Progress towards realization of the Nuclotron-NICA project

A.Sidorin, on behalf of the team

PP PAC, JINR, Dubna, 26 June 2017

Contents

- Nuclotron operation
- Preparation for BM@N
- Preparation for the Booster construction
- NICA MAC 22-23 May 2017

Nuclotron operation

- Statistics of run #54
- Machine development:

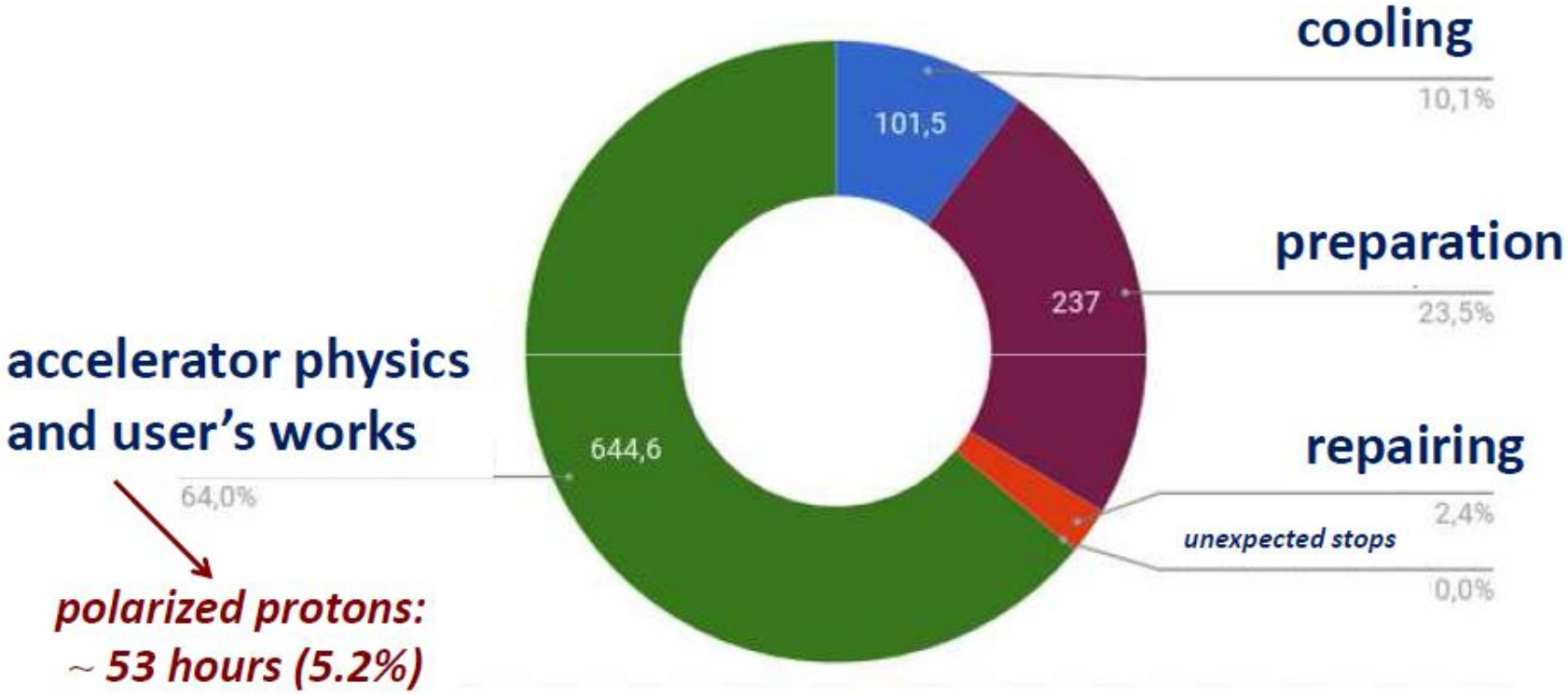
  - adiabatic capture

  - proton acceleration

  - improvement of slow extraction
- Nearest plans

Run #54 10.02 - 24.03.2017

The total run duration: ≈1008 hours

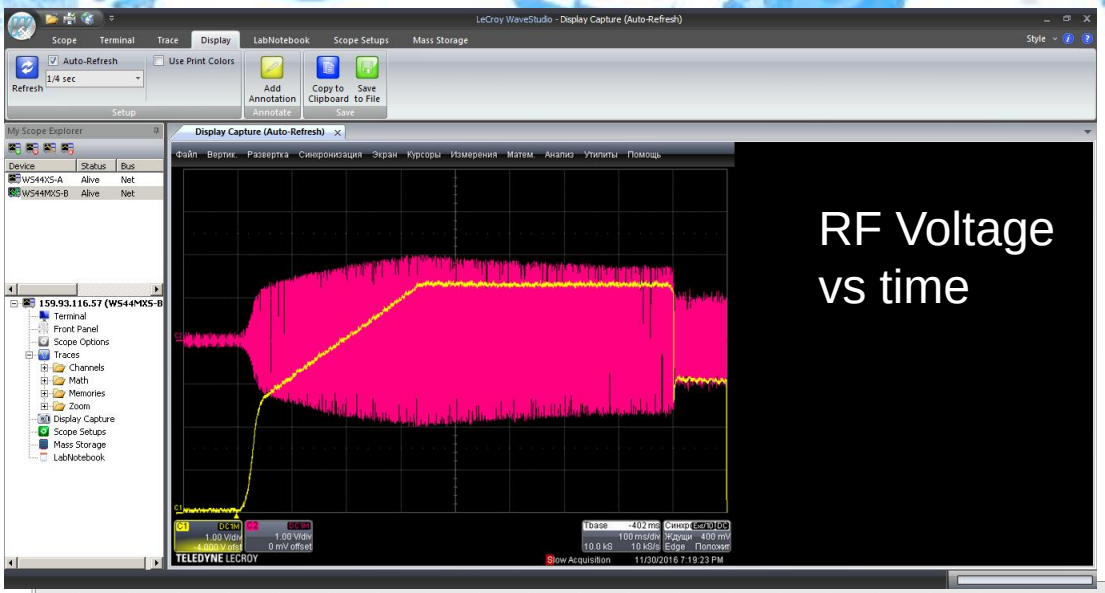


-Acceleration of polarized and unpolarized deuterons and protons from SPI
-Acceleration of carbon and lithium ions from laser source

Maximum extracted beam energy 5.2 GeV/u (1.85 T)

Adiabatic capture

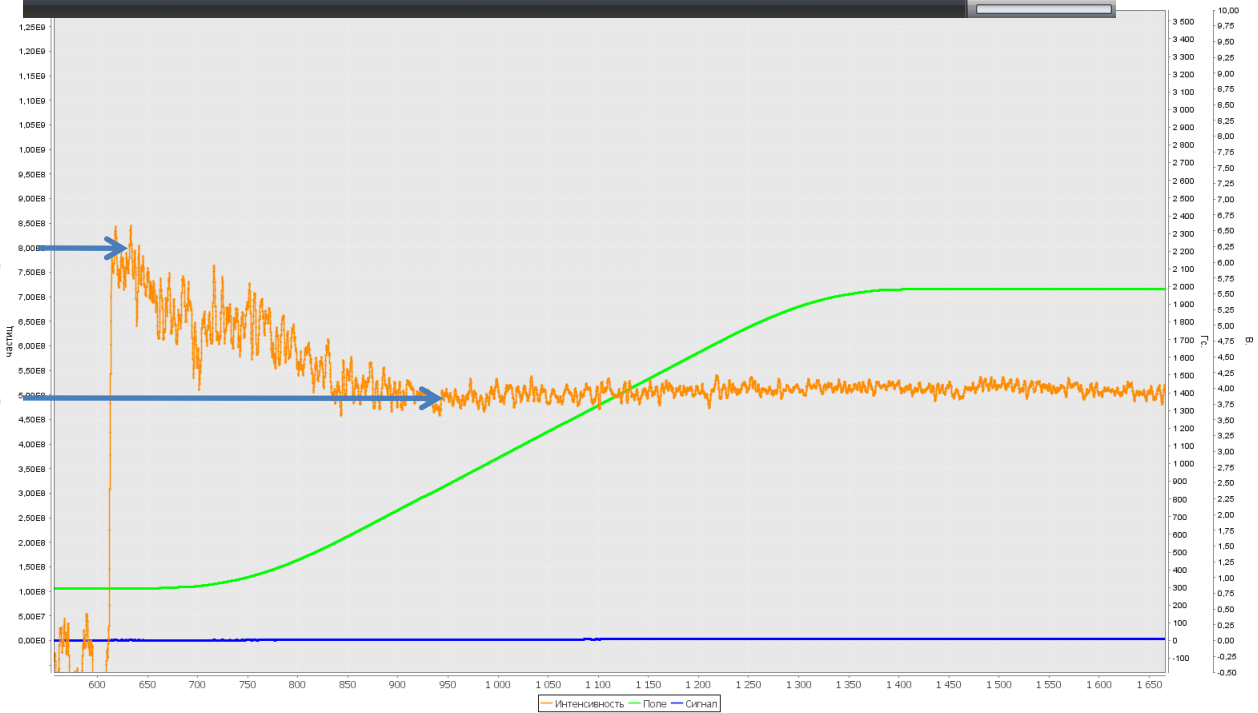
A.Butenko,
V.Slepnev,
O.Brovko,
A Eliseev



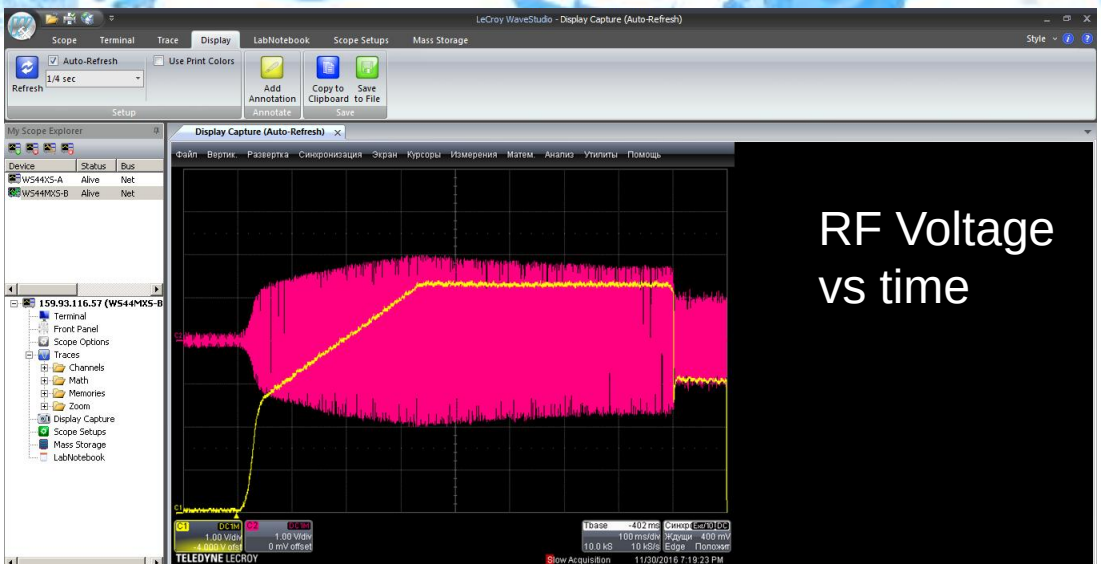
Capture efficiency
up to 70%

8e8

6e8



Adiabatic capture

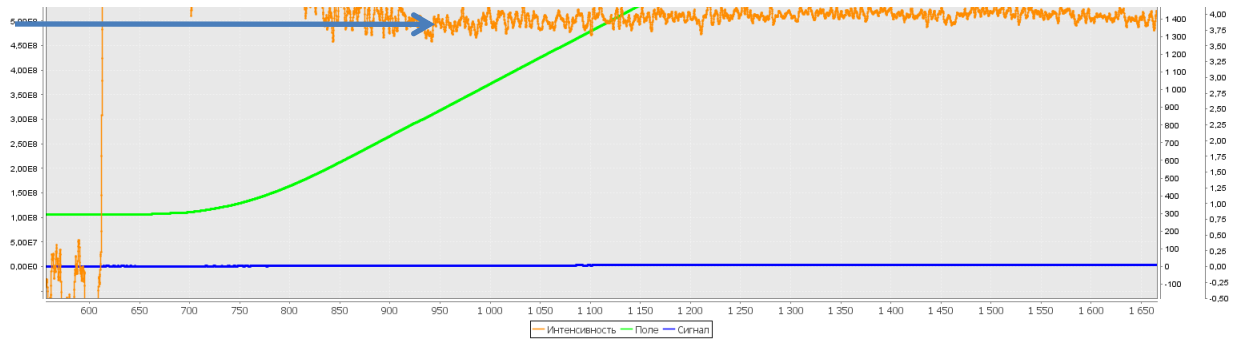


Capture efficiency
up to 70%

Routine operation during run #54 with injection at magnetic field plateau + adiabatic capture

8e8

6e8



Proton acceleration

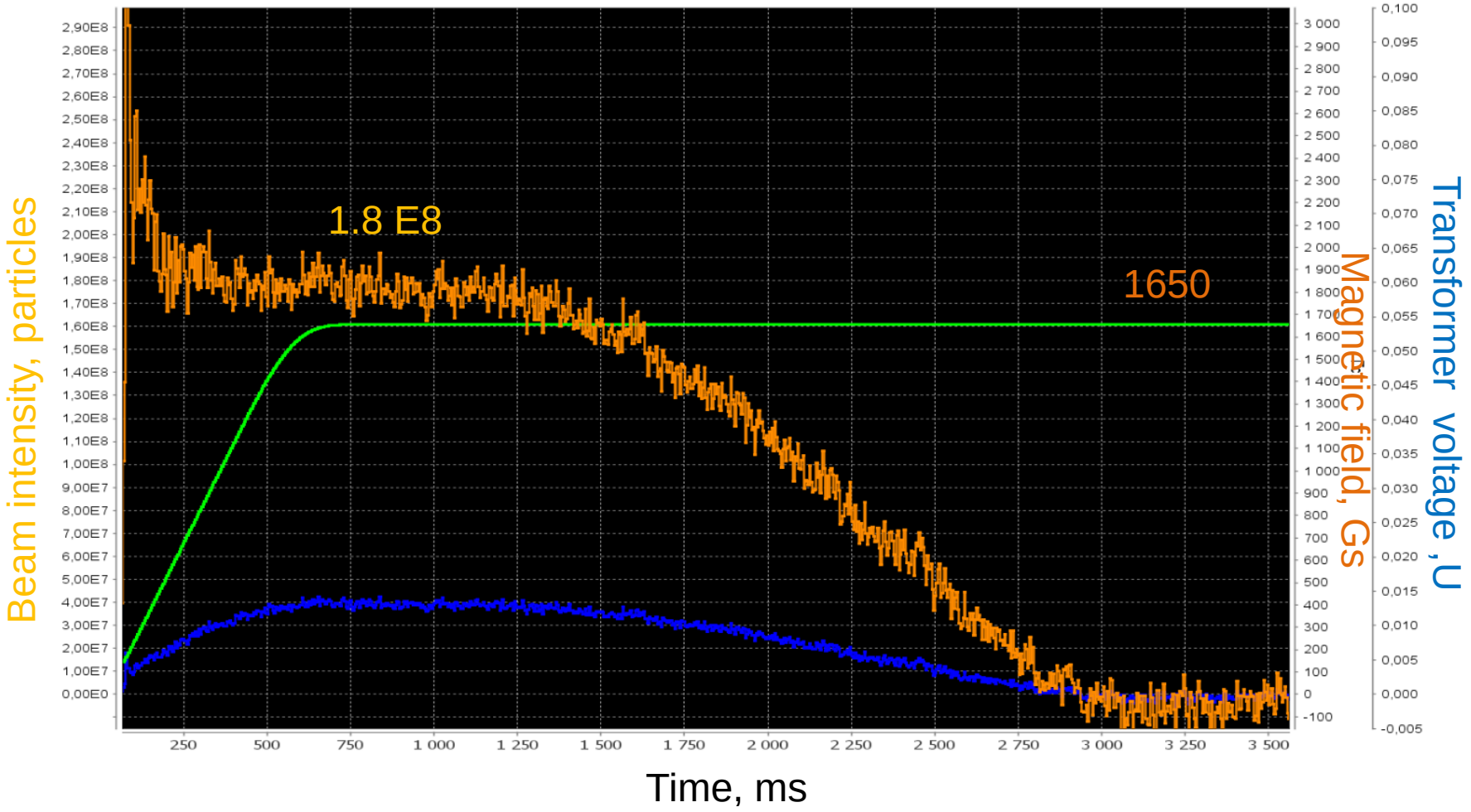
LU-20 was designed for the proton acceleration to 20 MeV
Injection energy of about 625 keV was provided by HV transformer

The deuterons and light ions were accelerated at second harmonics
Injection energy – 156 keV, output energy 5 MeV/u

New RFQ fore-injector provides output energy of 156 keV for all ions:
-the protons can be accelerated in LU-20 at the second harmonics only
-the output proton energy is **5 MeV**
-the Nuclotron magnetic field at injection has to be about **150 G**
(instead of 300 G for other ions)

Because of high importance of the proton program 4 shifts were spent for the tuning of the accelerator complex in the new regime:
-Tuning of LU-20 and injection channel
-Orbit correction at injection
-Working point adjustment
-Tuning of acceleration

Proton acceleration



For acceleration of polarized proton beam a spin-rotator in the LU-20 - Nuclotron transfer channel is necessary

Slow extraction

During the run #47 (March 2013) at the beam extraction at 5 GeV/u insulator of Electrostatic septum of the slow extraction system was broken due to HV discharge

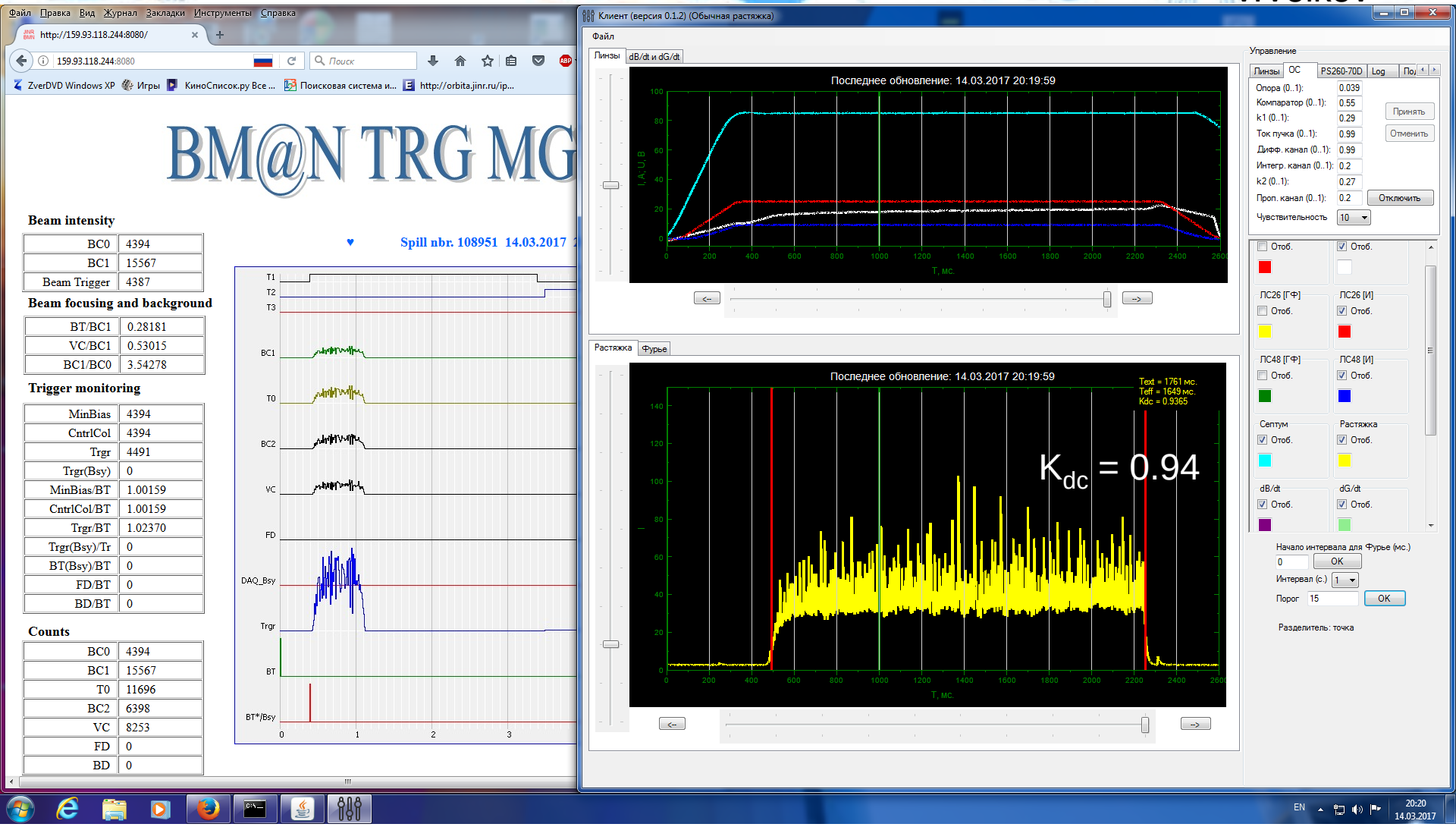
The first runs after installation of new insulator
the Voltage was limited at the level of about **120 kV**
(the good efficiency of the extraction was provided
up to energy of about 3 GeV/u only)

From June 2016 to March 2017 **three** Nuclotron runs were performed
at total duration more than **3000 h**

Intensive training of the Electrostatic Septum permitted to increase
Voltage up to **150 kV**
(for the beam extraction at maximum design energy one needs 160 kV)

Slow extraction

V.Volkov



Run #54, carbon ions, **5.2 GeV/u**, V_{ESS} = 145 kV

Nearest plans

2017:

Run #55: October – December
KRION source: C, Ar^{16+} and Kr^{26+}

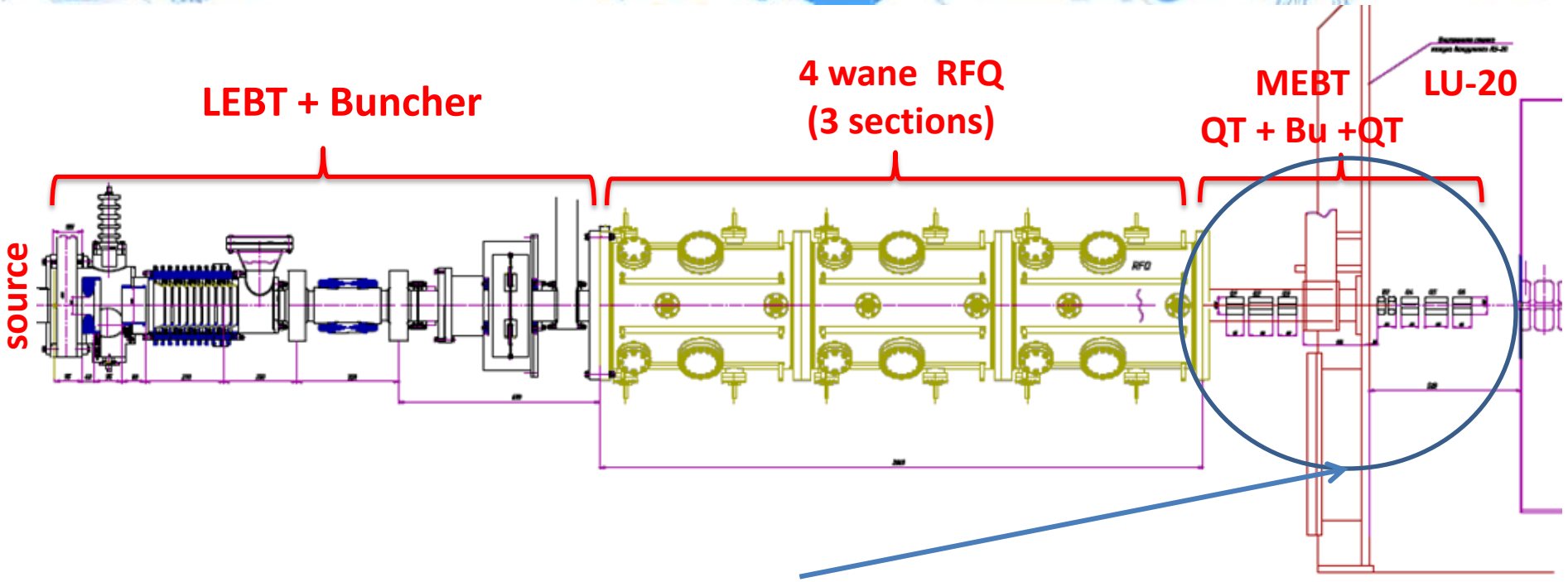
Due to importance of the physical program we plan to prolong the Nuclotron operation

2018:

February-March
Laser source: d, Li, C

After completion: **start of the Booster assembly**

Preparation for BM@N



The MEBT includes two triplets of quadrupole lenses and Buncher

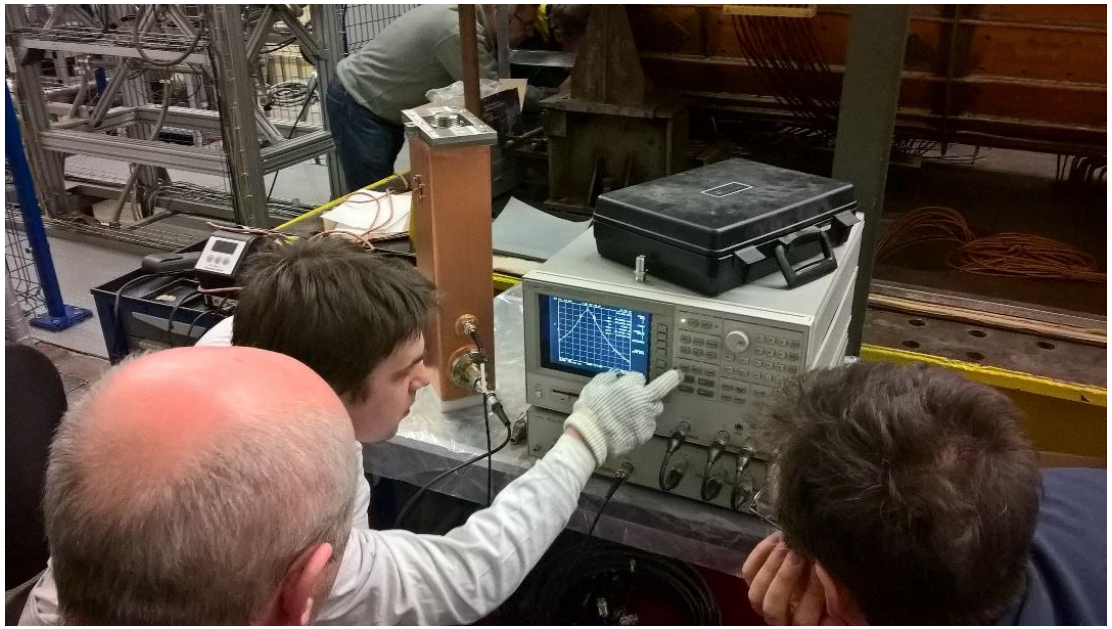
At the first stage the Buncher was absent
(Theory transmission ~ 20%, achieved up to 10%)

The buncher is prepared to the run #55:
Expected gain in transmission is about 3 times

Preparation for BM@N

ITEP,
Chernogolovka,
A.Butenko,
A.Govorov

Buncher tuning and installation (April 2017)



Presently: LU-20 run with the laser source – tuning of the injection chain

The Booster electron cooling system

V.Parkhomchuk,
A.Smirnov,
LEPTA team

Shipment from Novosibirsk

Assembly in Dubna

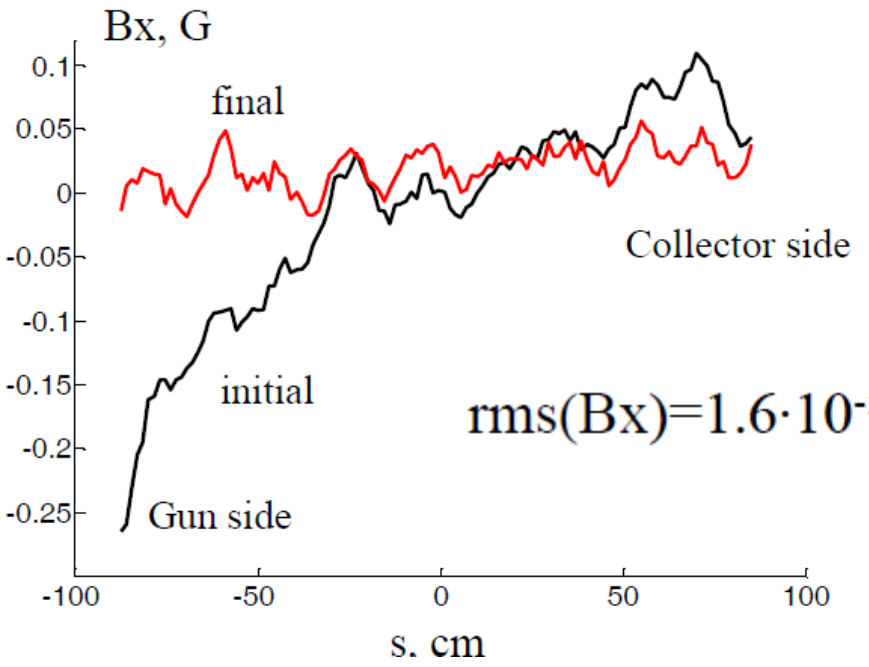
April 2017

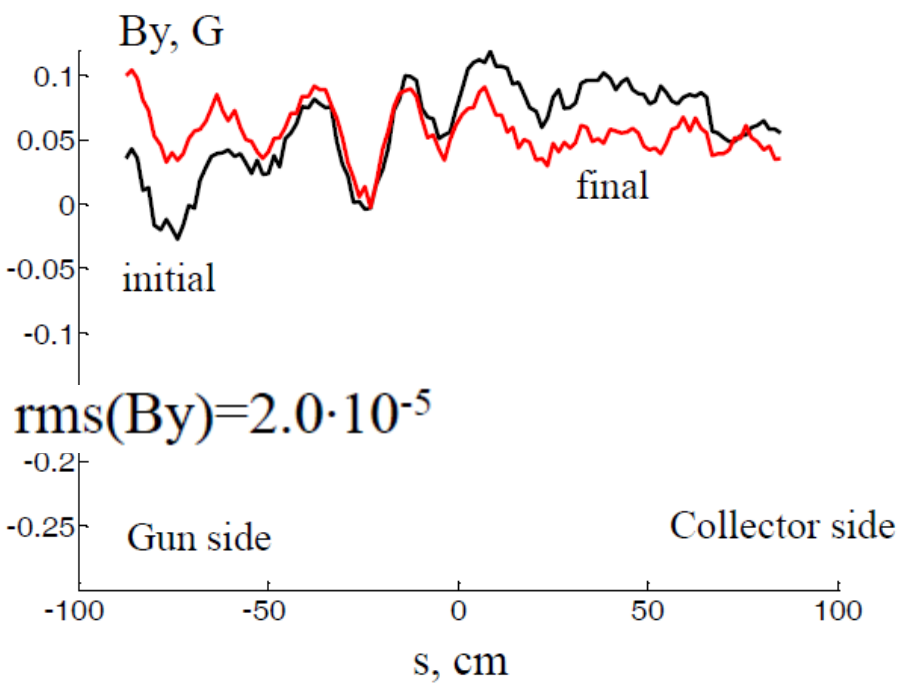
The Booster electron cooling system

Tuning of the main solenoid, May 2017

The Booster electron cooling system

Magnetic field quality **at B = 1 kG**





$rms(Bx)=1.6\cdot10^{-5}$, $rms(By)=2.0\cdot10^{-5}$

Presently:
Assembly of vacuum system, preparation for baking procedure
Assembly of HV system

Progress in the NICA development

NICA Machine Advisory Committee at JINR (Dubna)
May 22-23, 2017

From Resume of the NICA Machine Advisory Committee

Considerable progress in the NICA project has been achieved since the previous MAC meeting in October 2015.

The MAC highly appreciates
the official start of the collider civil construction,
the results of the operation of the source of polarized ions (SPI) and the new RFQ foreinjector in two Nuclotron runs.

The MAC congratulates the NICA team for commissioning of the new heavy ion linear accelerator (HILac),
and the facility for superconducting magnet assembly and cryogenic tests.

Nuclotron

The status of the Nuclotron corresponds to the requirements of the routine operation necessary for NICA.
Some optimization of the acceleration efficiency and the performance of slow extraction for the BM@N experiment have shown promising results, while ***an improvement of the spill structure of the extracted beam is still necessary.***

Booster

A preparation for the Booster synchrotron construction is progressing reasonably well.
However, ***the delay in the delivery of the beam pipes, the beam position monitors and the coils of corrector magnets challenge the project schedule***.

The proposed schedule looks very ambitious.
The realization will strongly depend on available human resources.
The presented estimate of the needed man-power for the assembly of Booster and injection complex looks quite low.

Collider

Since the last meeting the progress is good,
but ***the lattice design is not completed yet.***

The status of stochastic cooling design is behind other systems.
Significant efforts are required to catch up and to move it to the level required by the project.

For the moment there are many open questions in the concept of the NICA operation with polarized beams.
The proposed system based on spin-rotating solenoids looks adequate, but ***a realistic scenario of the accelerator complex operation was not presented and the possibility to achieve the proposed high luminosity is an open issue.***

MAC advises to establish a special scientific group to deeply investigate the spin dynamics (including the spin tracking) as well as the strategy to obtain the designed high luminosity.

MAC suggests that the MAC meetings should be organized not less than once per year.

In addition, it will be fruitful to organize workshops on the dedicated issues of the NICA project, *e.g. on* the beam dynamics concerning the NICA collider.

Two meetings of the NICA group were provided 20.06 and 23.06

I.Meshkov

All critical notes and recommendations by MAC have been analyzed in details.

“The NICA Tasks” for the nearest future have been formulated with the list of responsible persons and external experts.

Thank you for attention