



JINR Association of Young Scientists and Specialists
Conference "Alushta-2025"

Students contribution to the development of NICA Injector facilities

Ponkin Dmitry

LHEP JINR lead engineer

on behalf of the NICA acceleration division

Alushta, 08 - 15 June 2025

20 STUDENTS

tasks, practices, diploma work

FIELD OF WORK

electronics, software, mechanics

PERIOD

2018 - 2025

COUNTRIES

Russia, Belarus, Poland,
South Africa, Kazakhstan

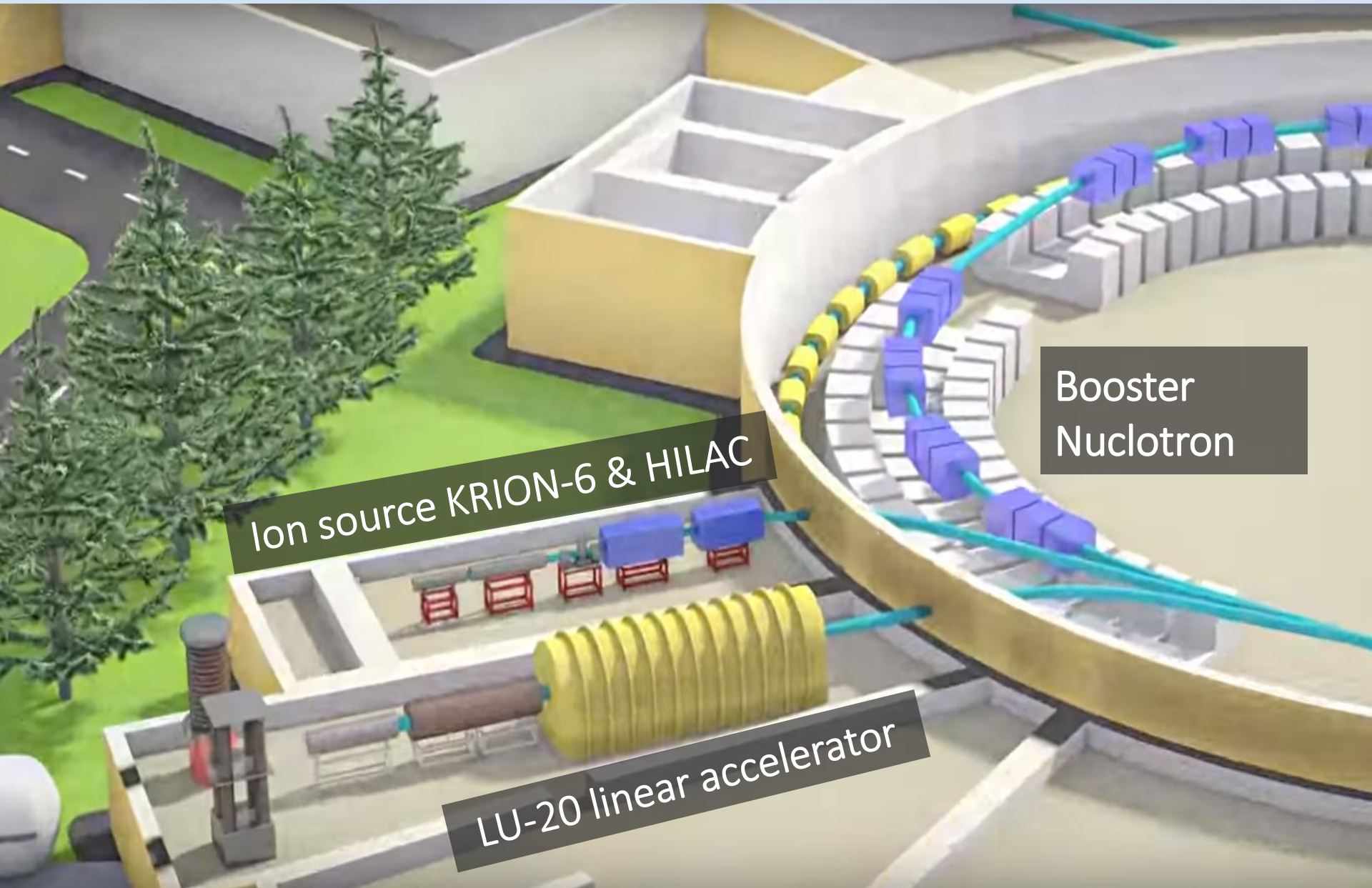
RESULTS

15 diploma work

~ 15 publications

3 PhD thesis

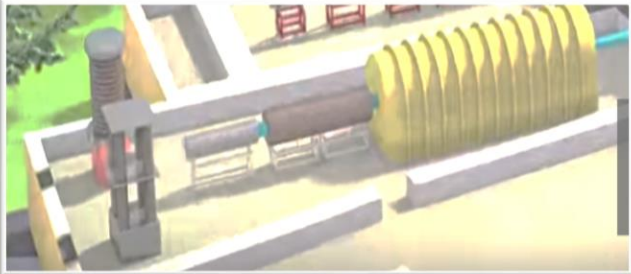
NICA injector complex



Ion source KRION-6 & HILAC

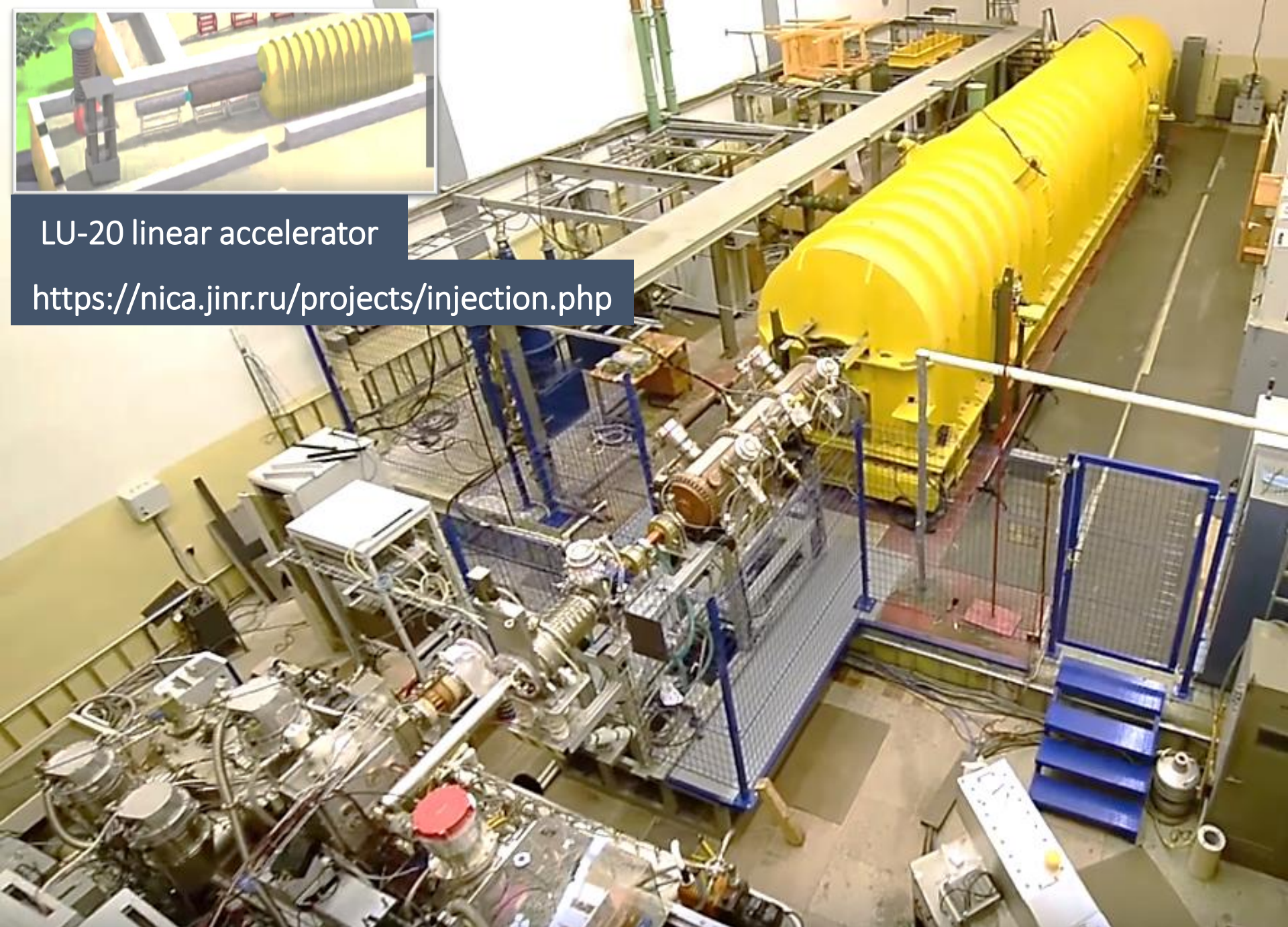
Booster
Nuclotron

LU-20 linear accelerator

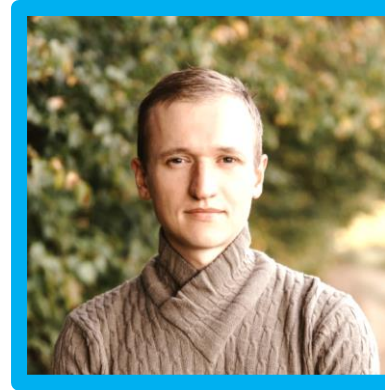


LU-20 linear accelerator

<https://nica.jinr.ru/projects/injection.php>



TEMPERATURE MEASUREMENT MODULE IN THE COOLING SYSTEM OF QUADRUPOLE LENSES OF THE LU-20 LINEAR ACCELERATOR



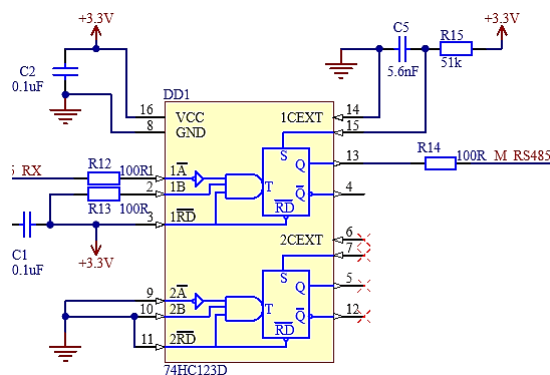
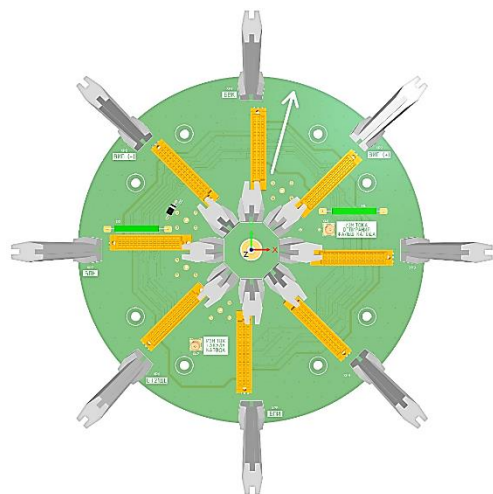
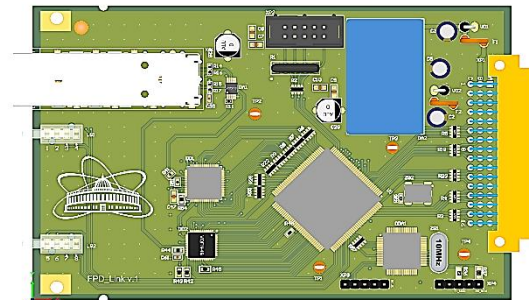
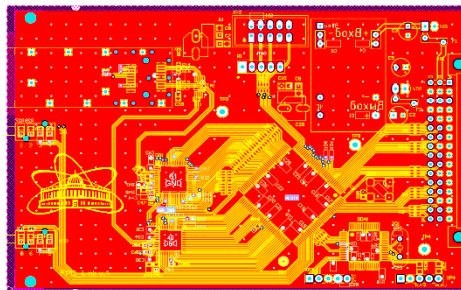
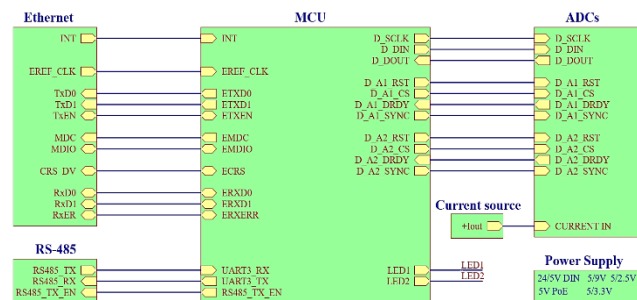
M. Shitenkov

2015

the task was set to replace the outdated equipment for monitoring the temperature of the coolant.



Design process



```

269
270
271 void task_KORAD(void *pvParameters)
272 {
273     KORAD_params KORADp, KORADtemp;
274     KORAD_state *src_state, src_stateTEMP;
275     unsigned int V2set = 0, I2set = 0;
276     unsigned int State2set = 0;
277
278     while(1)
279     {
280         // set voltage level if queue not empty
281         if(uxQueueMessagesWaiting(KORAD_SetV_q) > 0)
282         {
283             xQueueReceive(KORAD_SetV_q, (void*)&V2set, (TickType_t)0);
284             KORAD_SetVoltage(V2set);
285         }
286
287         // set current value if queue not empty
288         if(uxQueueMessagesWaiting(KORAD_SetI_q) > 0)
289         {
290             xQueueReceive(KORAD_SetI_q, (void*)&I2set, (TickType_t)0);
291             KORAD_SetCurrent(I2set);
292         }
293
294         // set output state if queue not empty
295         if(uxQueueMessagesWaiting(KORAD_SetState_q) > 0)
296         {
297             xQueueReceive(KORAD_SetState_q, &State2set, (TickType_t)0);
298             KORAD_SetState(State2set);
299         }
300
301         // read measured V I, and V I sets
302         KORADp.meas_v = KORAD_GetVoltage();
303         KORADp.set_v = KORAD_GetVSets();
304         KORADp.meas_i = KORAD_GetCurrent();
305         KORADp.set_i = KORAD_GetISets();
306
307     }
308 }
    
```



Modbus Poll - Generator-1.mbp

File Edit Connection Setup Functions Display View Window Help

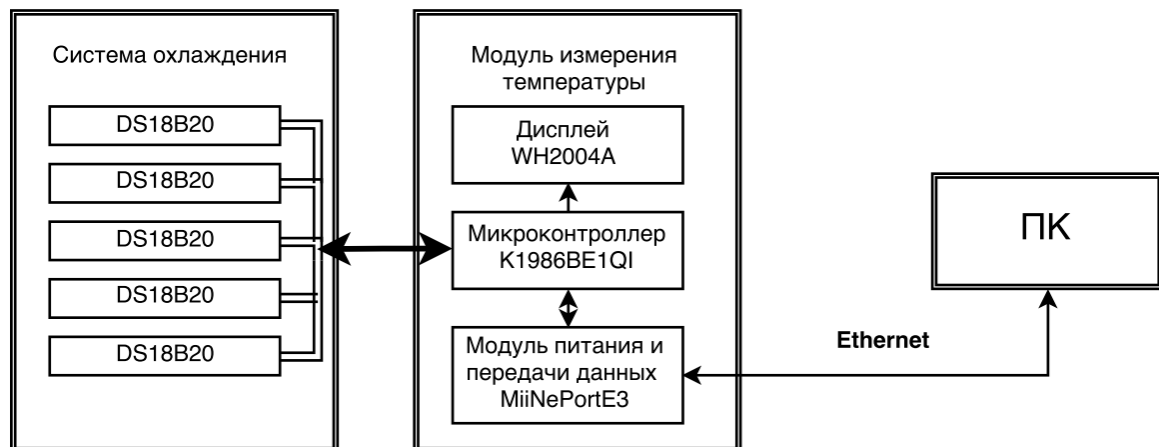
05 06 15 16 17 22 23 TC

Tx = 350 Err = 0 ID = 1 F = 03 SR = 1000r

Name	00000
U-1.11.2[V]	400
U-1.21.3[V]	398
U-1.31.1[V]	401
P[W]	0
P[W]	571
SW[A]	590
Oil Pressure	4
Temperature	87
Config	(t) 0x4549

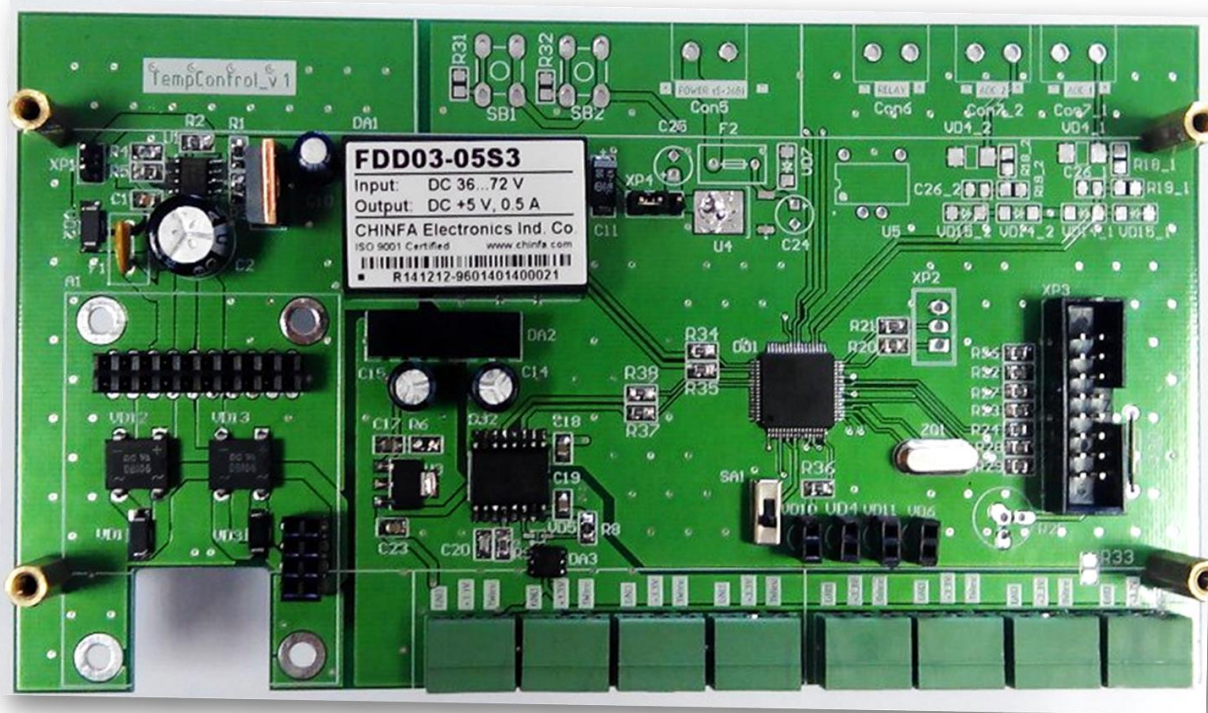
Tx = 334 Err = 0 ID = 2 F = 03 SR = 1000n

Name	00000
U-1.11.2[V]	401
U-1.21.3[V]	400
U-1.31.1[V]	399
P[W]	0
P[W]	547
SW[A]	571
Oil Pressure	4
Temperature	91
Config	(AB) 0x4142

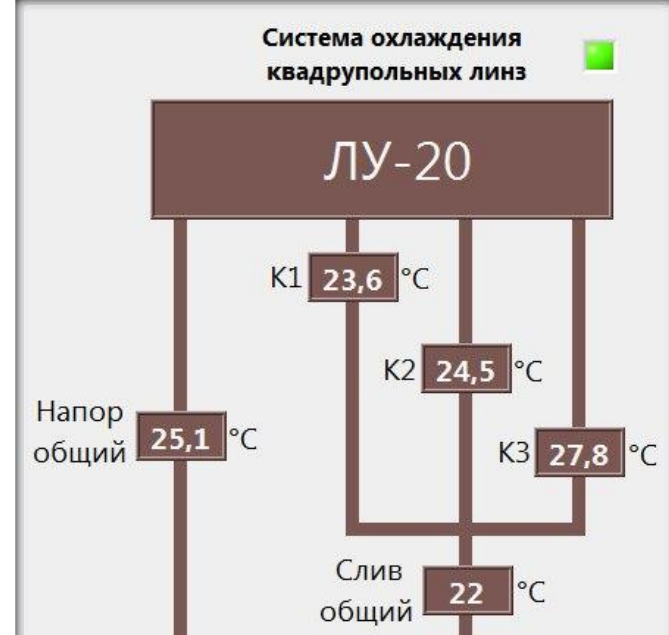


Bach. diploma:

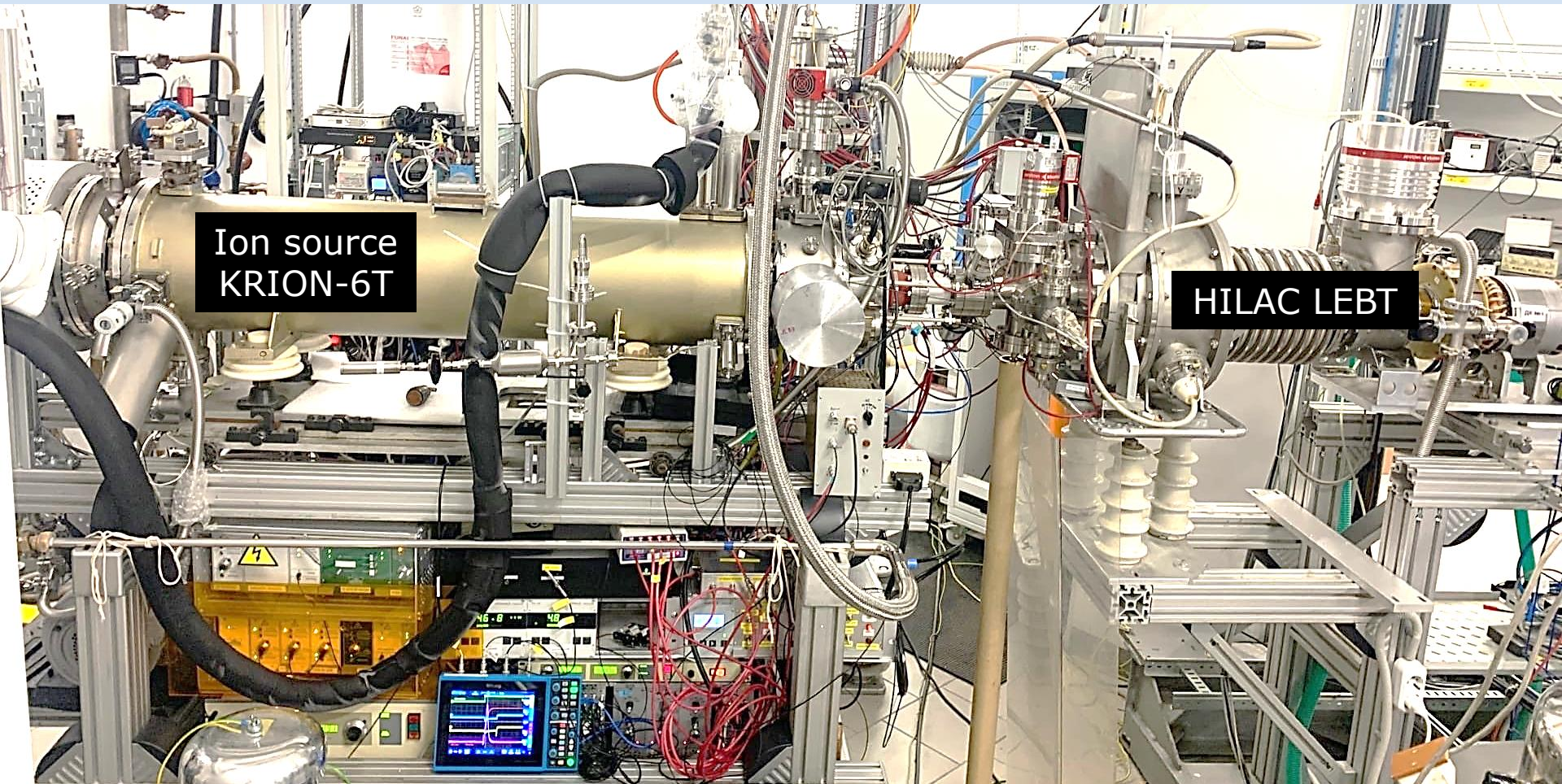
- structural schematic
- mechanics design
- hardware design
- firmware design
- Installation,
- assembly
- testing







Heavy ion source KRION 6T



Ions produced and injected: $^{78}\text{Kr}^{17+}$ $^{124}\text{Xe}^{41+}$ $^{40}\text{Ar}^{16+}$ $^{12}\text{C}^{6+}$...

- 5.4 T SC solenoid
- electron string
- highly charged ions

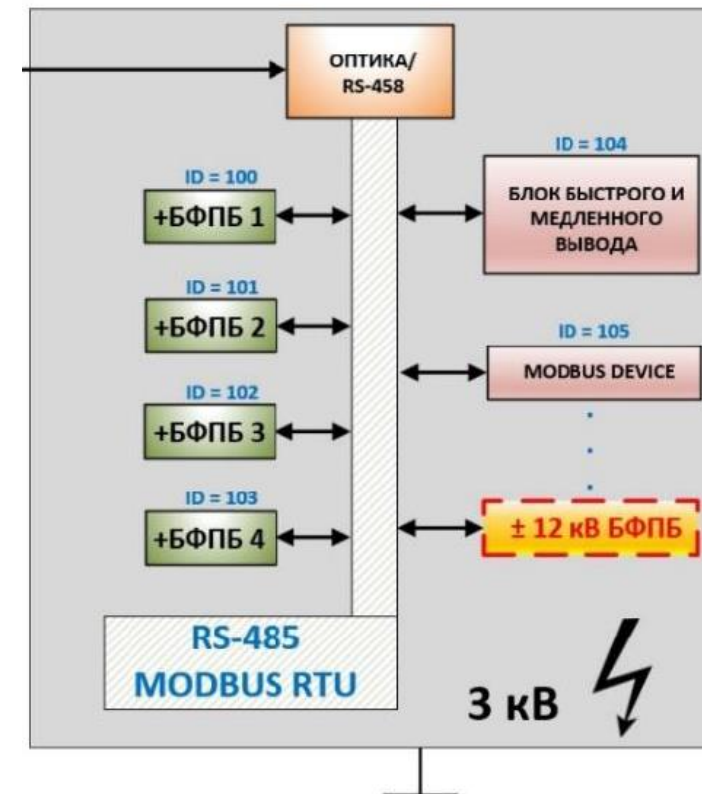
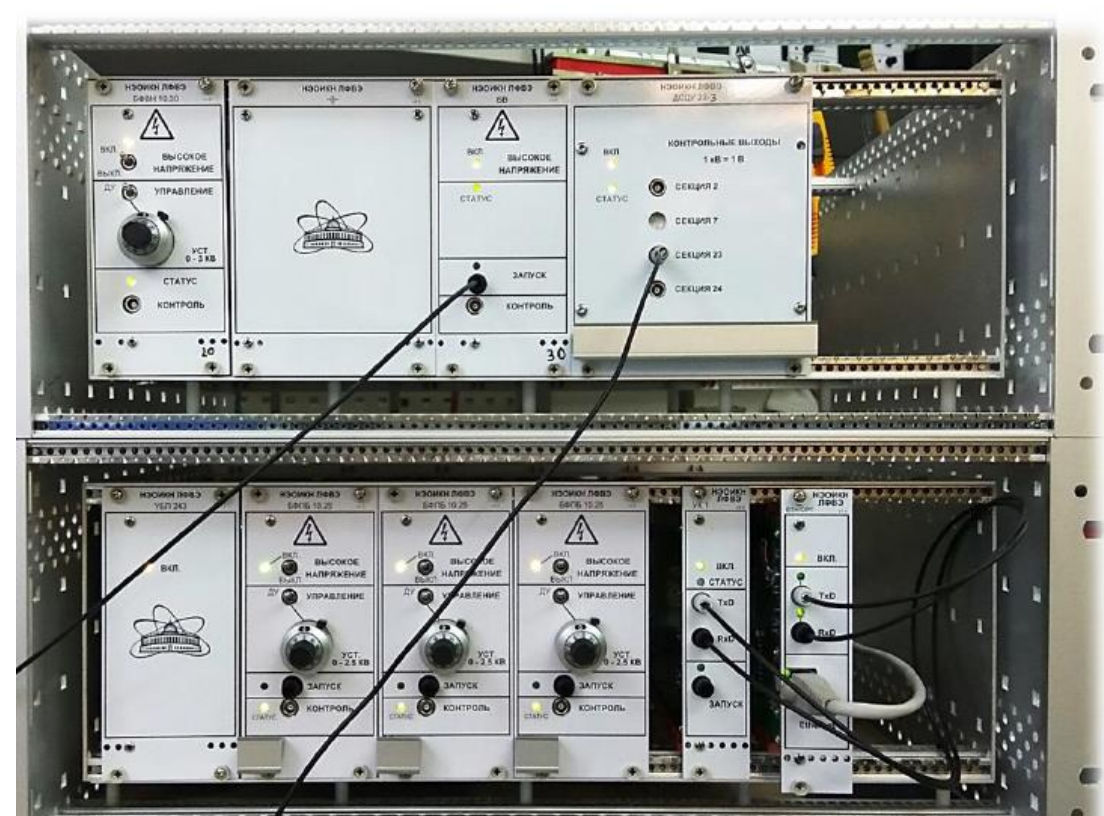
KRION-6T ION SOURCE EXTRACTION SYSTEM UPGRADE

Bach. diploma:

- structural schematic
- simulations
- hardware design
- firmware design
- assembly
- testing



E. Butenko



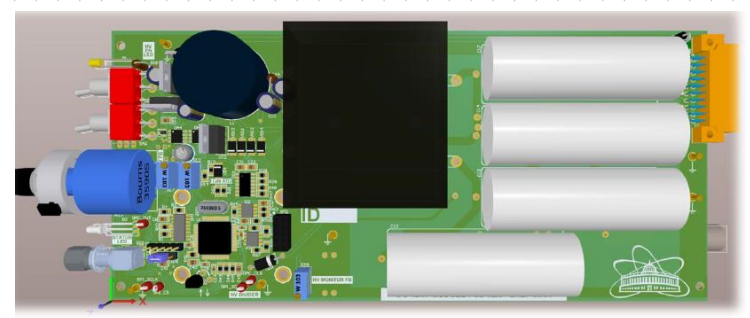
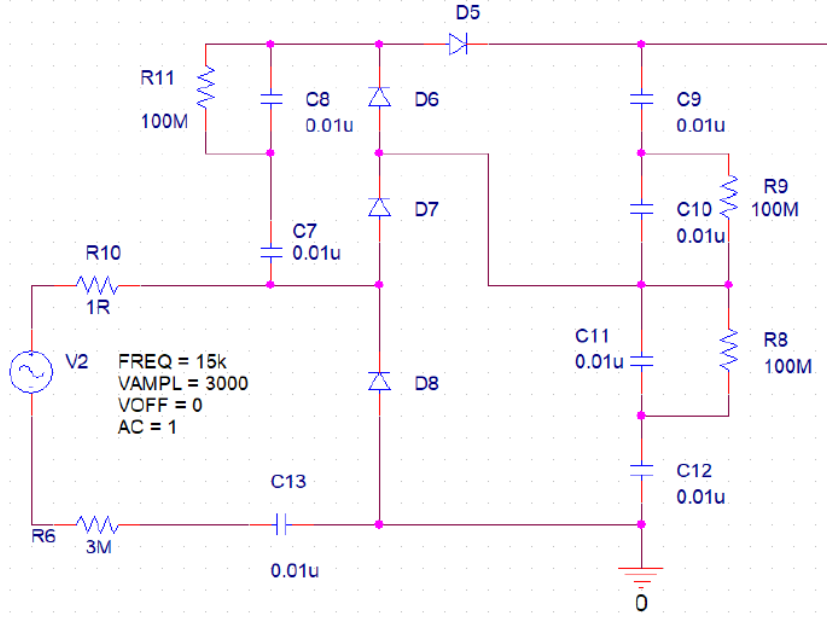
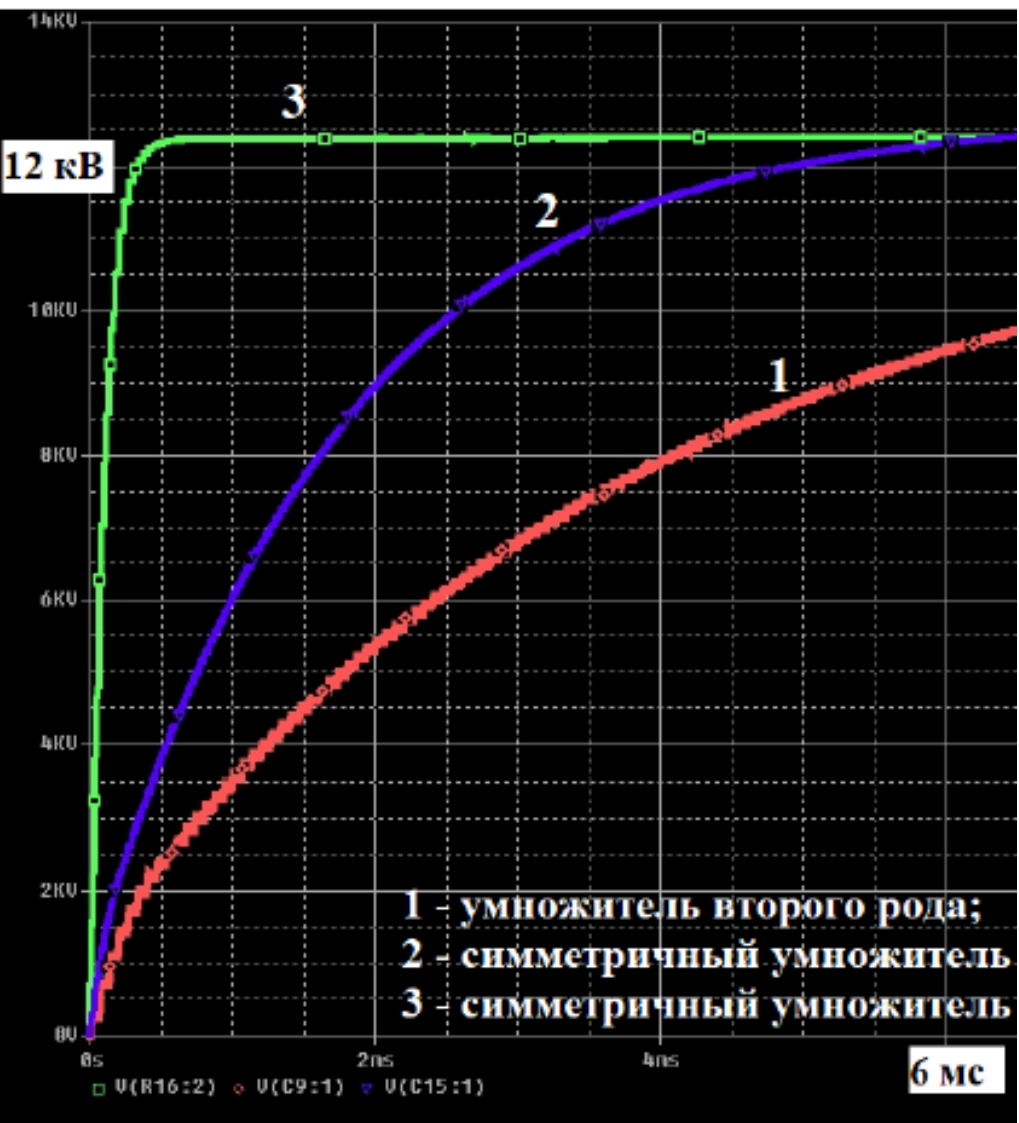
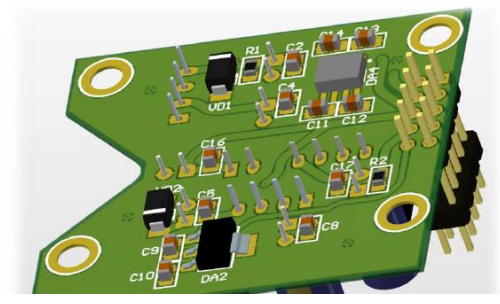
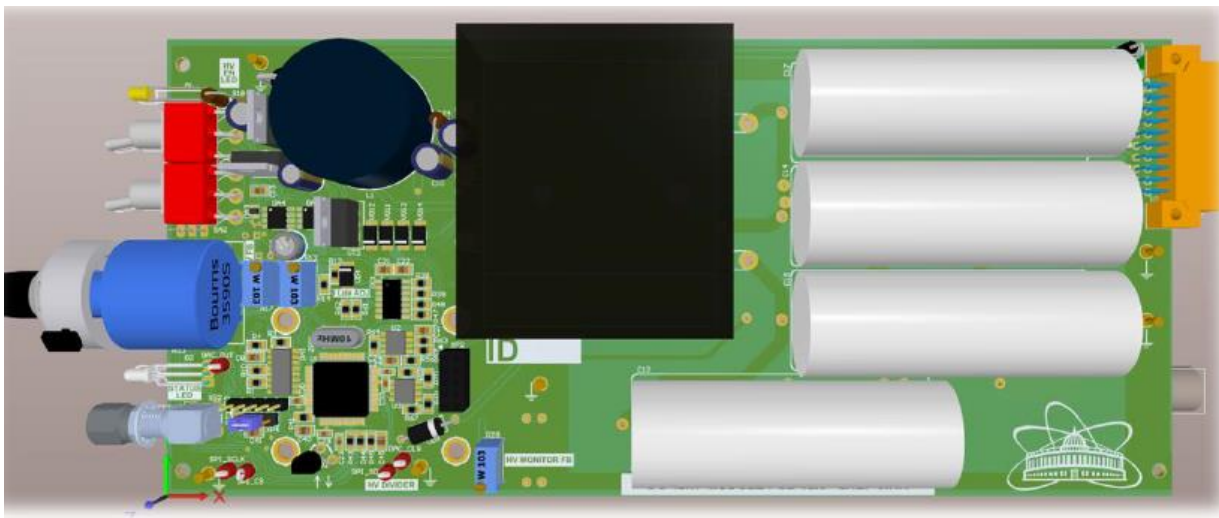


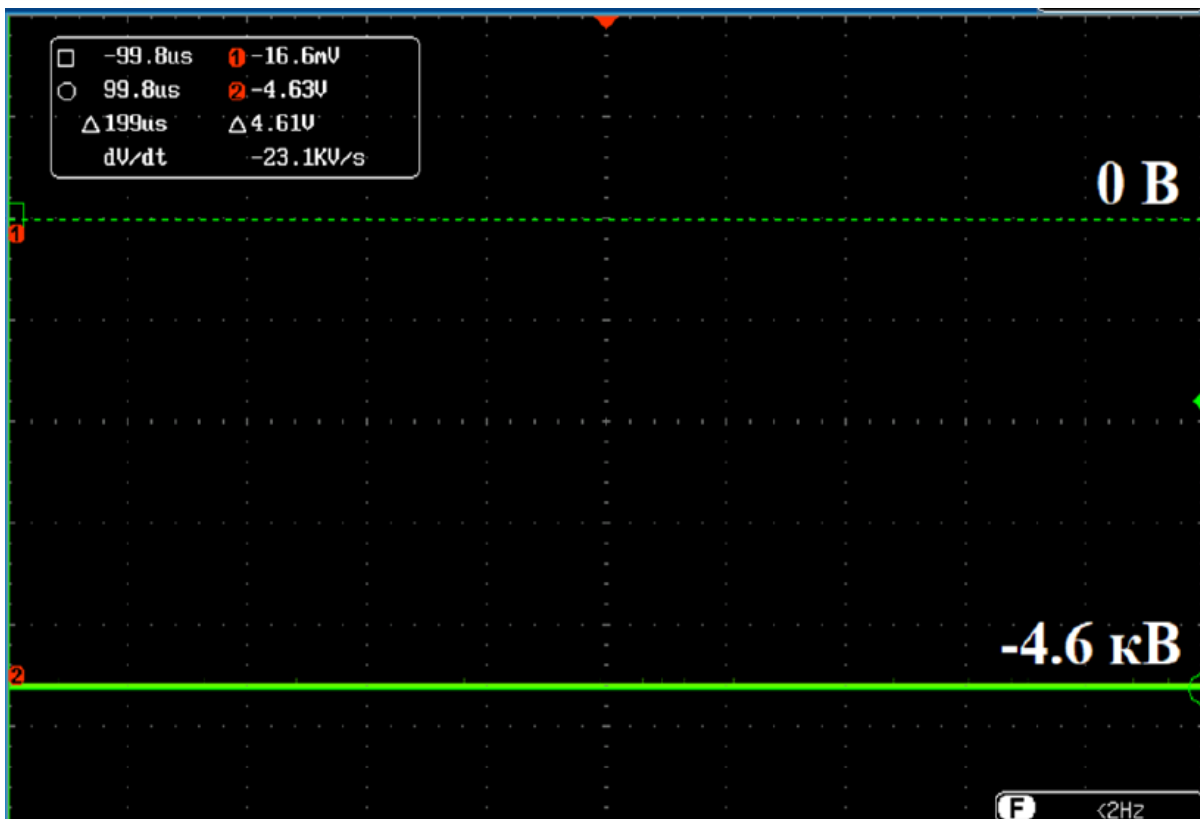
Рисунок 19. 3D-вид основной платы



- simulations - hardware design



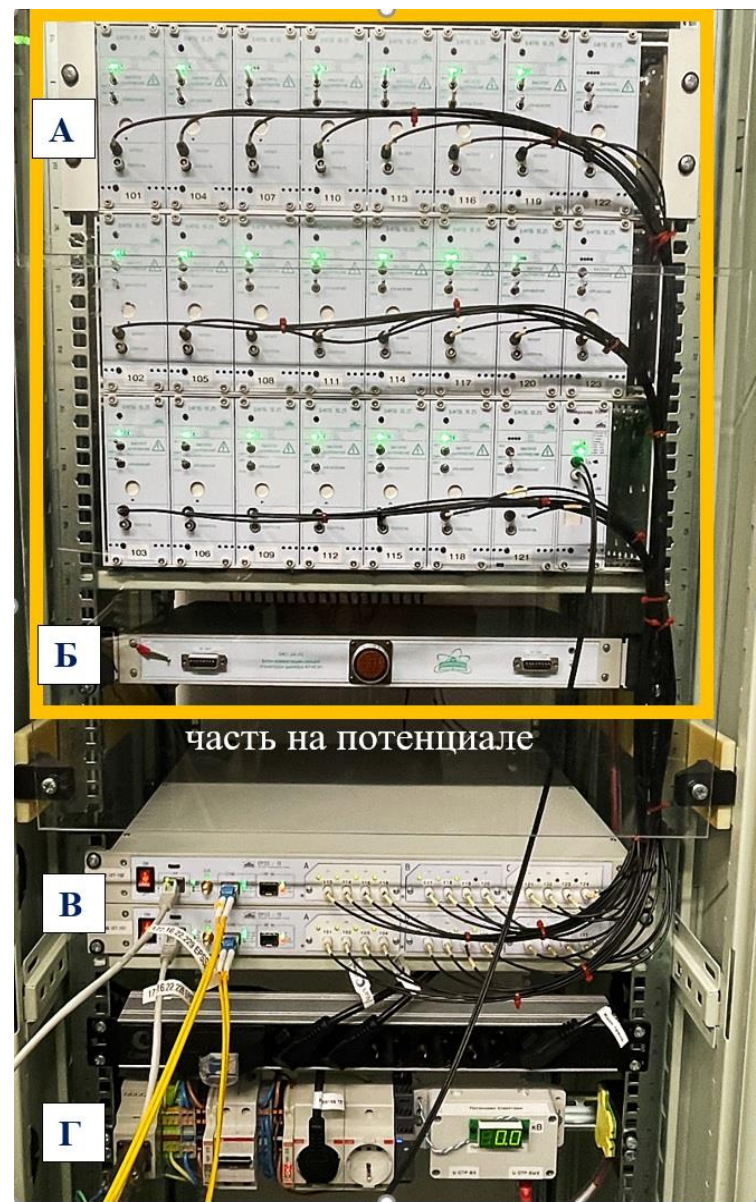
- soldering
- assembly
- tests: - 4.6 kV



Ion extraction system for KRION ion source

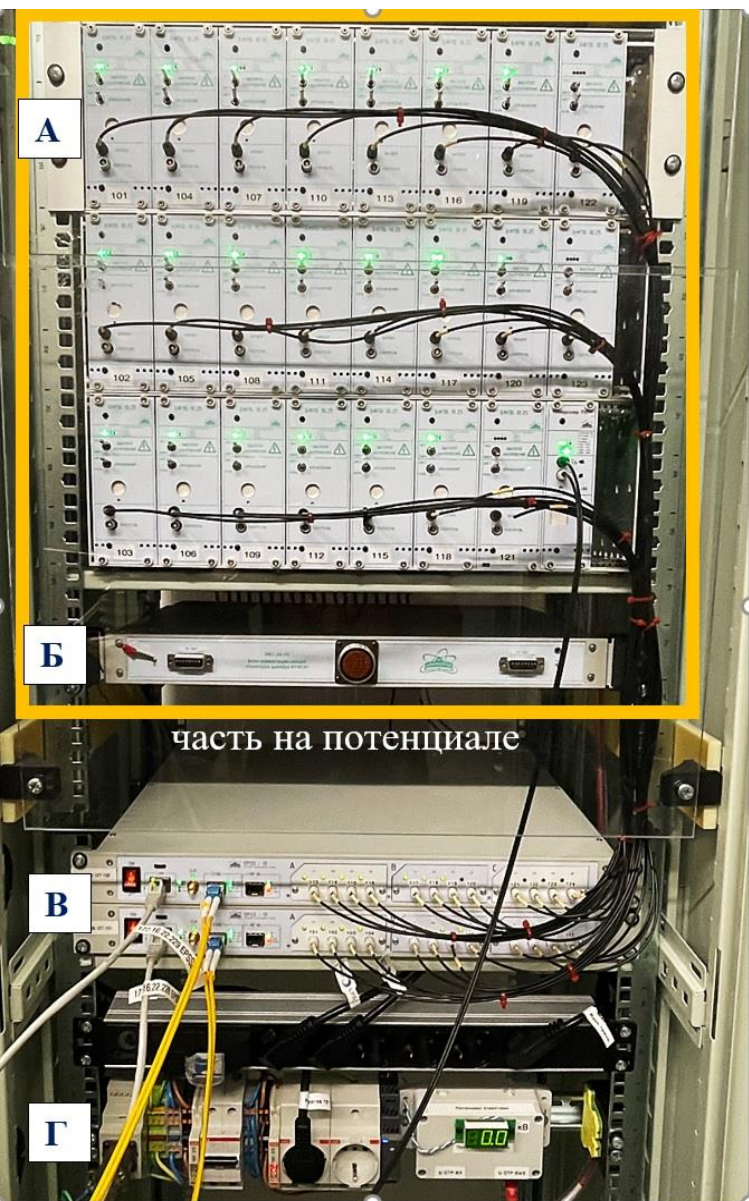


2019



2024

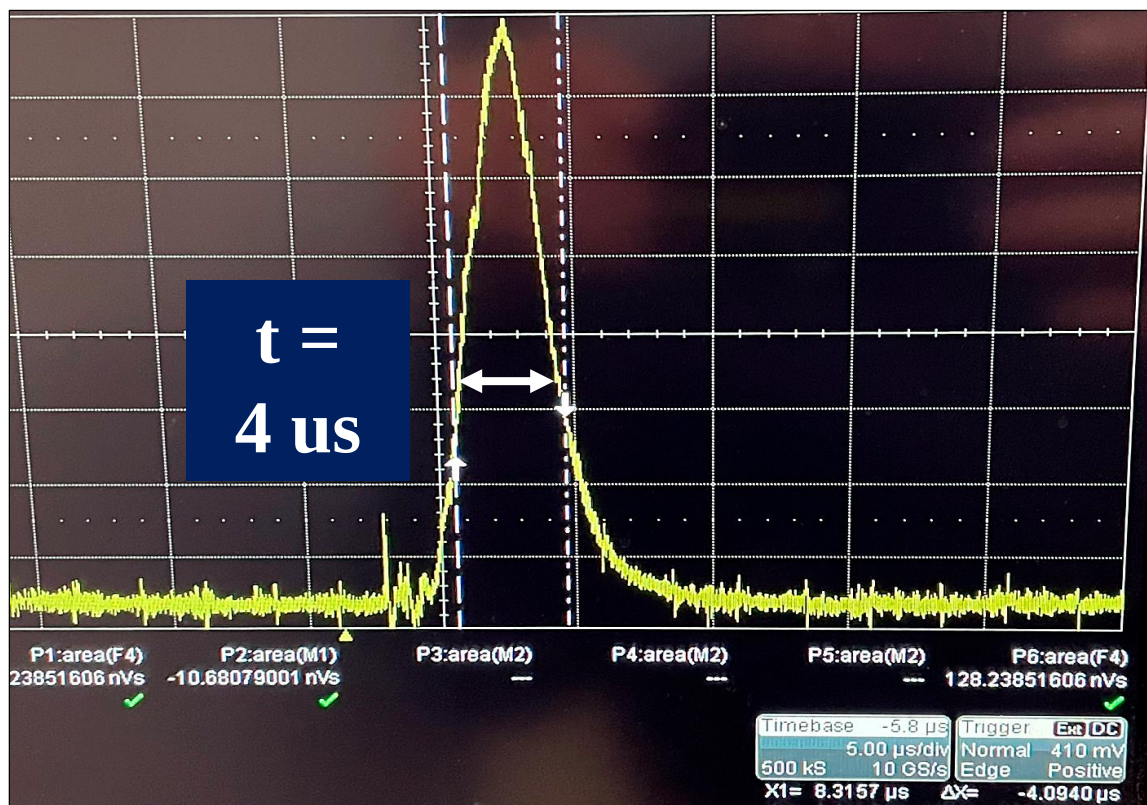
Fast ion extraction system for KRION ion source



Extracted Ion beam

$Q = 3-4 \text{ nC}$ $^{124}\text{Xe}^{28+}$

t ion extraction from 15 to 4 us !!!





Z. Panteleev



N. Malyshev



S. Mukhachev



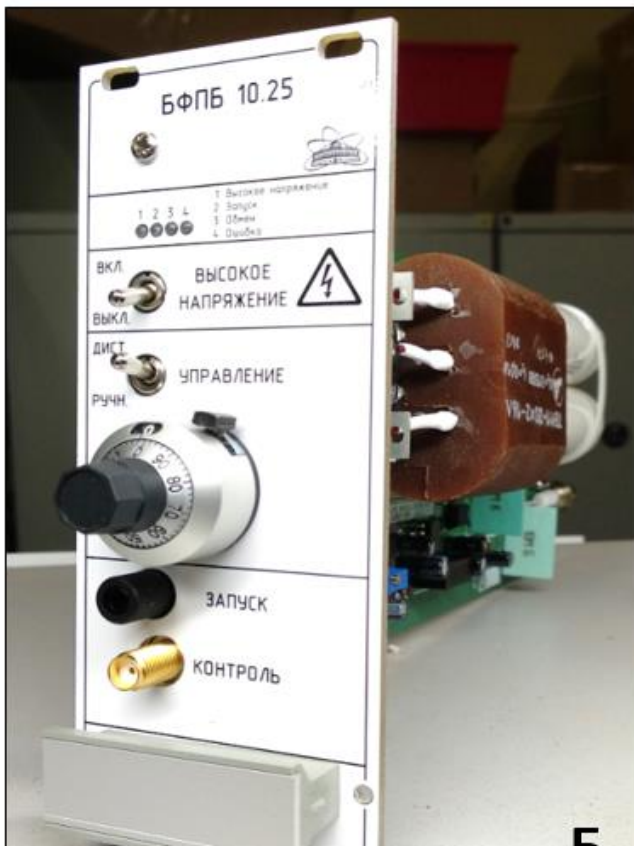
E. Matyukhanov



M. Dzugaev



A



B



B



Z. Pantelev



N. Malyshev



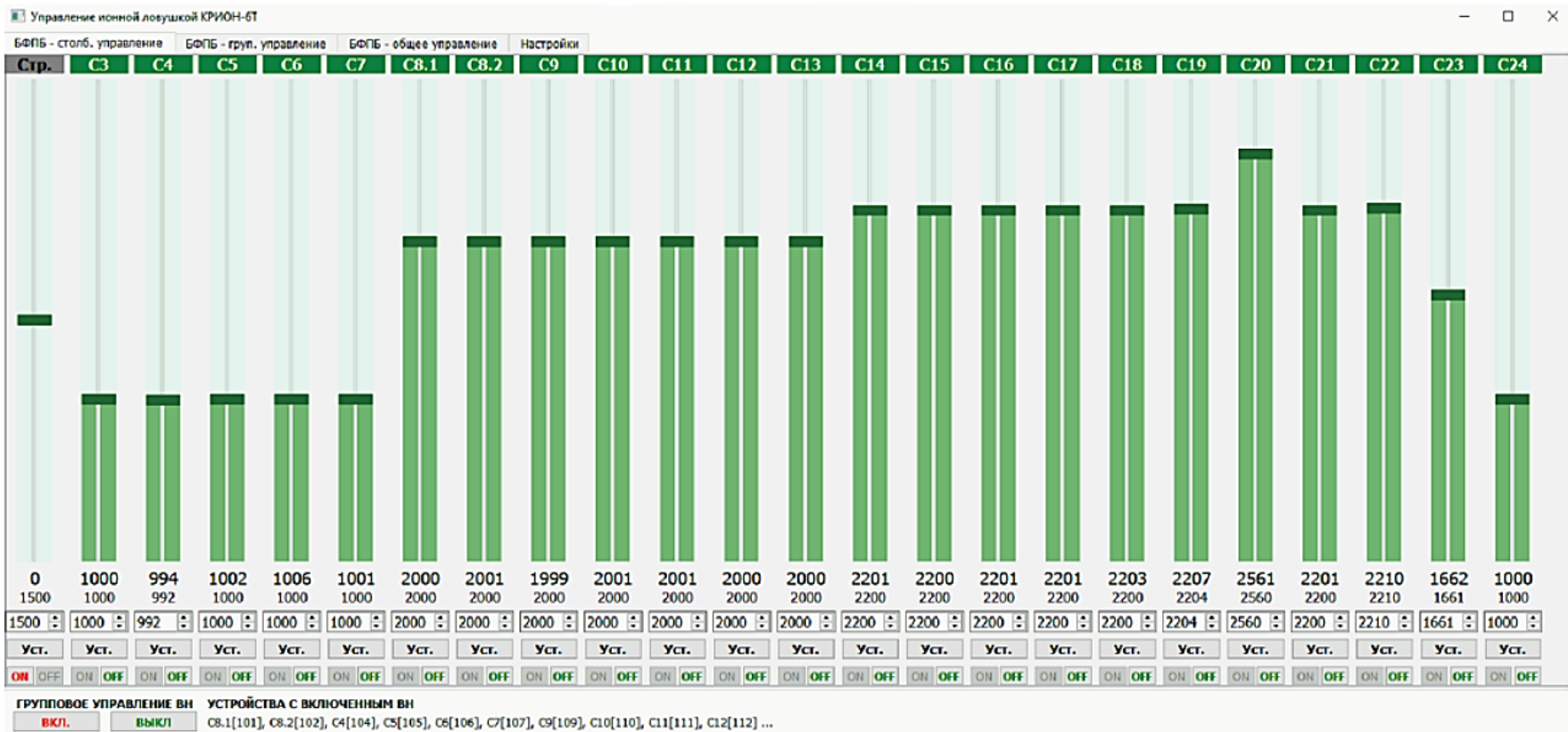
S. Mukhachev



E. Matyukhanov



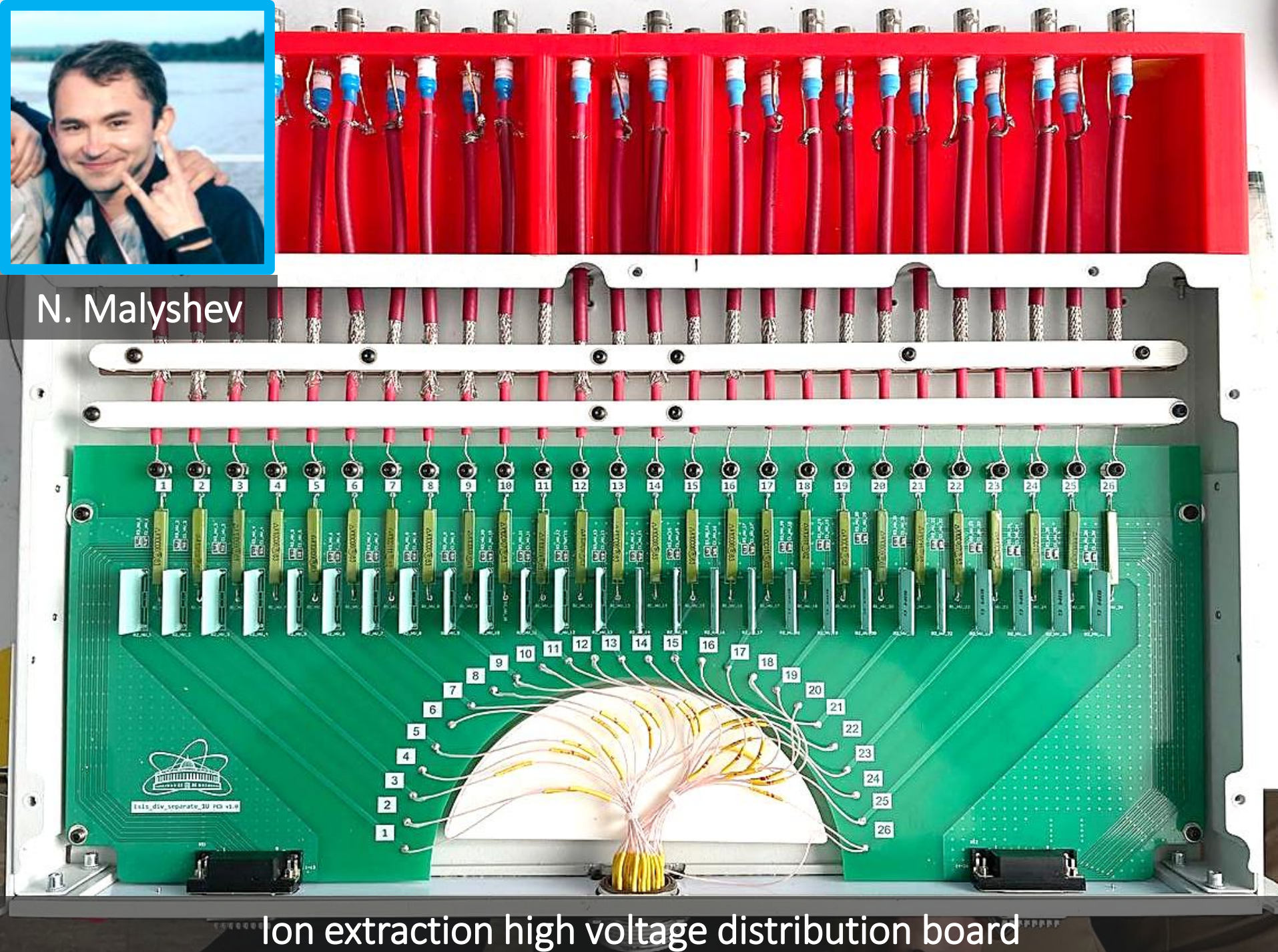
M. Dzugaev



Ion extraction control PC software



N. Malyshev



Ion extraction high voltage distribution board

Объединённый институт ядерных исследований
Лаборатория физики высоких энергий
им. В. И. Векслера и А. М. Балдина

ДИПЛОМ

ЛАУРЕАТОВ ПЕРВОЙ ПРЕМИИ

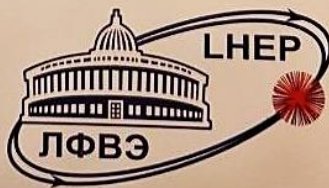
КОНКУРСА РАБОТ ЛАБОРАТОРИИ ФИЗИКИ ВЫСОКИХ ЭНЕРГИЙ

Настоящим дипломом награждается авторский коллектив в составе

**ДОНЕЦ Е. Е., РАССАДОВ Д. Н., ПОНКИН Д. О.,
РАМЗДОРФ А. Ю., МАЛЫШЕВ Н. А., БУТЕНКО Е. А.,
ДОНЕЦ Д. Е., ШУТОВ В. Б., БОЙЦОВ А. Ю.,
САЛЬНИКОВ В. В., ГУДКОВ С. В., ДЗУГАЕВ М. Г.**

за работу

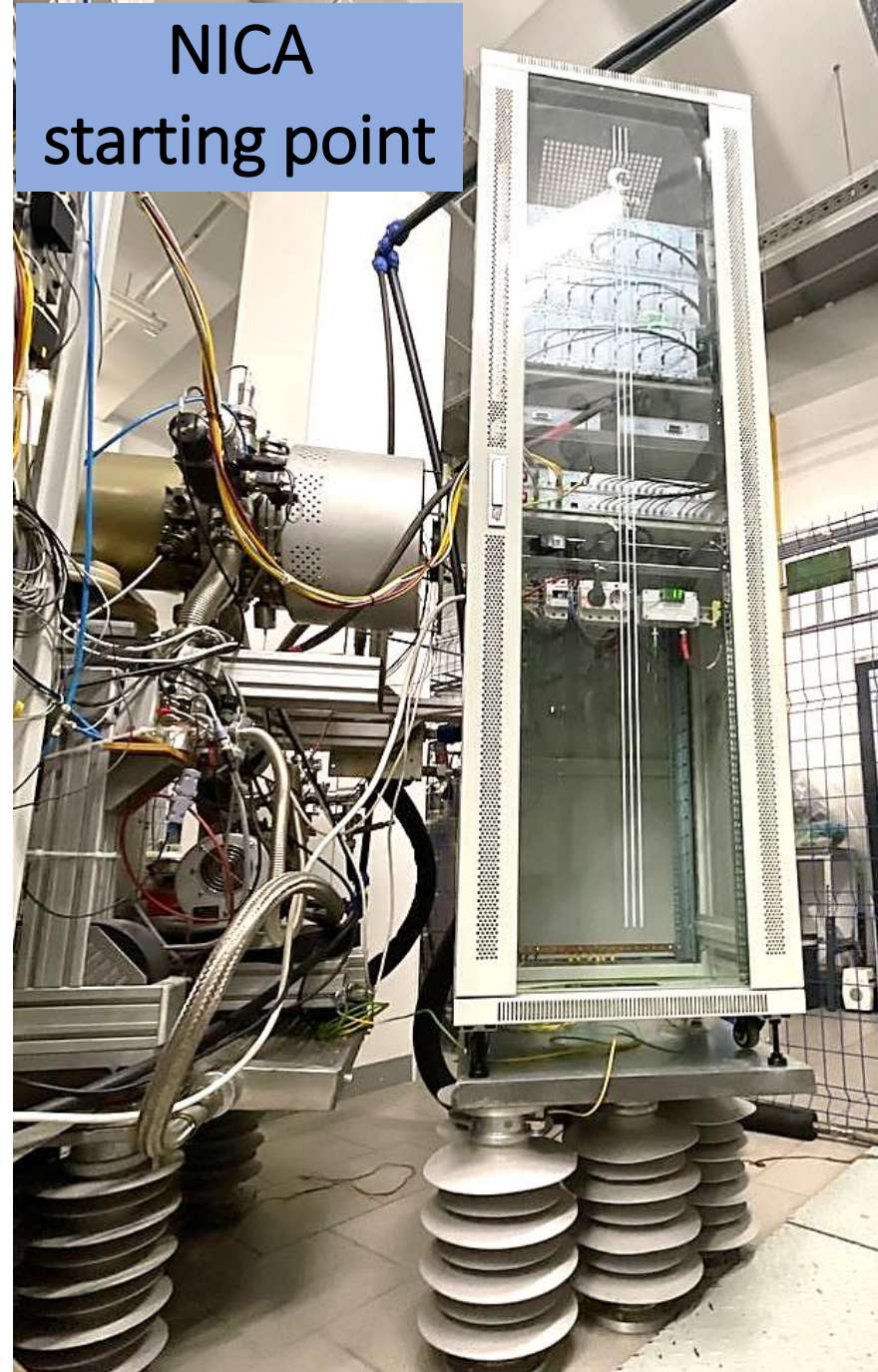
«Разработка, создание и апробация системы быстрого
вывода пучков высокозарядных ионов из источников «КРИОН»
в режиме многократной инжекции в Бустер»



Директор

А. В. Бутенко

NICA
starting point



KRION heavy ion source team awarding, 2024



4 – 20 MA PRECISION CRYOGENIC TEMPERATURE MONITOR

Bach. diploma:

- structural schematic
- hardware design
- assembly
- simulations
- firmware design
- testing



M. Dzugaev



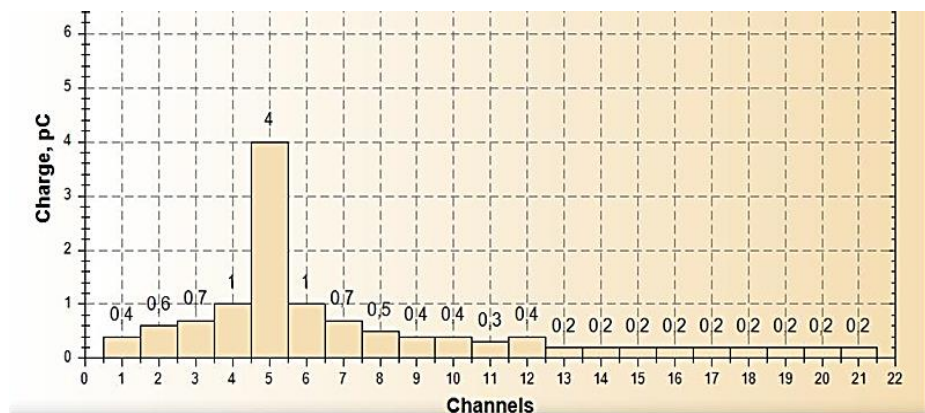
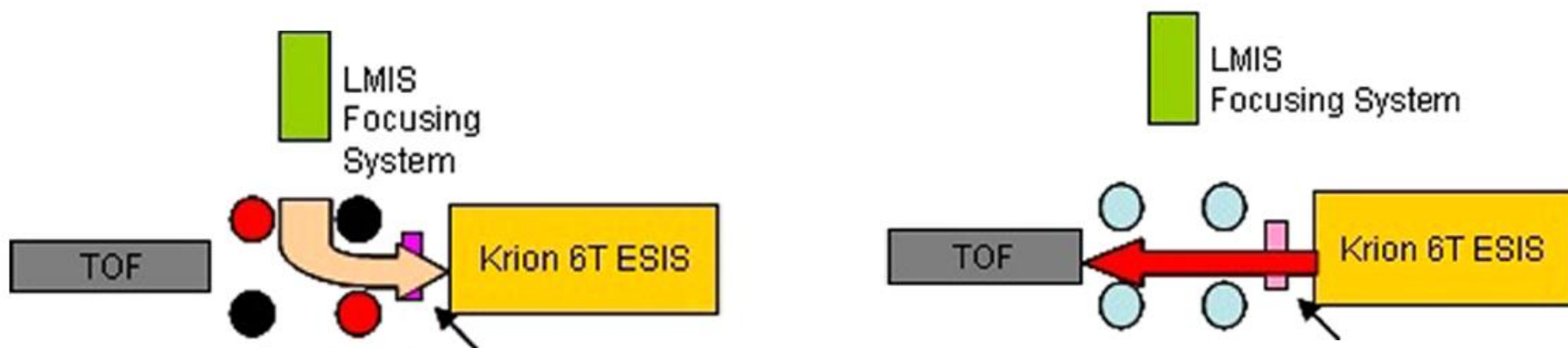
Liquid metal ion source assembly for external ion injection into an electron string ion source (ESIS)

M. J. Segal,^{1,2,a)} R. A. Bark,¹ R. Thomae,¹ E. E. Donets,³ E. D. Donets,³ A. Boytsov,³
D. Ponkin,³ and A. Ramsdorf³

¹*iThemba LABS, P.O. Box 722, Somerset West 7130, South Africa*

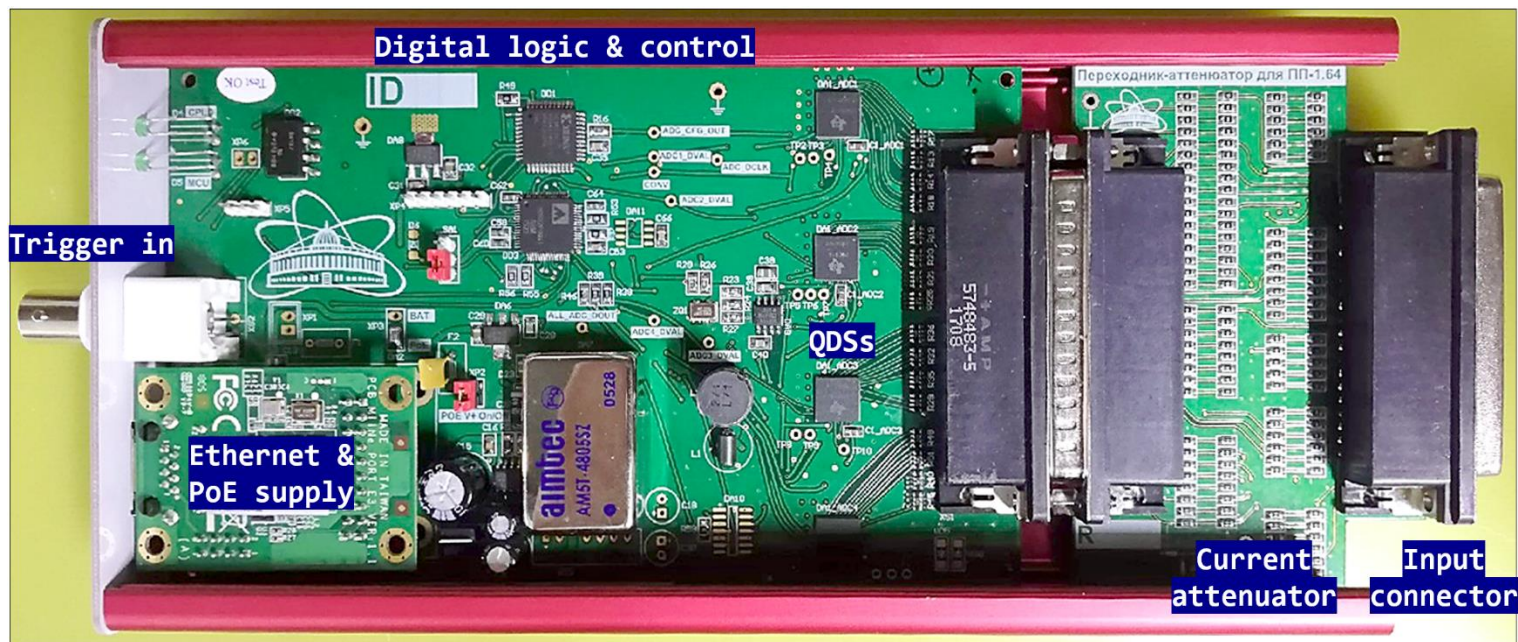
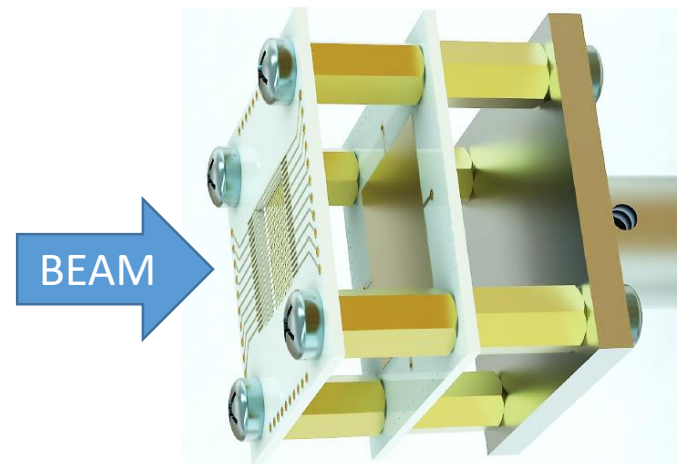
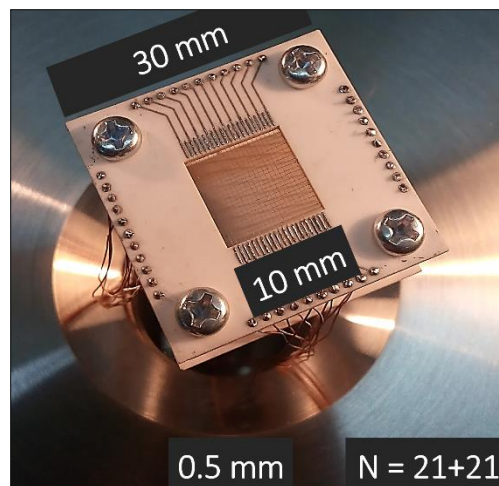
²*University of Cape Town, Rondebosch, Cape Town 7700, South Africa*

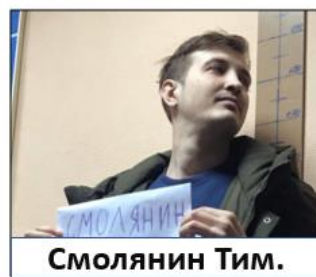
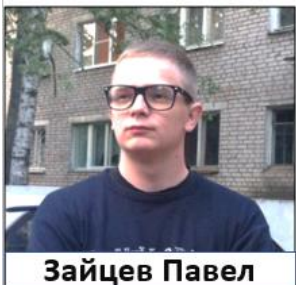
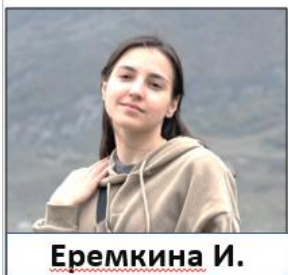
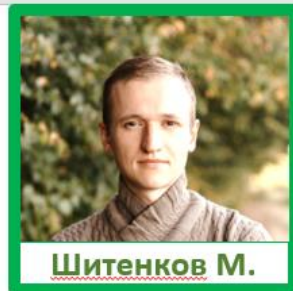
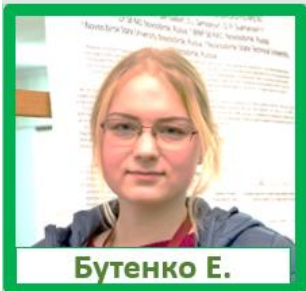
³*Joint Institute for Nuclear Research, Joliot-Curie 6, 141980 Dubna, Moscow Region, Russia*



Beam diagnostics => profile measurements

- sensitive:
down to 3 pC/channel
- PoE supply
- Modbus RTU
- modular (3U cases)
- pulsed: $t_{int} > 10 \mu s$





Thank you!