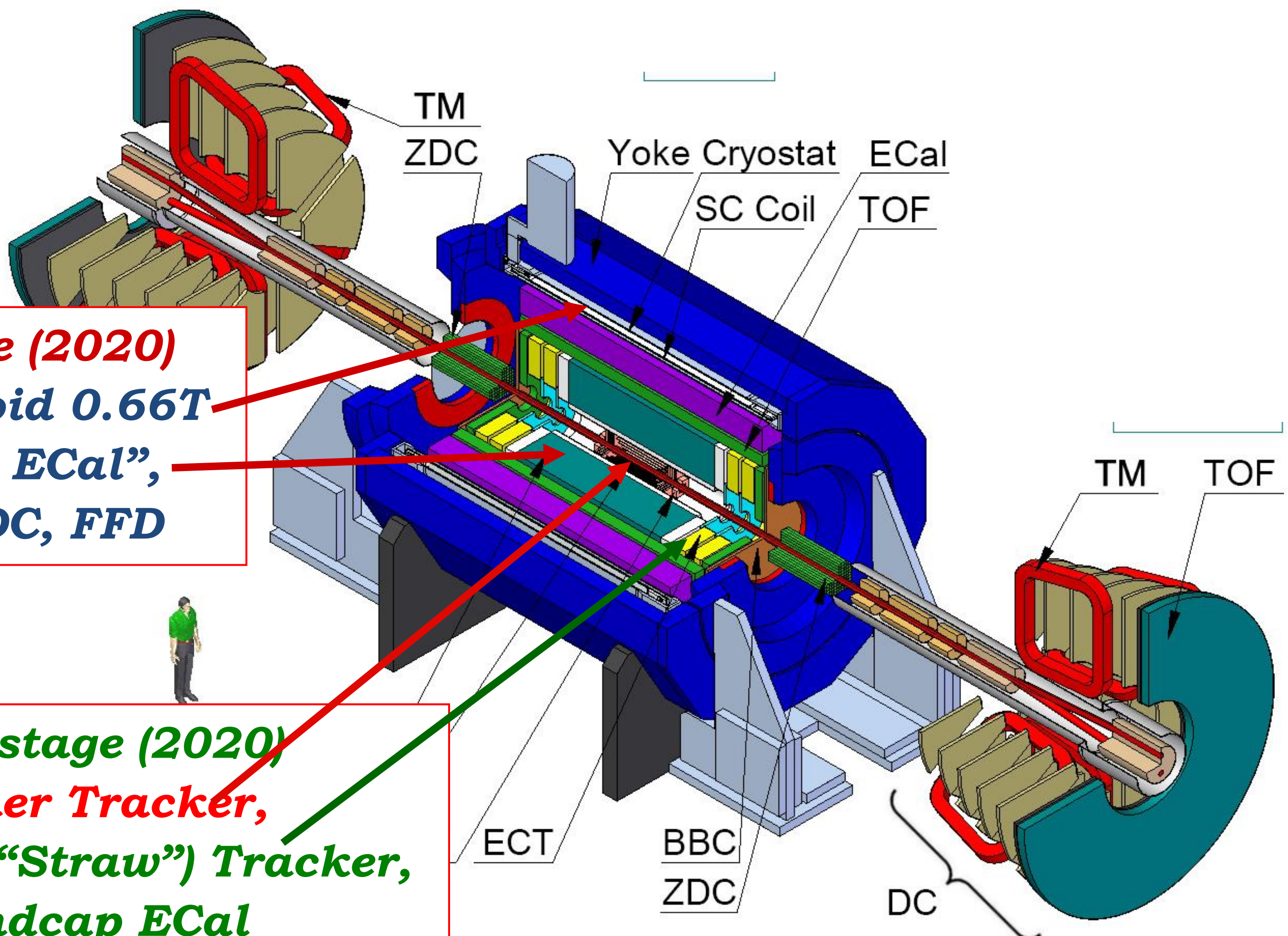
3 stages of The MPD Construction and Commissioning

1st stage (2020)
SC solenoid 0.66T
"Barrel ECal",
TPC, ZDC, FFD



MultiPurpose Detector (MPD)

3 stages of The MPD Construction and Commissioning

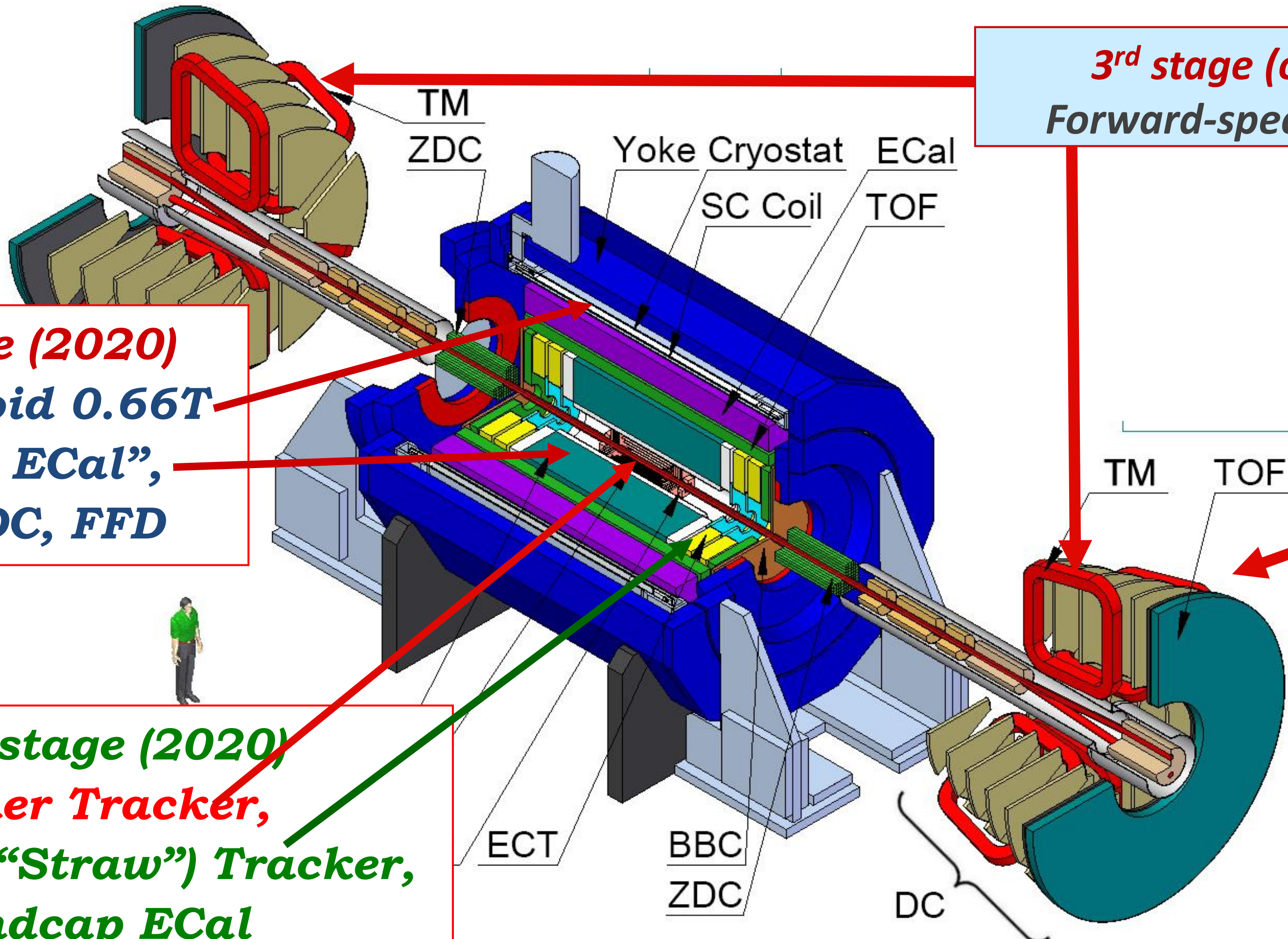


1st stage (2020)
SC solenoid 0.66T
"Barrel ECal",
TPC, ZDC, FFD

2nd stage (2020)
Inner Tracker,
EndCap ("Straw") Tracker,
Endcap ECal

MultiPurpose Detector (MPD)

3 stages of The MPD Construction and Commissioning



3rd stage (optional)
Forward-spectrometers

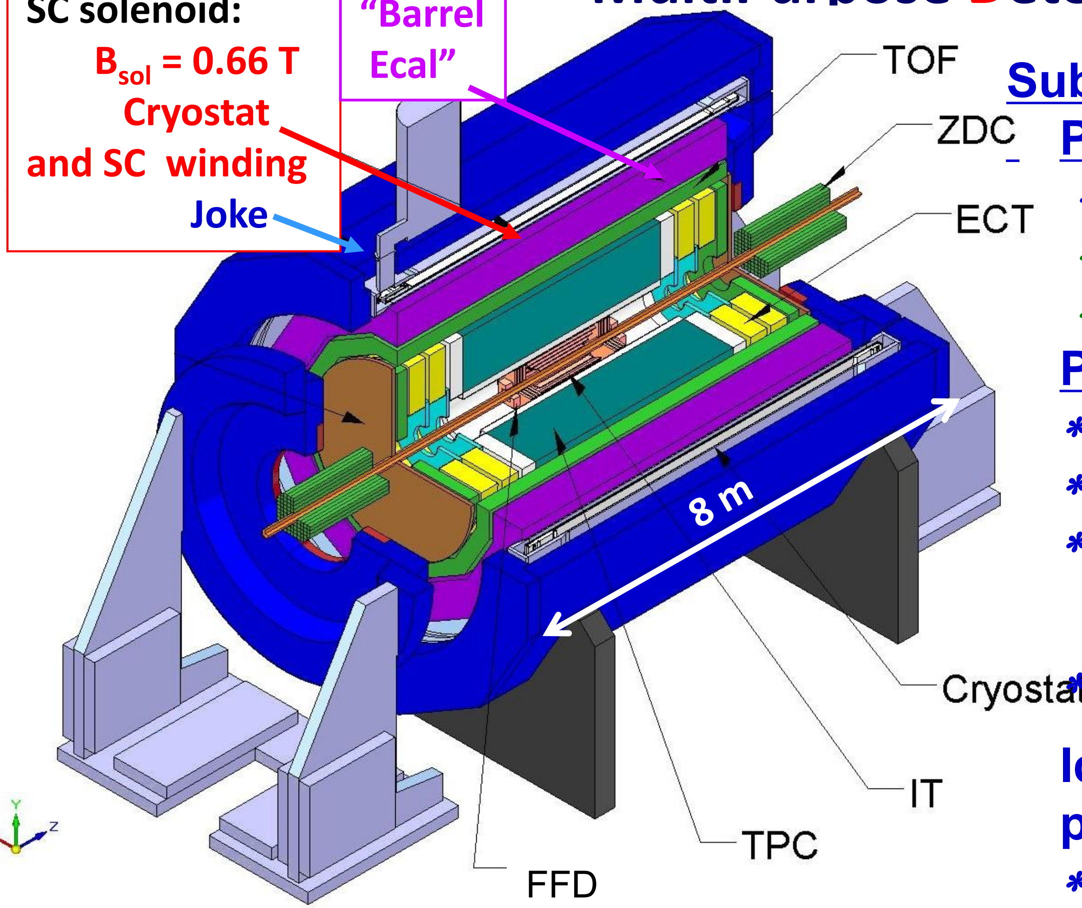
1st stage (2020)
SC solenoid 0.66T
"Barrel ECal",
TPC, ZDC, FFD

2nd stage (2020)
Inner Tracker,
EndCap ("Straw") Tracker,
Endcap ECal

MultiPurpose Detector (MPD)

SC solenoid:
$B_{sol} = 0.66$ T
Cryostat
and SC winding
Joke

“Barrel Ecal”



Subdetectors & probes’ identification:

Particle Tracking:
- *Time projection chamber (TPC)*
- *Inner tracker (IT)*
- *End Cap Tracker (ECT)*

Particle identification:
- *Time-of-flight detector (TOF)*
- *Electromagnetic calorimeter (Ecal)*
- *Time projection chamber (TPC)*

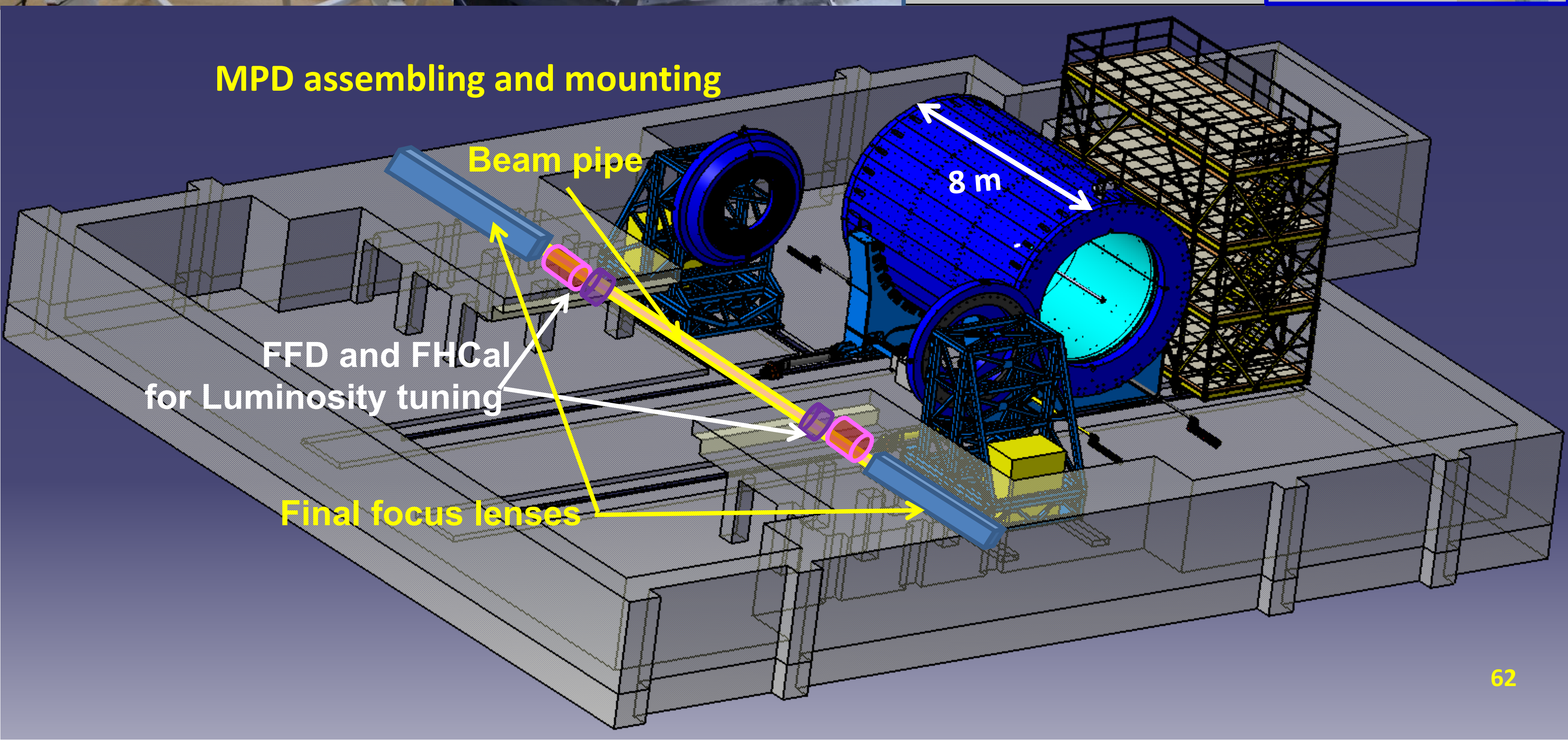
Triggering (T0)
- *Fast Forward Detector (FFD)*

Identification of centrality and event plane:
- *Zero Degree Calorimeter (ZDC)*

MPD max. counting rate = 7 kHz

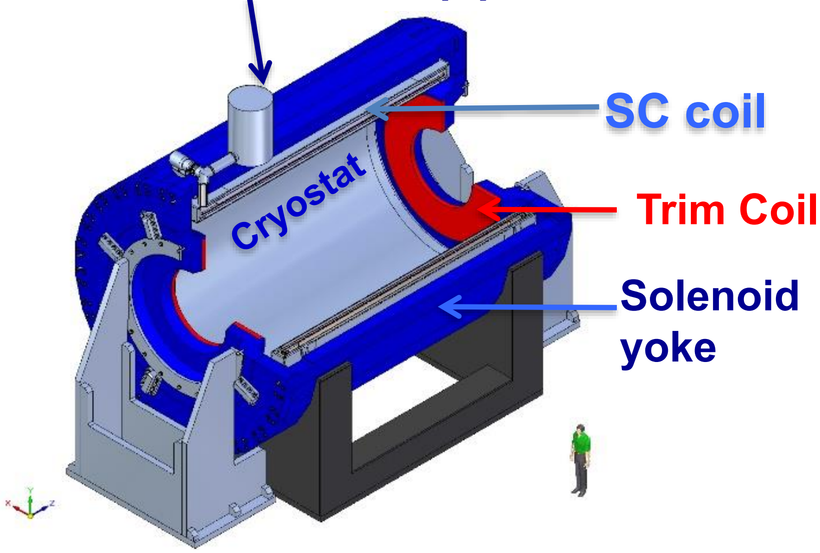
Stage II: Search for The Mixed Phase and New Physics In Heavy Ions' Collisions at NICA Collider

MultiPurpose Detector (MPD) – Construction Progress



MPD Superconducting Solenoid

ASG superconducting C° (Genova, Italy):



- *Cold Mass + Cryostat*
- *Vacuum System*
- *Trim Coils*
- *Control System & Power Supplies*
- *General responsibility*

B_0 = 0.66 T

$\Delta B/B \leq$ 1e-4 in TPC area

Weight ~ 900 t

Subcontractor: Vitkovice Heavy Machinery (Vitkovice, Czech Republic)

Sept. 5, 2016

The Stage II will be completed in Two Stages:

NICA Stage II-a (basic configuration):

1. Collider equipped with
- RF-1 (barrier voltage system) for ion storage
- RF-2 in a reduced version: 2 cavities per ring instead 4 (50 kV RF amplitude instead 100 kV)
- 1 channel of S-cooling system per ring (cooling of longitudinal degree of freedom)

Result: 22 bunches of the length $\sigma \sim 2$ m per collider ring that gives $L \geq 5e25$ $cm^{-2} \cdot s^{-1}$.

2. MPD equipped without
- Inner tracker
- Forward spectrometerrs

NICA Stage II-b (full configuration):

Collider
- RF-2 systems in the project version
- RF-3 systems in the project version
- S-cooling (transverse)
- E-cooling

MPD:
- Inner tracker systems
- Forward spectrometers (?)

Result: 22 bunches of the length $\sigma \sim 0.6$ m per collider ring that gives 1e27 $cm^{-2} \cdot s^{-1}$.

Stage III: Collider of Polarized Particles

$\sqrt{s_{NN}}$ = 14 - 27 GeV polarized p↑ (d↑) at $L \leq 10^{32}\ cm^{-2} \cdot s^{-1}$

Accelerator facility:

1st concept of the *polarized colliding beams in NICA* has been developed by JINR group, but strongly criticized.

Group of experts from BINP has been invited to develop the project independently and agreement has been achieved in July 2017.

Detector:

Concept of the Spin Physics Detector (SPD) is under development during several years, however no concrete (final) version has been formulated.

Stage III: Collider of Polarized Particles

$\sqrt{s_{NN}}$ = 14 - 27 GeV polarized p↑ (d↑) at $L \leq 10^{32}$ $cm^{-2} \cdot s^{-1}$

Accelerator facility:

1st concept of the *polarized colliding beams in NICA* has been developed by JINR group, but strongly criticized.

Group of experts from BINP has been invited to develop the project independently and agreement has been achieved in July 2017.

Detector:

Concept of the Spin Physics Detector (SPD) is under development during several years, however no concrete (final) version has been formulated.

"August putsch"

August 17, 2017

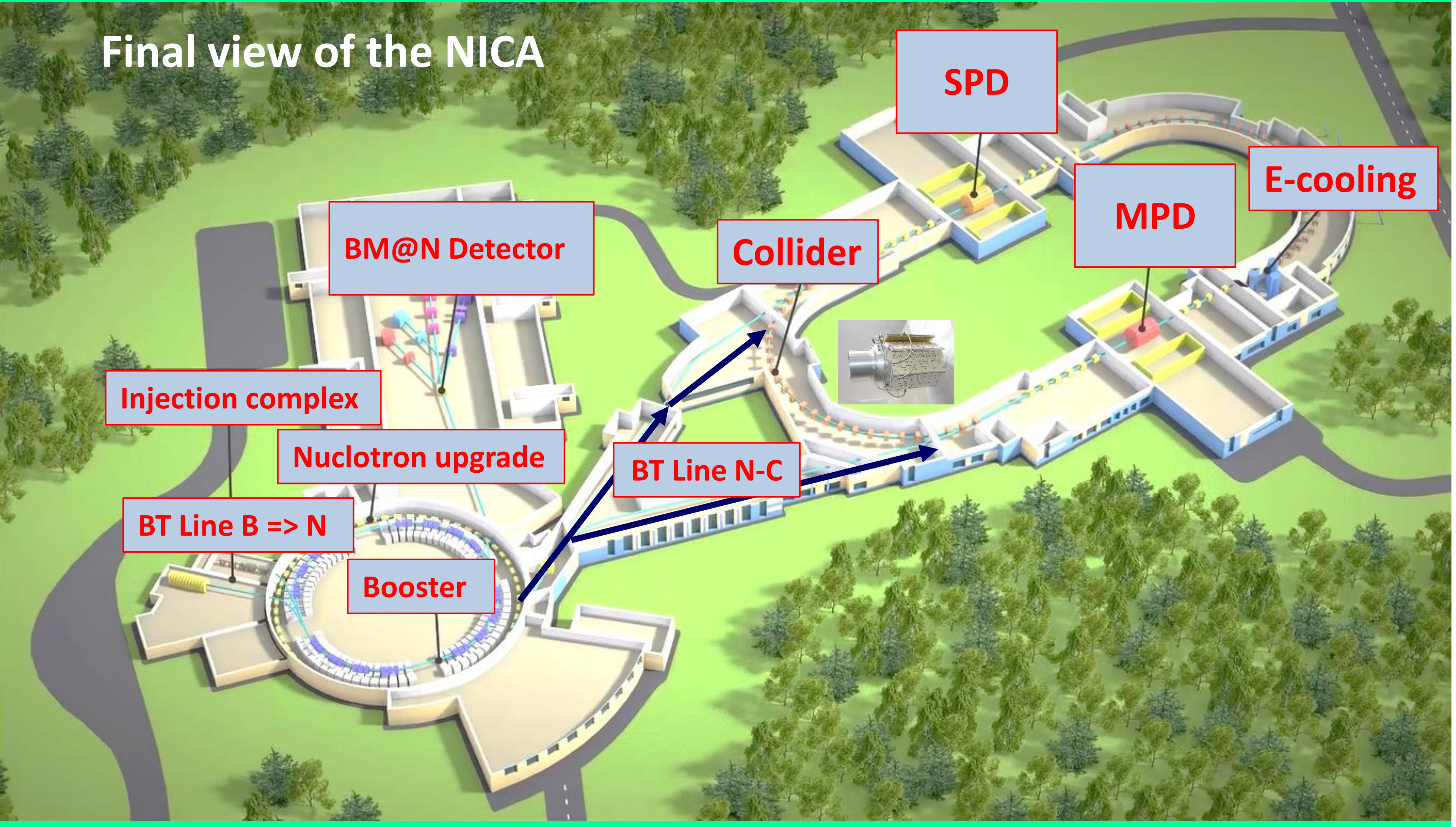
First meeting for "NICA-polarized" has been performed:

1. **Two concepts of the Spin Physics Detector (SPD) were presented.**
2. **SPD group coordinator and coordinators of subgroups were appointed.**

Preparation of SPD CDR is in progress…

Formation of SPD collaboration was started.

Stage III: Collider of Polarized Particles



NICA Collider Building Construction

NICA Collider Building Construction


November 21, 2013


June 22, 2015
Graticule marking,
earth bores drilling

October 28, 2016


January 10, 2017

May 23, 2017
NICA MAC members visiting construction site

NICA Collider Building Construction

August 25, 2017

NICA Milestones

Component	Developer/Producer	Commissioning date
NICA Stage I (BM@N)		
1. Heavy ion source KRION	VBLHEP JINR	November 2018
2. HILAc	BEVATECH+VBLHEP JINR	Commissioned (2016)
3. Booster synchrotron	VBLHEP JINR	December 2018
3.1. RF system	BINP	Ready for mounting
3.2 E-Cooler for Booster	BINP	Ready for mounting
4. BTL Booster—Nuclotron	BINP	February 2019
5. BTL Nuclotron—BM@N upgrade	VBLHEP JINR	February 2019
6. BM@N experiment with Au^{79+}	VBLHEP JINR	November 2019
NICA Stage IIa (Basic configuration)		
7. Nuclotron upgrade, fast extraction	VBLHEP JINR	November 2019
8. BTL Nuclotron—Collider	SigmaPhi (France)	1 December 2019
9. Collider – Stage IIa	VBLHEP JINR	December 2020
9.1. RF systems		
RF-1	BINP	December 2020
RF-2 (2 RF stations per ring)	BINP	December 2020
9.2. Stochastic cooling	BINP	December 2020
(1 Channel/ring)		December 2020
3. Beam dump system	VBLHEP JINR	December 2020

NICA Milestones

NICA Stage IIb (Project configuration)		
11. Collider – Stage IIb	VBLHEP JINR	July 2023
11.1. RF systems RF-2 (2 RF stations per ring) RF-3 (8 RF stations per ring)	 BINP BINP/INR RAS (?)	 October 2022 October 2022
11.2. Stochastic cooling 2 channels per ring	VBLHEP JINR/Izhevsk C°	October 2022
11.3. Electron cooler	BINP	October 2022
11.4. Feed back system 1 channel per ring	VBLHEP JINR	October 2022
12. MPD – NICA Stage IIb	VBLHEP JINR	December 2022

NICA Stage IIb (project configuration)	2023

NICA Stage III (polarized beams and spin physics)	2025

Status of The NICA Project

2008 Project beginning

Status of The NICA Project

2008 Project beginning

2012 Active, but slow phase

Status of The NICA Project

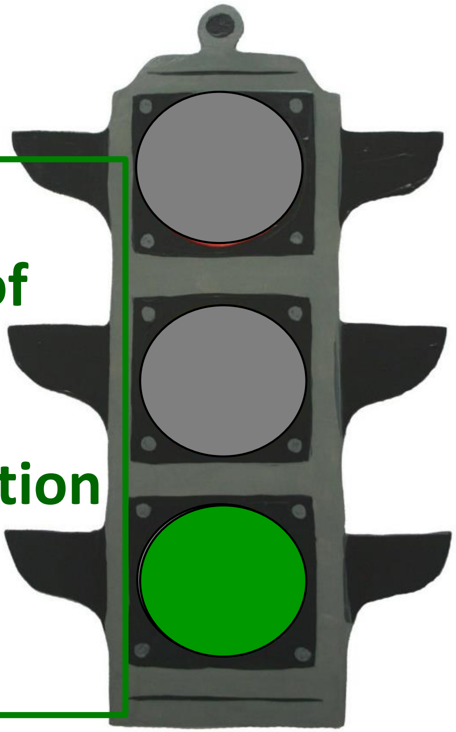
April 27, 2016 – NICA Megaproject

April 27, 2016
Order of The Government of Russian Federation

₽ 8.8 billion Russian Federation

+

₽ 8.7 billion JINR



2008 Project beginning

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2016 NICA must be built!

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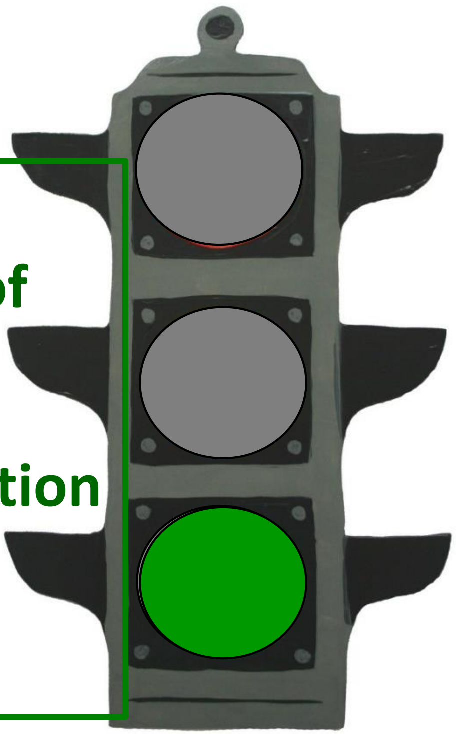

2008 Project beginning

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2016 NICA must be built!

ACKNOWLEDGEMENT

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August 25, 2017
Thank you for your attention!
STRABAG