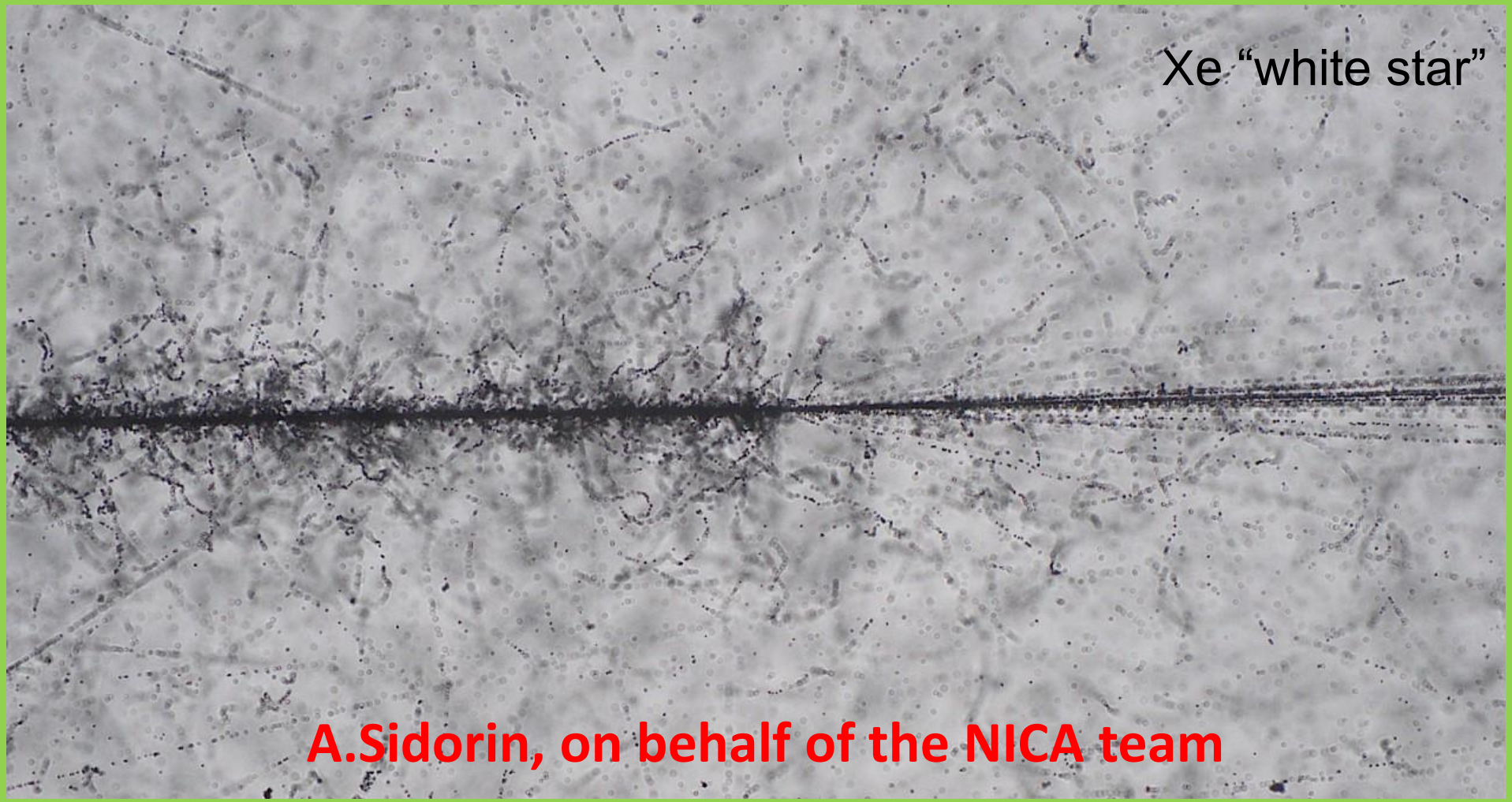
Realization of the Nuclotron-NICA project



A.Sidorin, on behalf of the NICA team

PP PAC, JINR, Dubna, 23 January 2023

Contents

Accelerator complex commissioning:

- Third and Fourth commissioning runs.

Status of the collider construction

Plans

Third run

A.Alfeev

Performed during the period from 2 January to 01 April

Total time of the facility operation was about 2150 h.

Carbon ions from LIS, the maximum beam energy ~ 3 Gev/u

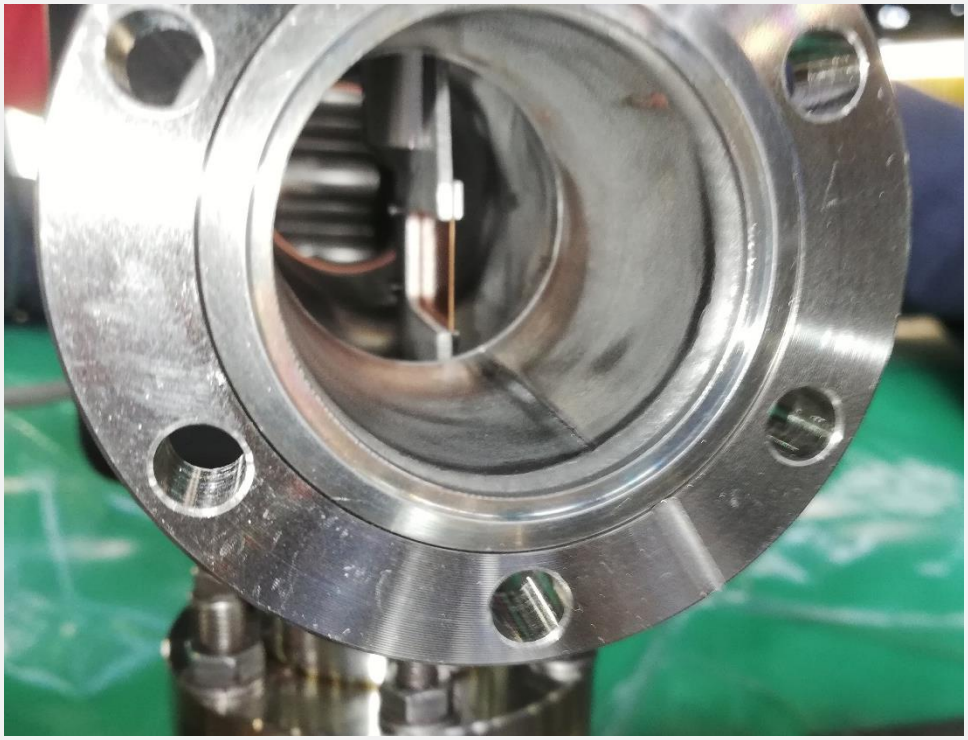
Goals:

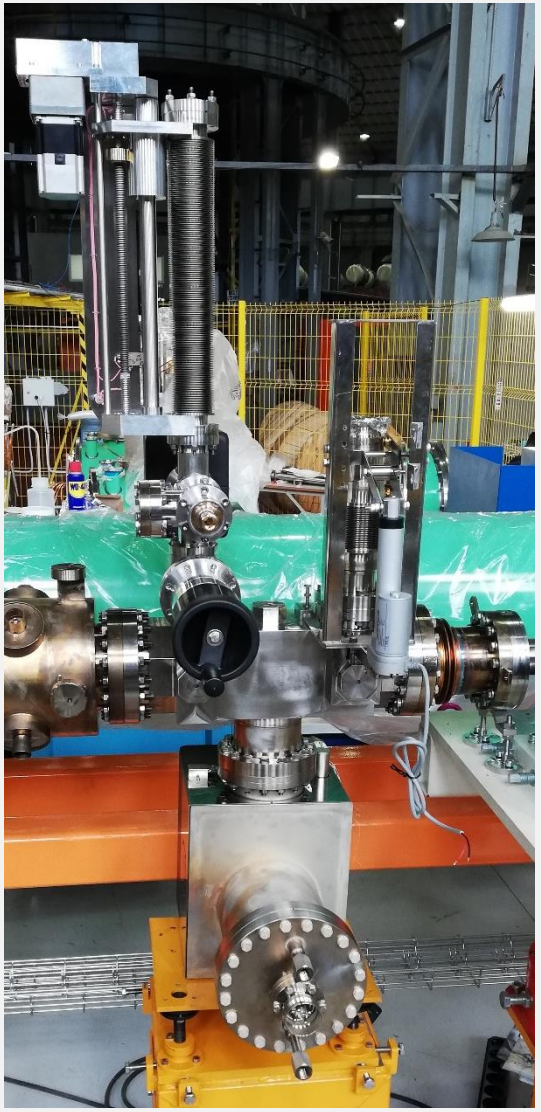
- Cryo-cooling of two rings
- Test of the stripping target
- Injection into the Nuclotron from the Booster
- Test of new power supply system of the extracted beam lines
- Long-term stable operation for SRC experiment

Ion stripping

BINP, A.Tuzikov

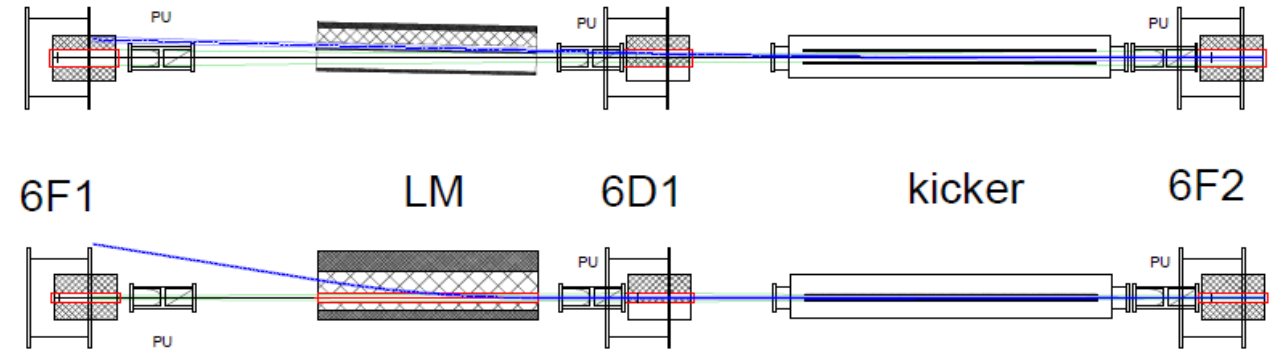
- Three stripping foils, remotely controlled.
- Change of stripping foils without opening vacuum chamber of the stripping station.
- Stripping foils –Cu. Thickness of foils – from 10 to 150 μm.
- Foil aperture 50×70 mm^2.



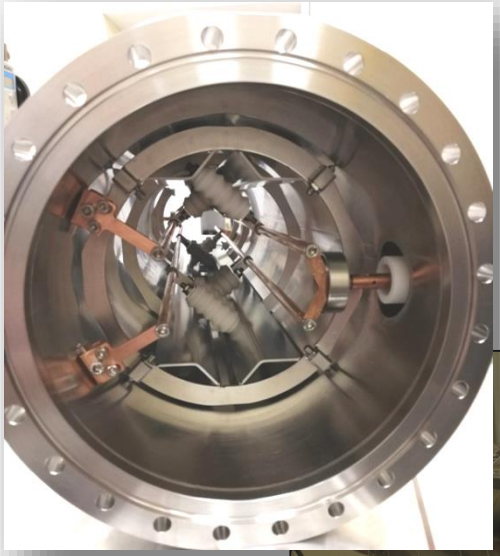


Beam injection into Nuclotron

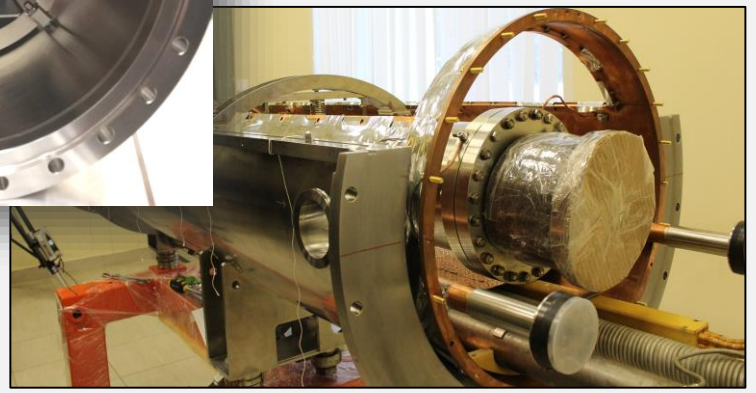
A.Tuzikov, A.Fateev



Lambertson magnet



Four-road kicker



Designed – JINR, fabricated – VST (Belgorod)

Run at LU-20

K.Levterov

Large amount of the new equipment determined a risk of malfunction or unstable work.

To guaranty test of the power supply system of the extracted beam lines and realization of the experimental program,

in parallel with tuning of the injection from the Booster the LU-20 accelerator together with additional lazer source were prepared for carbon acceleration and injection into the Nuclotron avoiding Booster.

Houpfully it was not required during this run.

Power supply for extracted beam lines

V.Karpinsky

To the start of the run, the assembly and test of new power supply system of magnetic elements in the extracted beam lines were completed.
The main features of the power supply system are high indicators for the accuracy of maintaining high current values (current from 600 to 4000 A) at relatively low voltage values (from 75 to 230 V DC).

The system consists of of the following elements:

- 6 kV network switchgear (SG) substation No. 15;
- power transformers 6/0.69kV;
- 0.69 kV network switchgear;
- high precision power supplies;
- switching cabinets;
- cable communications;
- automated control system.

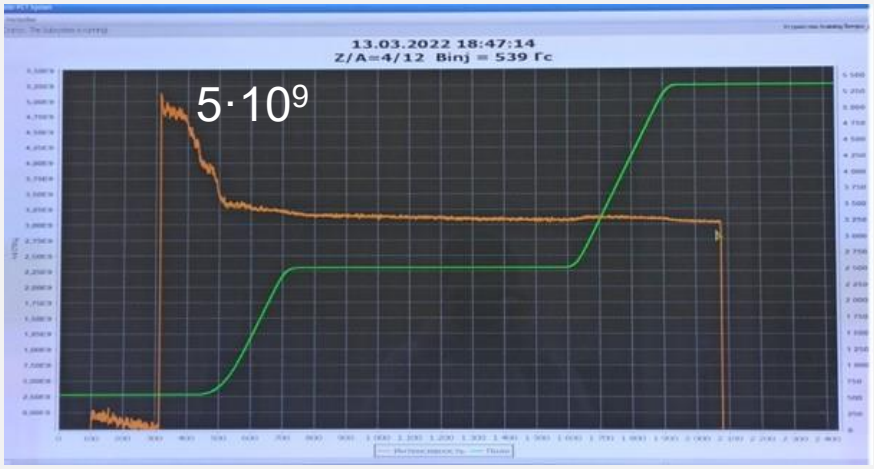
Installation of the power supply units

The stable operation of the complex for SRC experiment was realized during about 24 days.

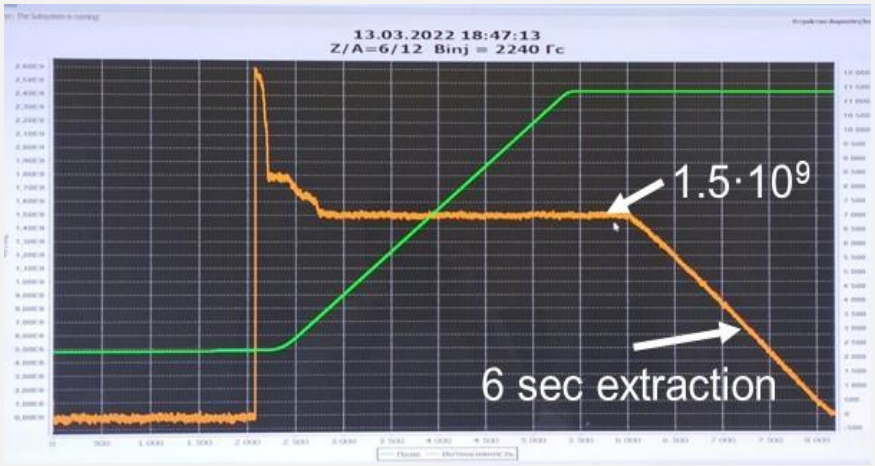
Long term stable operation

AD

Signals from parametric current transformers



Booster



Nuclotron

The achieved transfer efficiency at acceleration
from the ion source to the Nuclotron exit was about 30%

Run at HILAC with KRION source

E.Donets, K.Levterov

28 of April the run at HILAC accelerator was started for optimization of Ar and Xe generation and acceleration

KRION-6T alighment on the high Voltage platform

Fourth run

A.Alfeev

Performed during the period from 20 September 2022 to January 2023

Total time of the facility operation is more than 2000 h.

Ar and Xe beams from KRION, the maximum beam energy ~ 3.6 Gev/u

Goals:

- 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

Test of SOCHI with heavy ions

E.Syresin

In October a test of the SOCHI station with Ar^{12+} was performed.

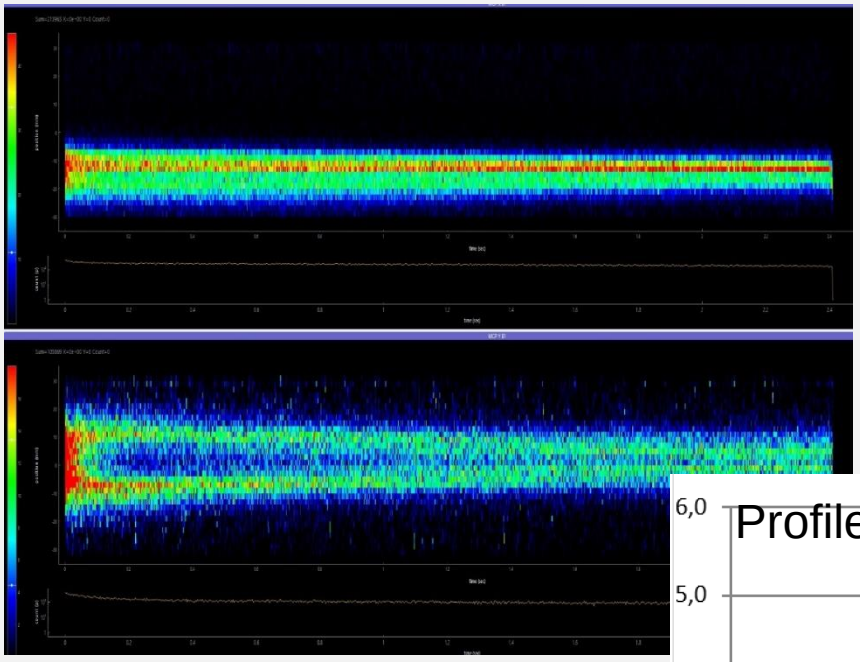
The ion beam at diameter of 100 mm was formed
with homogeneity of dose distribution better than 10%
on the chip size of 20×20 mm.

The microchips XC6SLX16 were irradiated by Ar^{12+} at ion energy 3.2 MeV/n.
The cross section of single event effects (SEE) was $1{,}9\times10^{-2}$ cm^{-2}
at ion fluence of 3.5×10^{4} ion/cm^2.

Booster electron cooling

$^{124}Xe^{28+}$ at injection energy

I.Meshkov
A.Sergeev

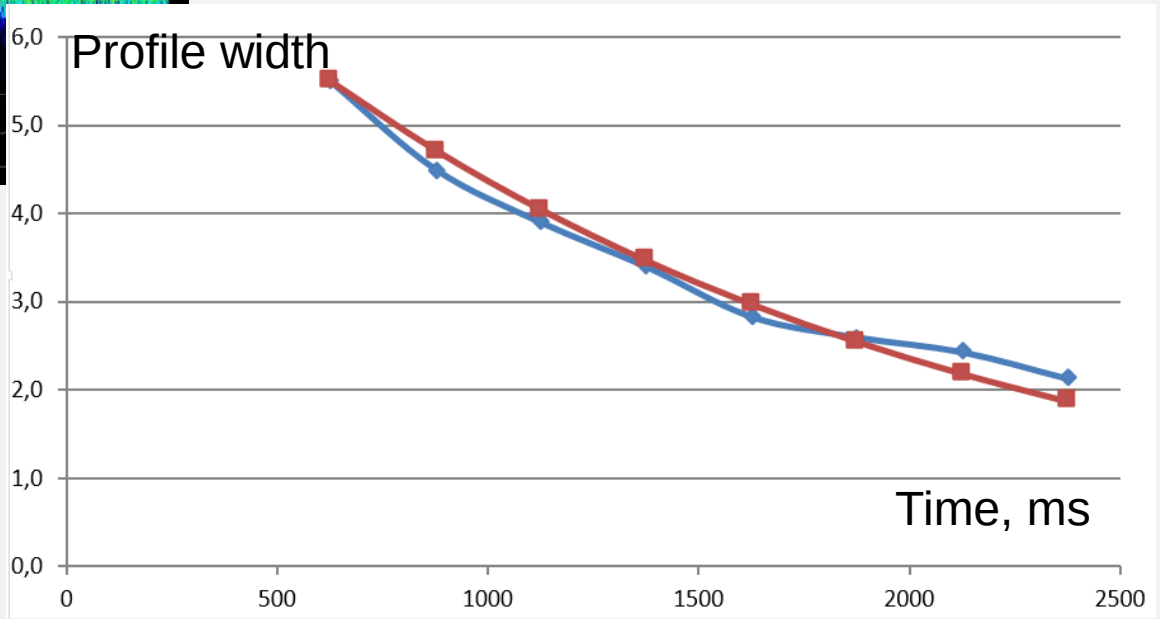


Transverse cooling

Electron energy 1,93 keV
Electron current 150 mA

Signals from
Ionization profile monitors

Dynamics of the cooling process

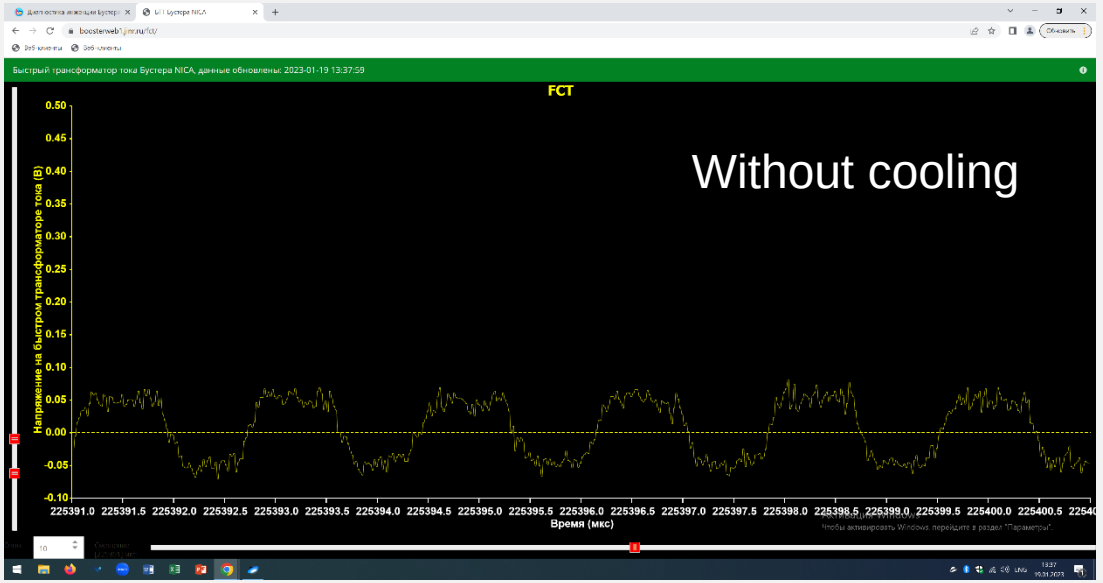


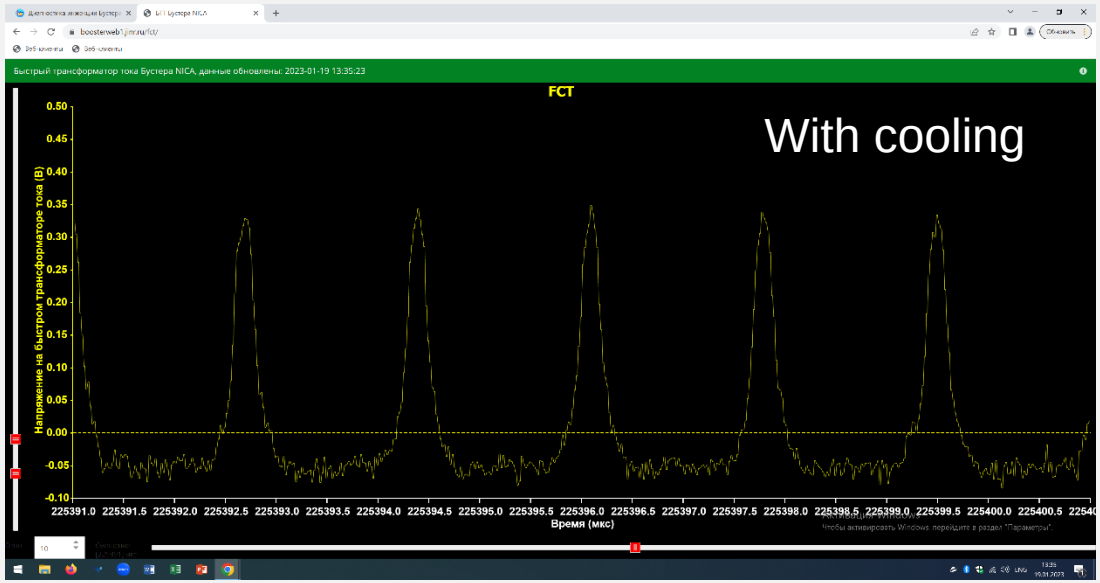
Stable operation of the cooling system during a few shifts

Booster electron cooling

I.Meshkov
A.Sergeev

Longitudinal cooling





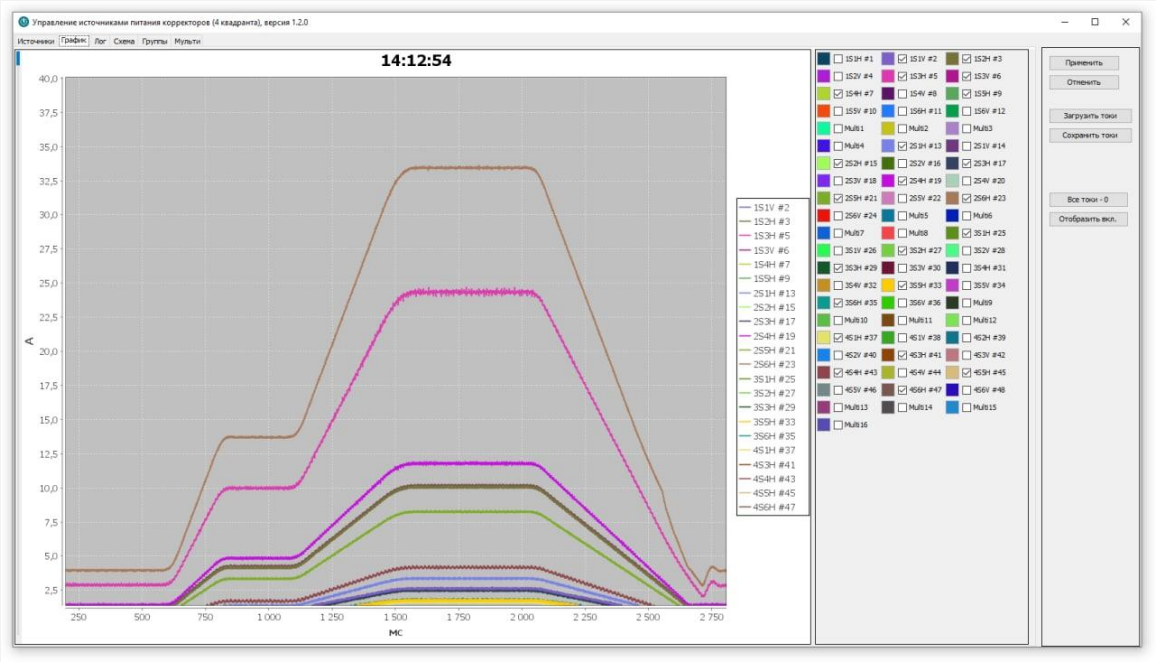
Bunch length measured with FCT

Dynamic orbit correction at Booster

V.Lebedev
M.Shandov

For the stable beam acceleration, optimization of the orbit bump during the beam extraction the dynamic orbit correction is necessary. An experience of the orbit correction is of grate importance for the future collider operation.

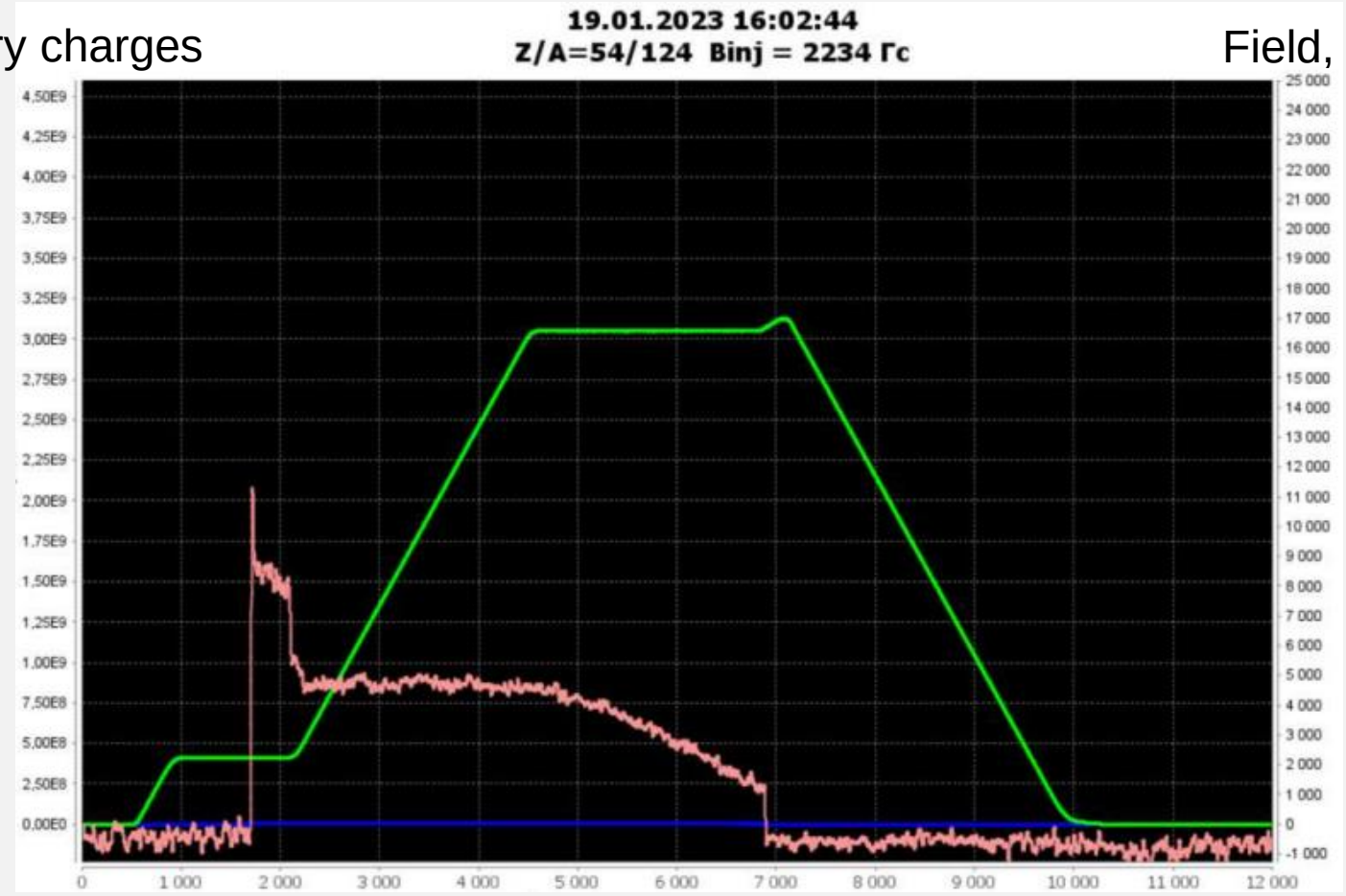
The following works were realized:
- debugging of the corrector power supplies,
- debugging of the corrector power supplies software,
- development of the Tango-device for reading and storage data from 24 BPMs in each planes,
- storage of the BPM data each 100 ms,
-development of the Tango-device for measuring differential orbits in automatic mode.



Cycles of the correctors at Booster

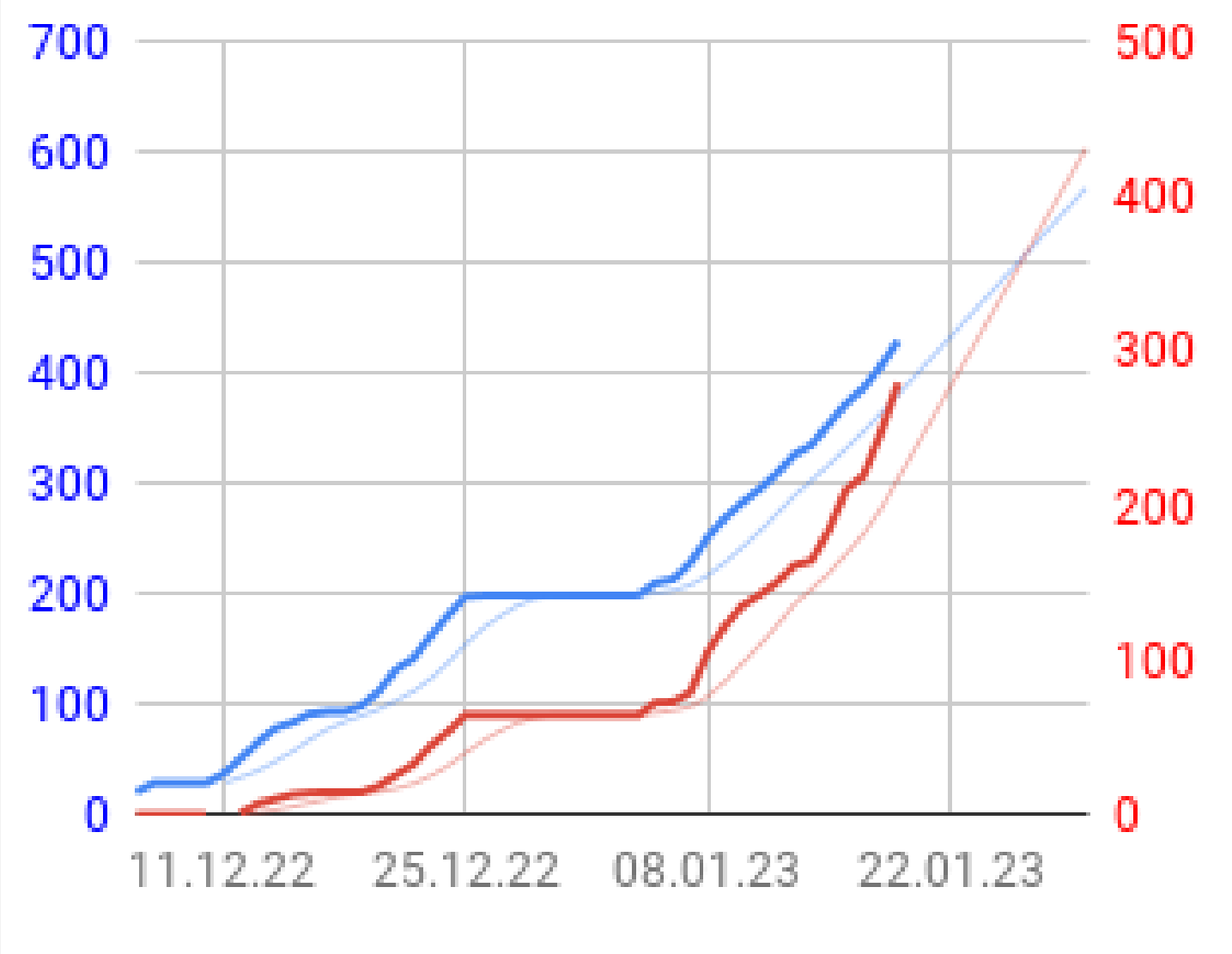
Beam acceleration and slow extraction

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.

BM@N Beam time and counting events



Status of the collider construction

A.Galimov

In June all the collider dipole magnets were installed
and mechanically adjusted in the collider tunnel, connected by pairs each to other.
The assembly of the collider is postponed until completion
of the engineering infrastructure mounting that is expected to the end of May 2023.

The collider ark dipole magnets in the tunnel

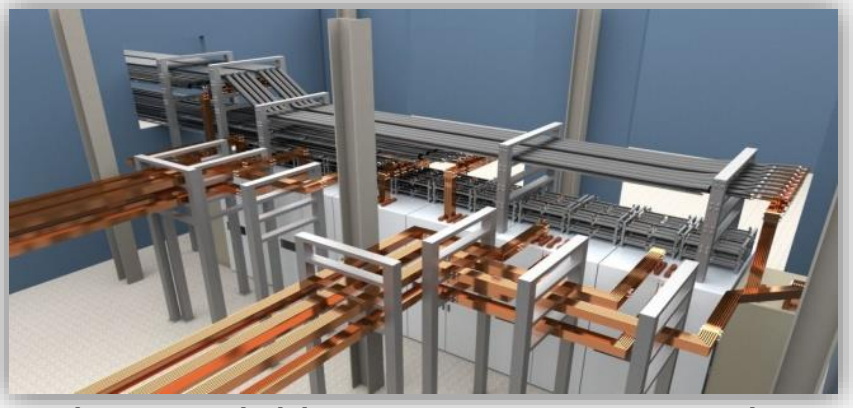
Collider power supply system

V.Karpinsky

Each collider ring has its own power supply system based on 3 main current sources: PIT11-50, PIT01-40, PIT0.6-30.
2 sets of sources for both collider rings are manufactured by NPP "LM Inverter" and transferred to VBLHEP.

PIT 11-50 power supplies

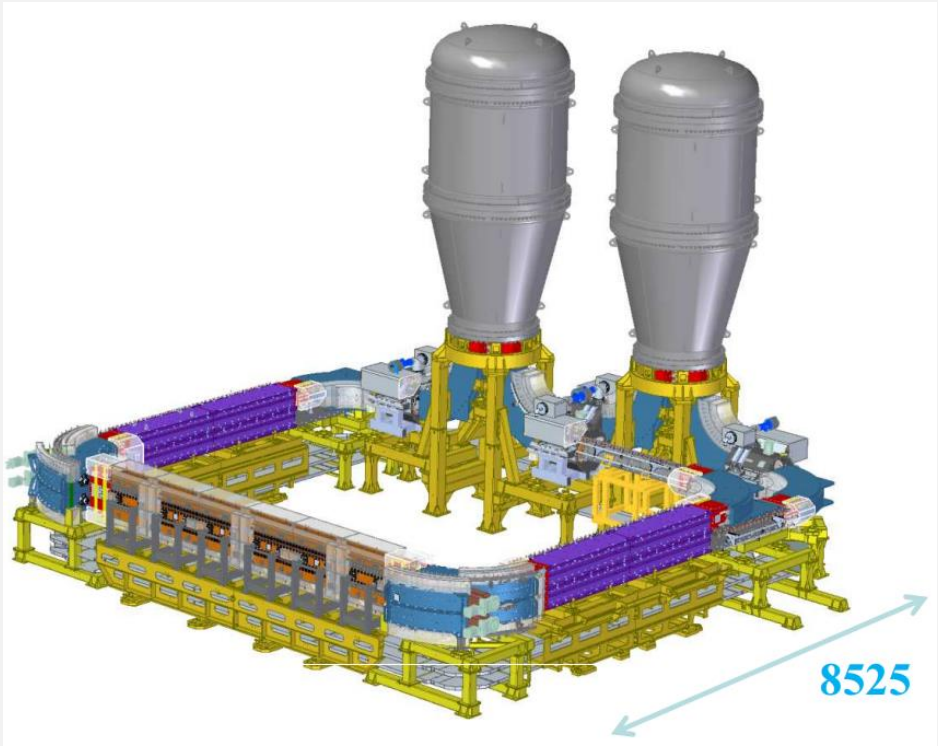
12 electromechanical energy evacuation switches are manufactured and located at VBLHEP



Busbar model in rooms No. 240 and 109/1

Electron cooling system

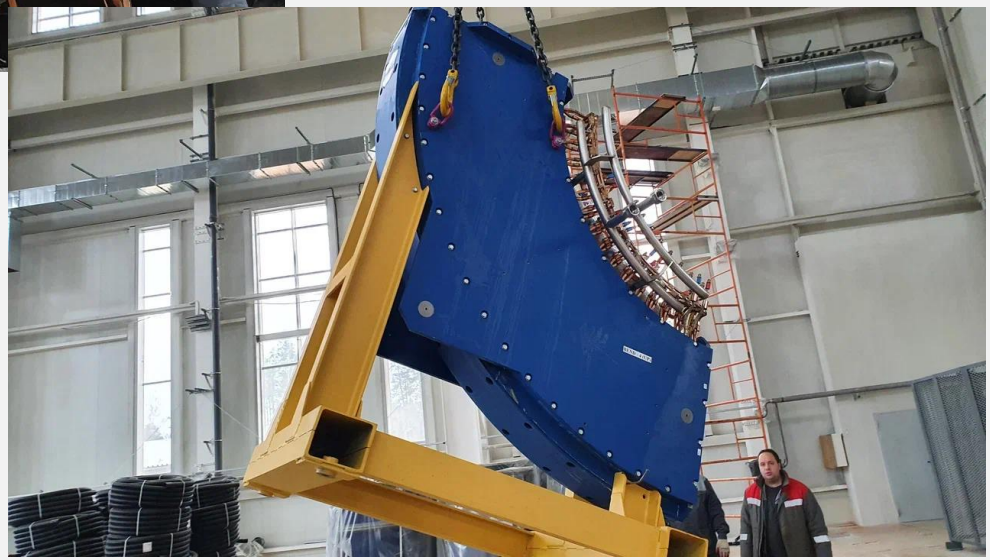
Test assembly of the collider electron cooling system was performed in October at Budker INP



Electron cooling system

I.Meshkov
A.Sergeev

HV vessel



Toroidal solenoid

22 November – start of transportation of the cooler elements to JINR

Plans for the collider commissioning

August – September 2023: technological run

Main limitation –
completion of engineering infrastructure bld. 17

End of 2023 (?): first beam run

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

(negotiations with contractor)

- Injection into Collider
- Synchronization system

Preliminary program of first technological collider run (middle of 2023?)

- Insulating volume and beam pipe vacuum tests
- Test of cryogenic system
- Start of the collider control system
- Test of the main power supply and cycle control system on equivalent load
- Commissioning of thermometry system
- Cooling of the rings
- Commissioning of quench detection system
- Commissioning of energy evacuation system
- Test of the main power supply on superconducting load

Thank you for attention