Realization of the Nuclotron-NICA project

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PP PAC, JINR, Dubna, 21 June 2023

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Fourth run

Performed during the period from 20 September 2022 to 3 Febrary 2023
Ar and Xe beams from KRION, the maximum beam energy ~ 3.6 Gev/u

Results:

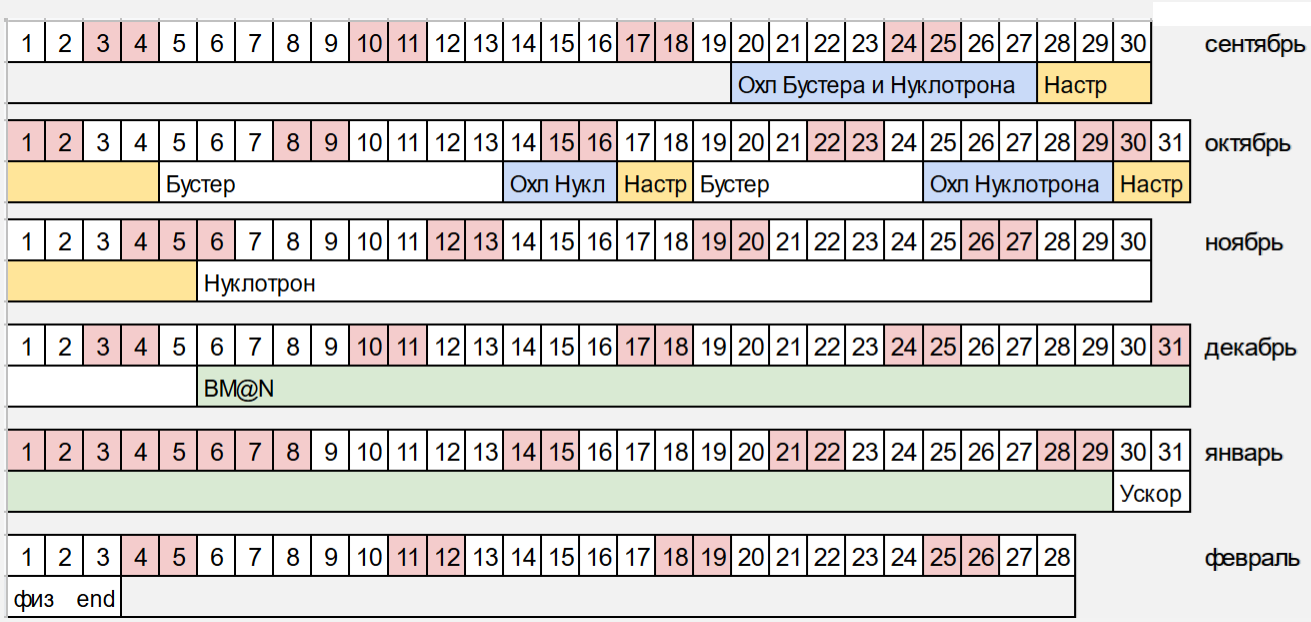
- Common operation of all elements of the heavy ion injection chain, optimization of the beam dynamics, operation of electron cooling
- Test of SOCHI station with heavy ions
- Calibration of the new diagnostic system in the extracted beam line
- Modernization of the vacuum system of the extracted beam lines
- Long-term stable operation for BM@N experiment

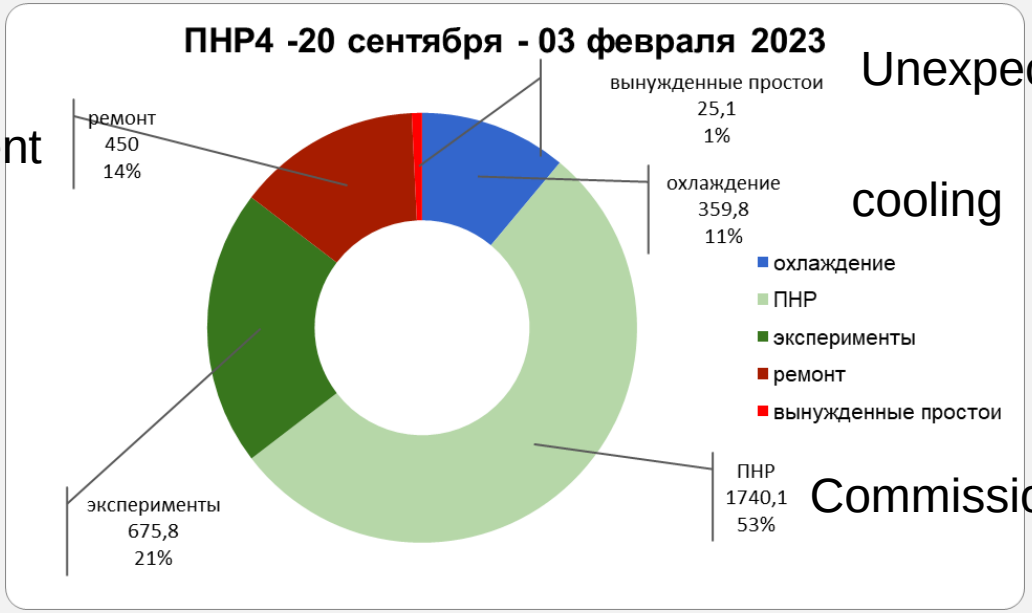
(550 ME at two energies)

- Start of ARIADNA program at the beam dump position
- Becquerel experiment

The timetable of the run (135.5 days)

A.Alfeev,
R.Esaulkov





repairment

Unexpected losses

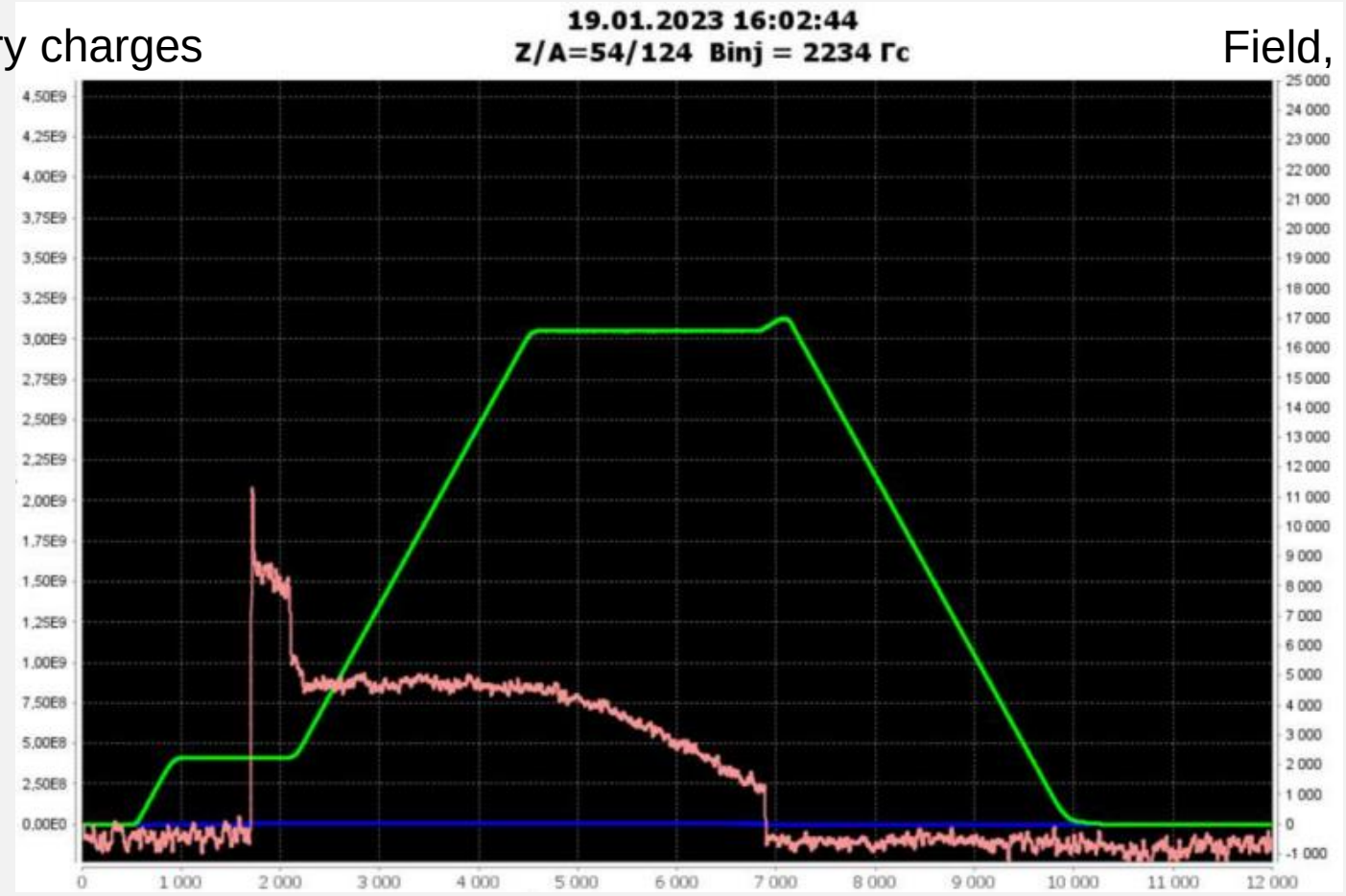
cooling

experiments

Commissioning works

Beam acceleration and slow extraction

Intensity, elementary charges

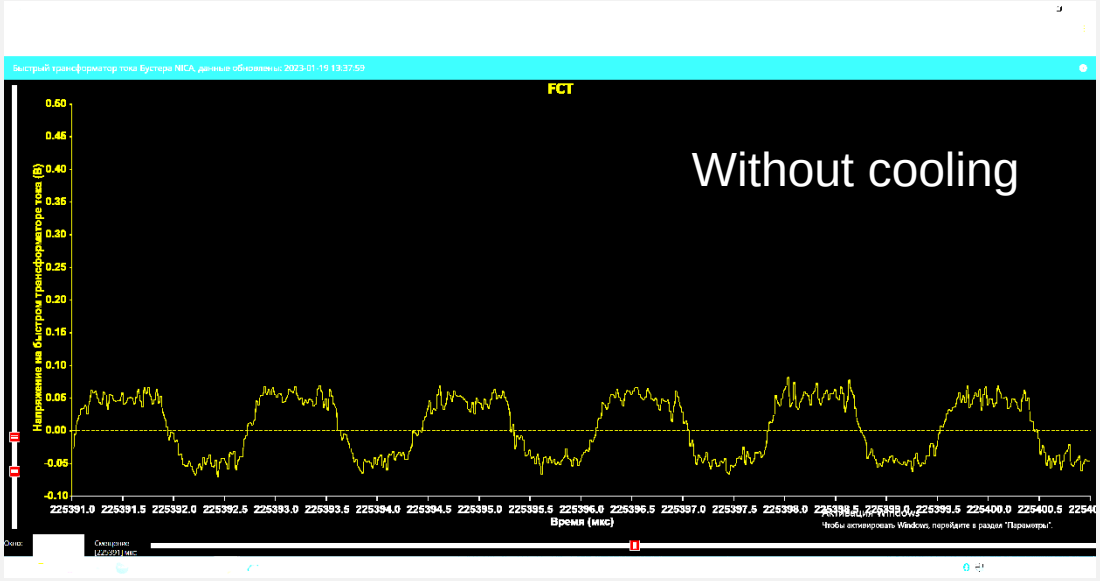


Beam acceleration in the Nuclotron up to 1.65 T magnetic field plateau (about 3.6GeV/u).
Intensity of the accelerated beam up to about $2 \cdot 10^7$ ions.
Extracted beam spill duration up to 2 s (cycle period 12 s).

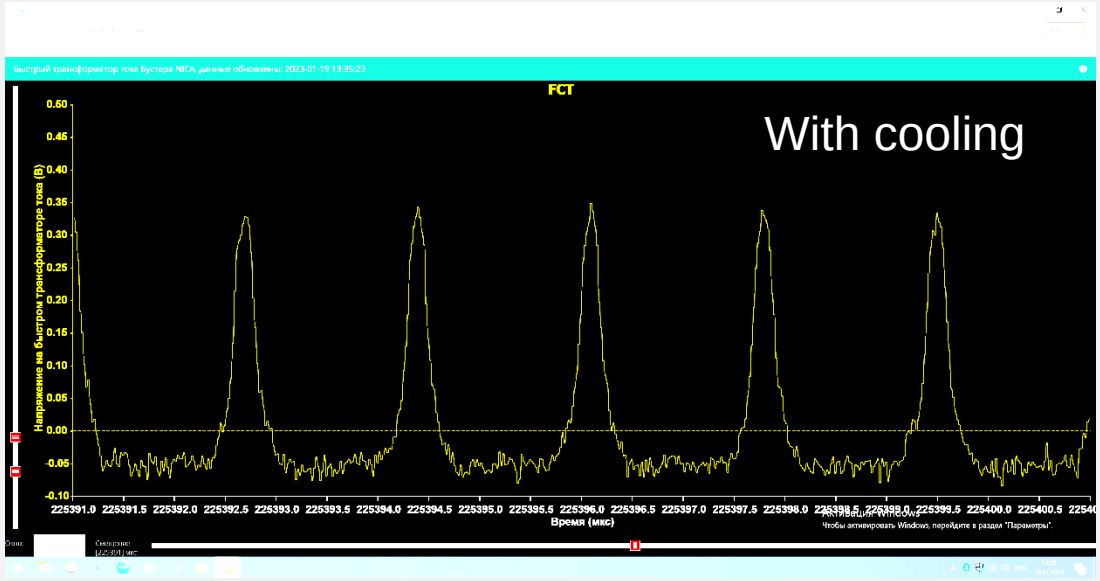
Booster electron cooling

I.Meshkov
A.Sergeev

Longitudinal cooling



Cooling time
~ 100 ms



Bunch length measured with FCT

Accelerator complex NICA: Problems and prospects

27 March – 4 April 2023, climbing camp Tsey

62 participants
36 presentations

Results of technological runs
(malfunctions, repairment, performance limitations)

Status of the current works

Plans for the collider commissioning

Number of Ions through the Accelerator Complex

	Energy [MeV]	Rev. freq. [kHz]	Number of ions [10^6]
Ion source	0.0166	n/a	~100
Booster injection	3.203*	117.6	~50
Booster flat top	203.8*	812.58	~30
Nuclotron injection (1st turn)	201.87*	679.21	~10
Nuclotron extraction	3.896	1169.30	~5

* Measurement is based on the revolution frequency assuming the following circumferences: Booster – 210.96 m (design), Nuclotron – 251.52 m.

Major sources of poor acceleration efficiency (no e-cooling)

- Too long bunch coming out of the ion source (~ x0.6)
- Insufficient RF voltage in Booster (~ x0.7)
- Poor orbit correction through entire machine => small acceptances (~
- Stripping efficiency (~ x0.8)
- Longitudinal emittance growth in Booster acceleration (~ x0.5)
- Insufficient RF voltage in Nuclotron (~ x0.7)

0.6*0.7*0.5*0.8*0.5*0.7=0.059

Program of preparation for nearest beam run

Goal:

to increase intensity by 1-2 orders of magnitude in comparison with Run#4.

- Decrease of the ion source pulse duration down to 4 μs
- Operation of the source and HILAC at 10 Hz
- Storage of 10-20 injection pulses inside the Booster

in the longitudinal phase space with electron cooling

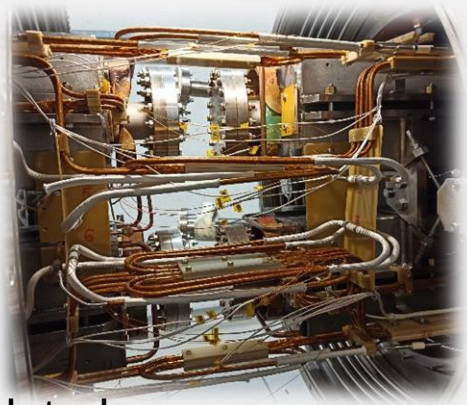
- Orbit correction in both rings and transfer lines
- Adjustment of the acceleration rate

in accordance with RF amplitude

Detailed schedule of the technical and administrative works has been developed

Status of the collider construction

Technological run



Cryo-magnetic system
Cryogenic test of last magnet - August

Assembly of connection has been stopped in May 2022.
Cable communications and water cooling insulation are not completed

Vacuum system

Assembly in progress

Power supply, energy evacuation:
2 sets of sources for both collider rings are manufactured by NPP "LM Inverter" and transferred to VBLHEP, 12 electromechanical energy evacuation switches are manufactured and located at VBLHEP

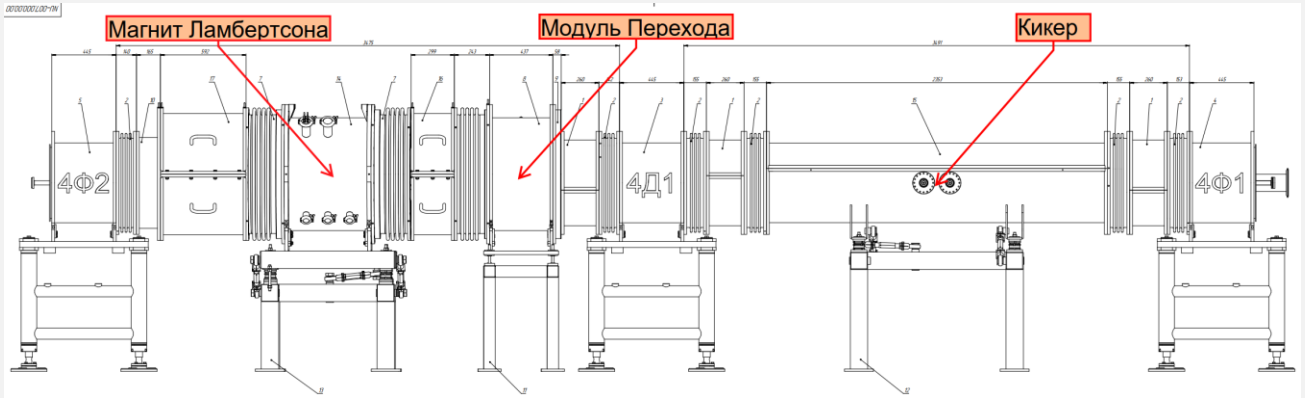
Cryogenic system
Report by N.Agapov

Status of the collider construction

Beam Run

Fast extraction from the Nuclotron

Technical project
is completed
Expected term
of construction June 24



Transfer lines from Nuclotron to Collider

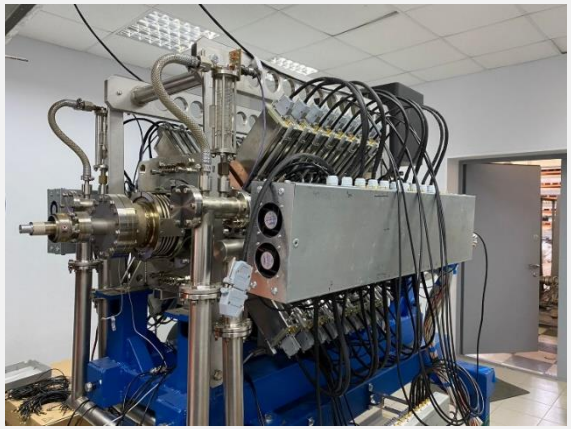
Type	Long dipole	Short dipole	Quad. Q10	Quad.Q15	Steerer
Project	21	6	22	6	33
Delivered	20	5	21	5	0

Designed and partially fabricated –
SigmaPhi (France)

Status of the collider construction

Beam Run

RF system:
RF1 at VBLHEP,
4 cavities of **RF2** at VBLHEP at VBLHEP, 4 cavities under test at BINP
2 cavities of RF3 under test at BINP, other are manufacturing



Electron cooling system:
Since November of 2022 – transportation to JINR

Plans for the collider commissioning

December 2023 – April 2024: technological run

Main limitation –
Completion of engineering infrastructure bld. 17
Commissioning of compressor station

2024: first beam run

- Fast extraction from the Nuclotron
- Assembly of the Nuclotron-Collider beam line

(negotiations with contractor)

- Injection into Collider
- Synchronization system

Thank you for attention