



# Experimental Complex NICA ЛФВЭ – High Energy Physics Laboratory Polish activity.

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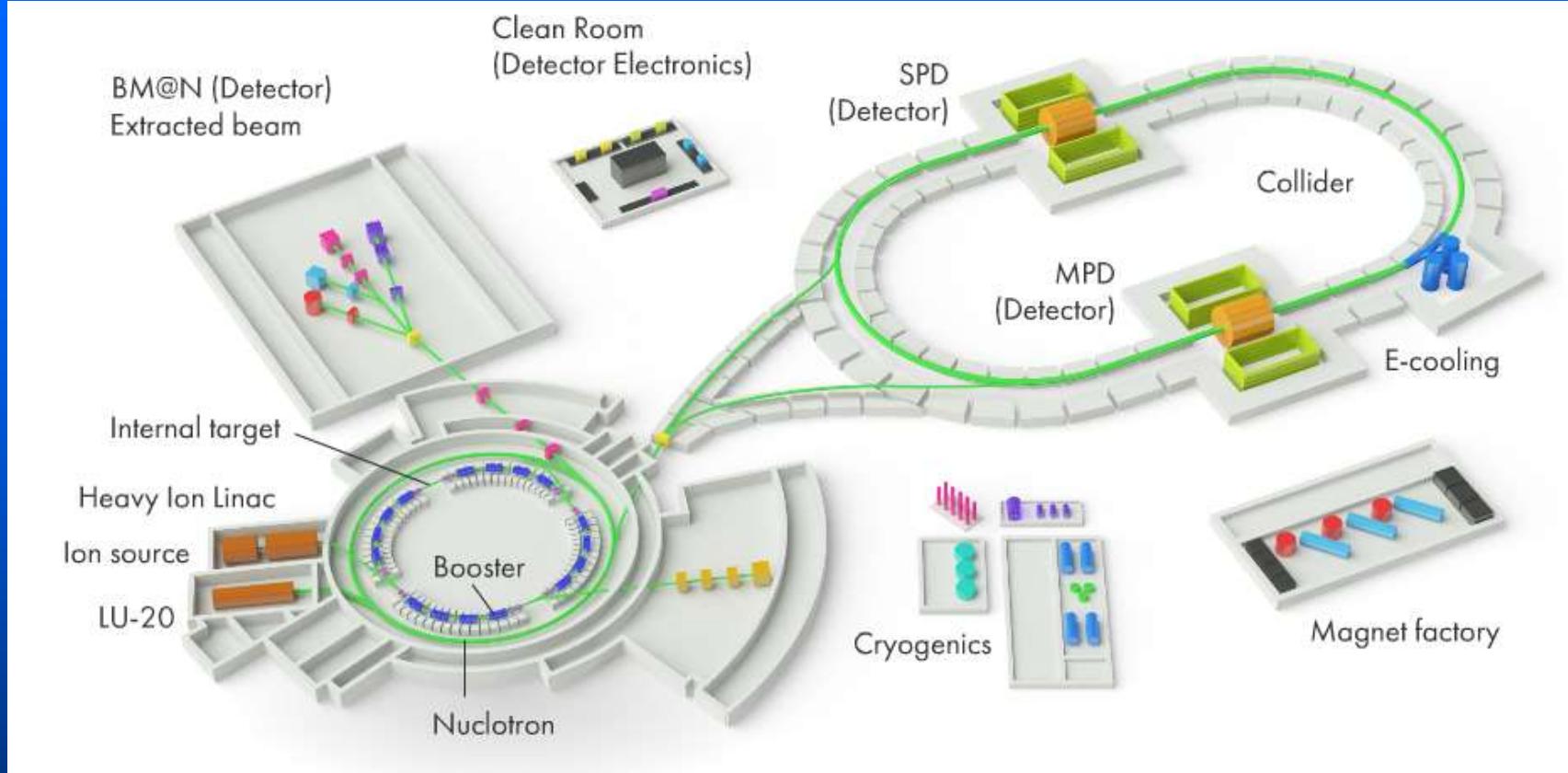
# High Energy Physics Laboratory - Polish activity.

## Outline

1. NICA complex
2. Polish activity
3. Students practice



# 1. NICA complex



## Polarised beams

[LU-20](#)

[Nuclotron](#)

Extracted beam

Internal target station

[SPD \(Detector\)](#)

## Heavy Ions

[Ion source \(KRION-6T\)](#)

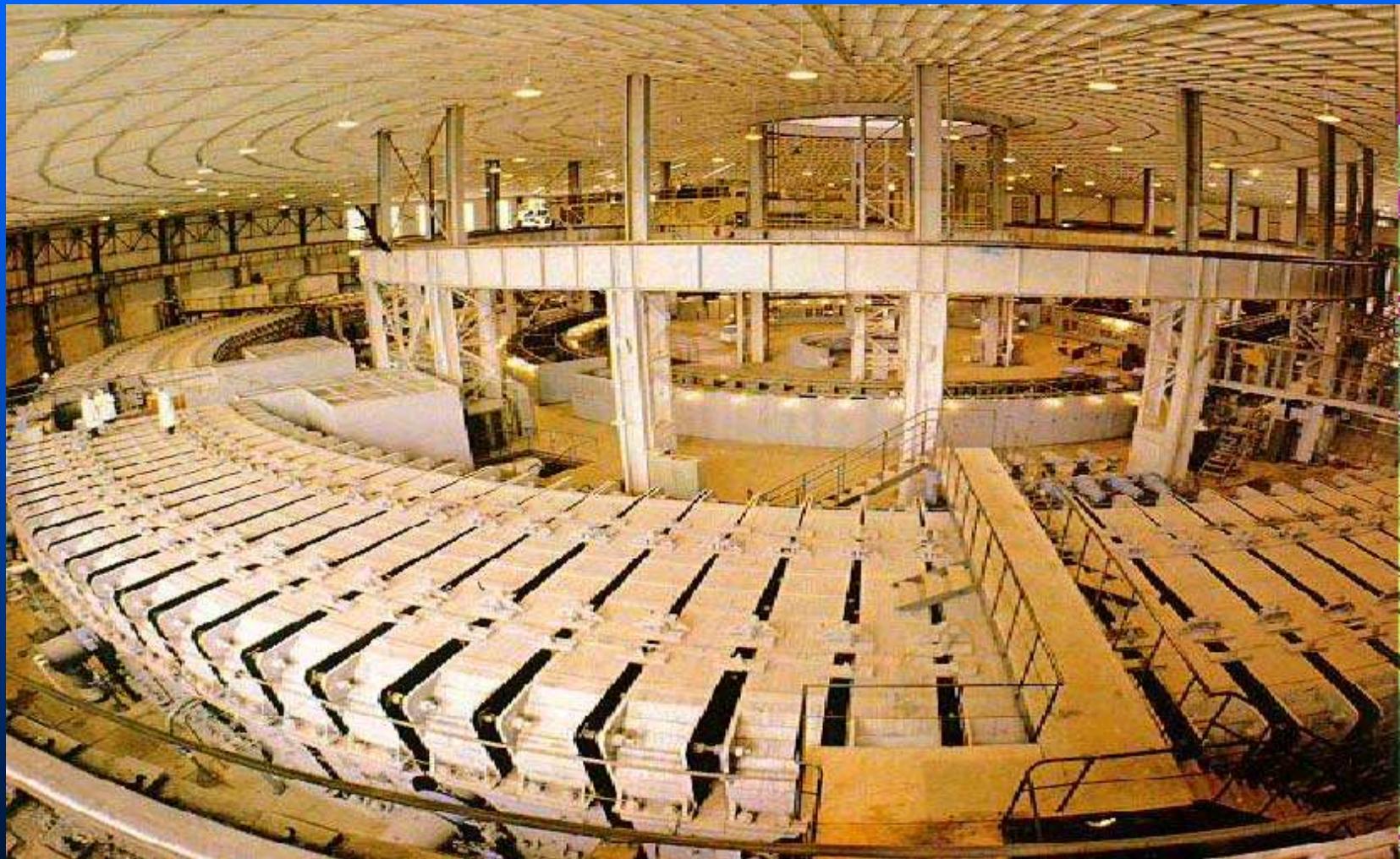
[Heavy Ion Linac \(HILac\)](#)

[Booster](#)

[BM@N \(Detector\)](#)

[MPD \(Detector\)](#)

# 1. Akceleratory (Stary Sychrophasotron Dubna)



# 1. NICA complex



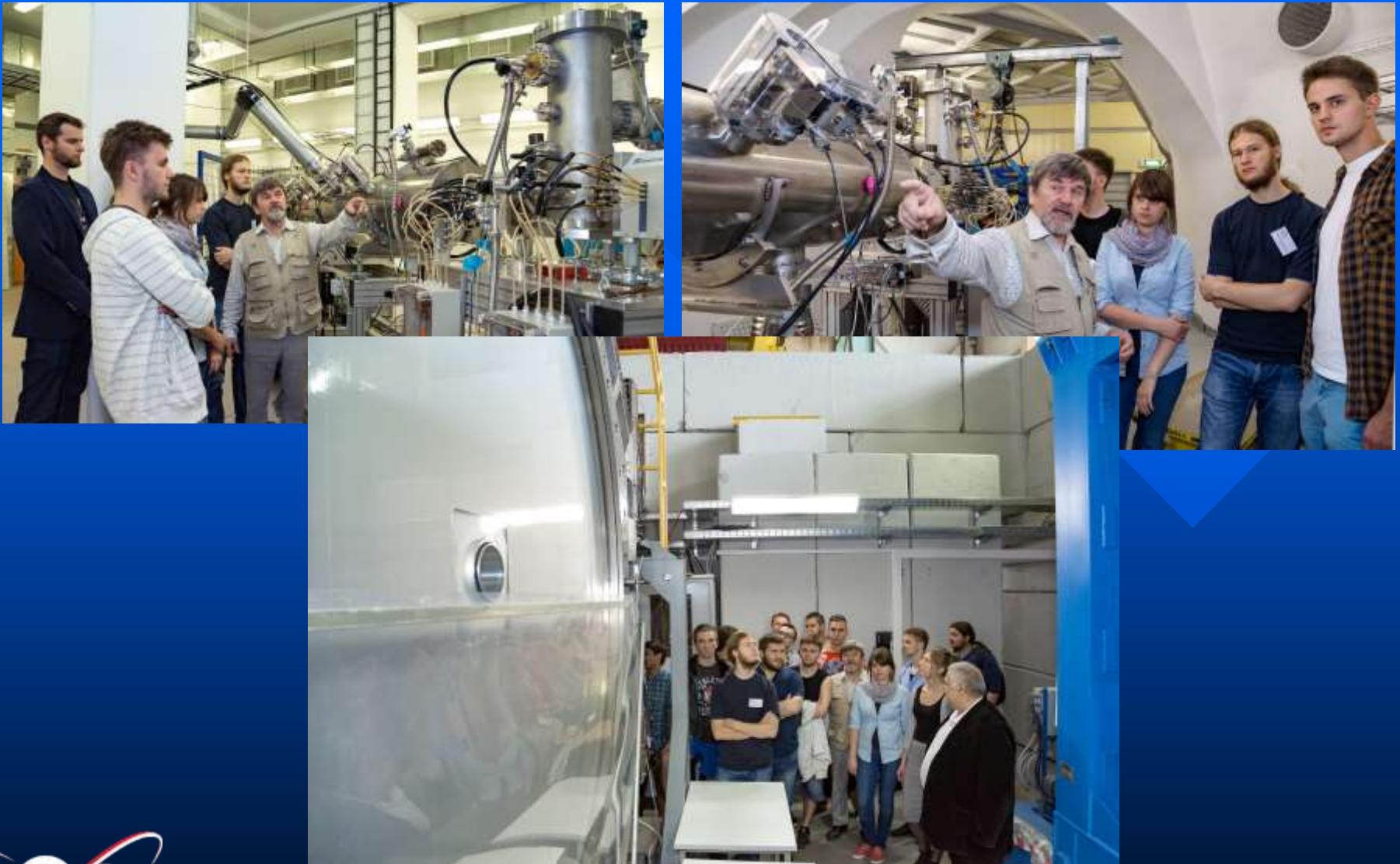
NICA - Seminar 11.I.2018

# 1. NICA complex

- Nuclotron (VBLHE) – wide spectrum of possible energies  $E_p = 500$  MeV to 8 GeV, strong focusing,  $10^{12} - 10^{13}$  protons per hour



# 1. NICA complex



NICA - Seminar 11.I.2018

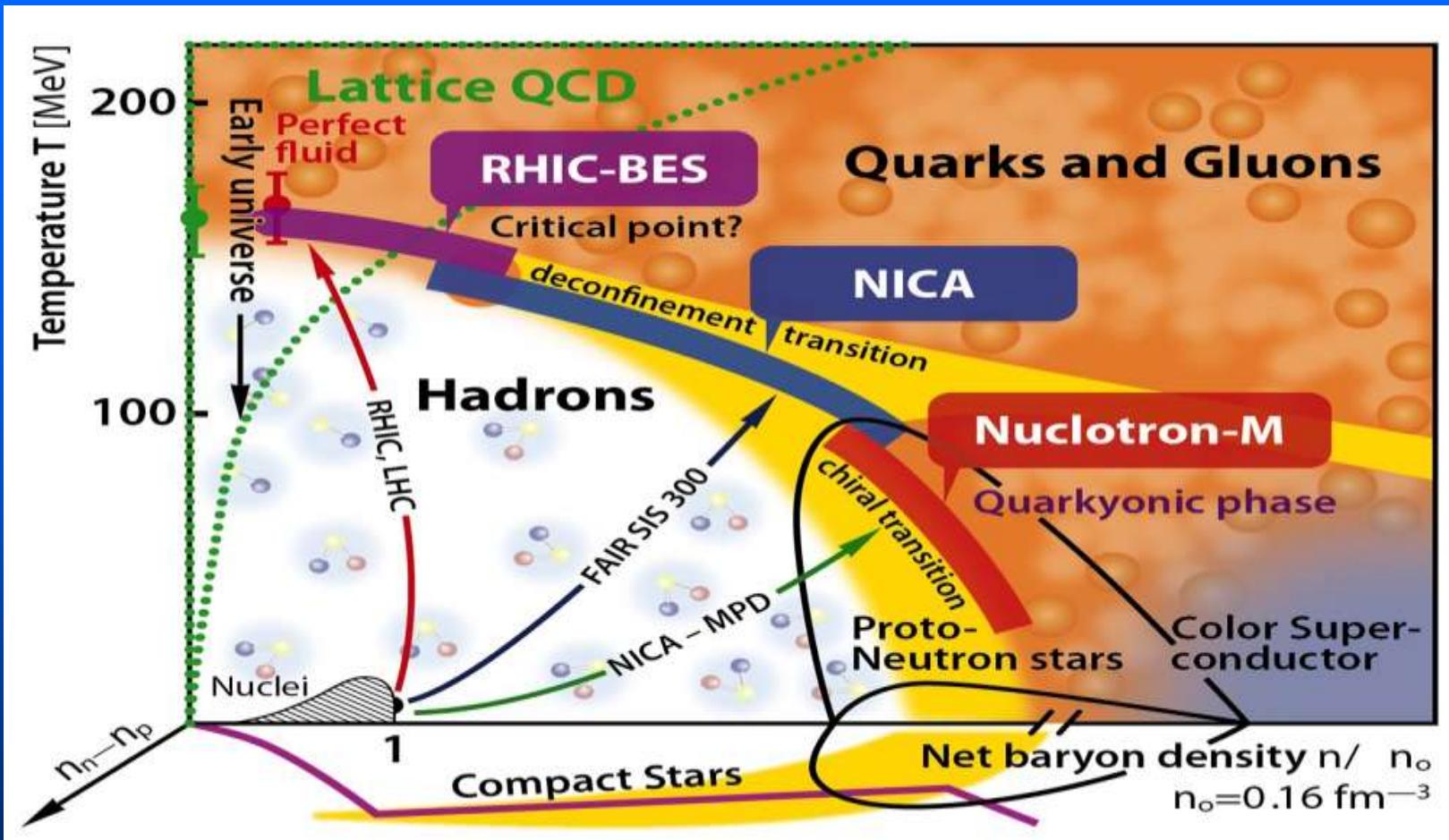
# 1. NICA complex



<https://youtu.be/u5RAZ5LmoHA>

NICA - Seminar 11.I.2018

# ■ 1. NICA complex



The international mega-science project “NICA complex” is aimed in the study in the laboratory of the properties of nuclear matter in the region of the maximum baryonic density.

# 1. NICA complex

1. The theoretical understanding of the properties of this phase transition is still rather poor, and quantitative predictions cannot yet be made with confidence because lattice gauge calculations can not be employed at the finite baryon densities.
2. The range of collision energies from 4 to 11A GeV is very promising for dilepton studies since the effect of modifications is expected to be sensitive to the baryon density, while the latter happens to reach the maximum in central Au+Au collisions at NICA.

## 3. Physics tasks of the NICA heavy-ion program

- event-by-event fluctuation in hadron productions (multiplicity, Pt etc.);
  - femtoscopic correlation;
  - directed and elliptic flows for various hadrons;
  - multi-strange hyperon production (including hypernuclei): yield and spectra
  - photon and electron probes
  - charge asymmetry
4. The NICA project realization start the BM@N experiment with the Nuclotron extracted beams in 2017. The first technical run of the BM@N detectors was performed with deuteron and carbon beams in spring 2015. After modernization of the BM@N beam line elements, the xenon and gold ion beam is planned. The commissioning of the design configuration of the NICA accelerator complex is foreseen in 2023.

# 1. NICA complex

The Injection Complex consists of the following elements:

- cryogenic heavy ion source KRION of Electron String Ion Source (ESIS) type,
- laser source,
- duoplasmatron source,
- source of polarized protons and deuterons,
- modernized linac LU-20 (existing),
- new heavy ion linear accelerator (HILAC),
- transfer channels.

The injection complex has two independent parts:

- 1) **The injector for light ions** contains ion sources (laser, duoplasmatron sources, source of polarized protons and deuterons), modernized LU-20 and existing beam injection channel into the synchrotron Nuclotron.
- 2) the injector for heavy ions - Electronic string source of the highly-charged ions "KRION-6", provides heavy ions of  $\text{Au}^{31+}$  (up to  $2 \cdot 10^9$  per pulse with a pulse repetition rate of 10 Hz) and delivers them into the HILac. High current (10 mA) heavy ion Linac (HILac) with transistor RF amplifier, consists of three accelerating elements: the section RFQ and DTL two sections with two matching transport channels, the average energy-focusing beams



# 1. NICA complex

The main goals of the Booster are the following:

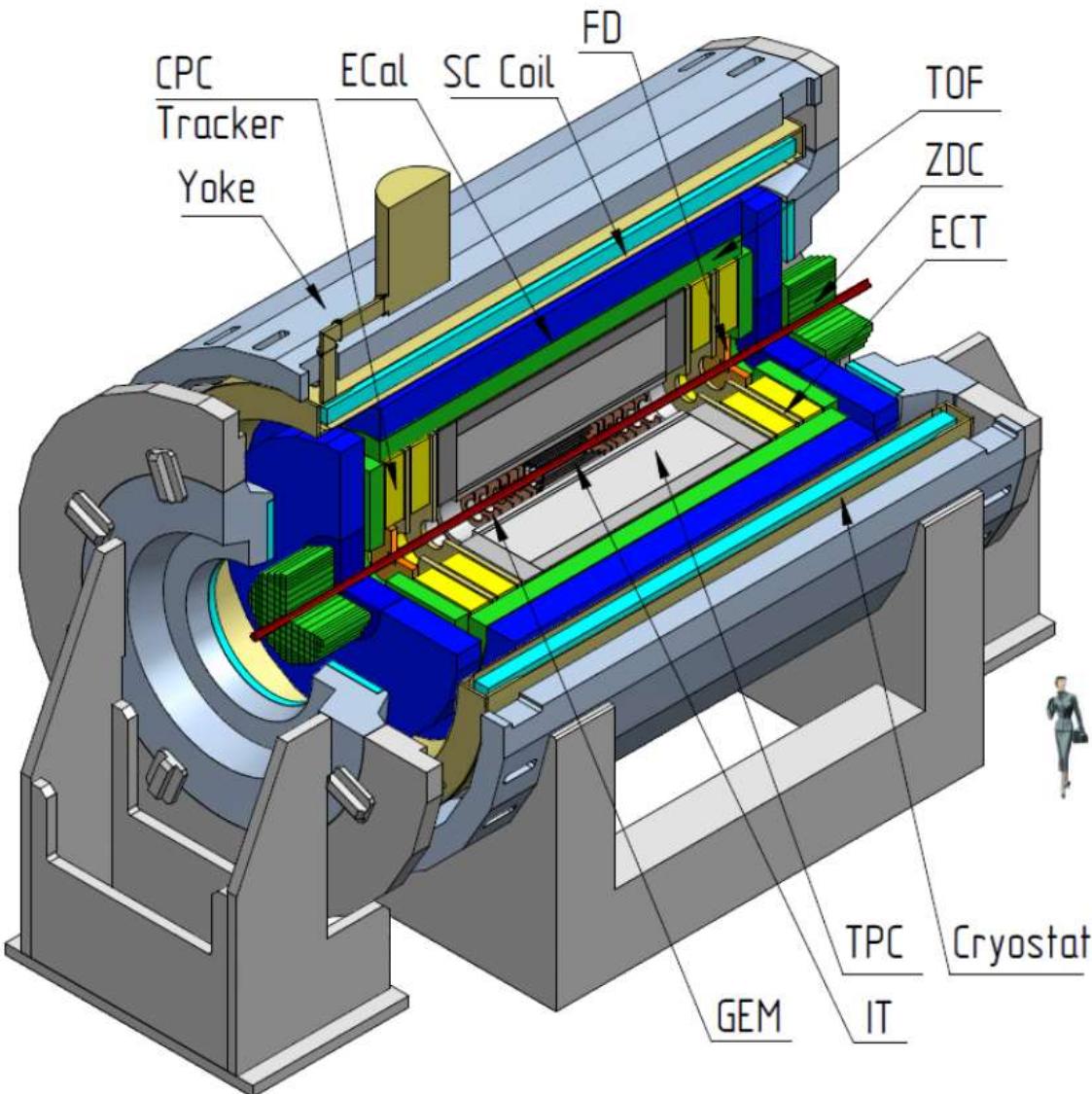
- accumulation of  $2 \cdot 10^9$  Au $31^+$  ions; acceleration of the heavy ions up to energy required for effective stripping;
- forming of the required beam emittance with electron cooling system;
- providing a fast extraction of the accelerated beam for its injection into the Nuclotron.

The Nuclotron operation modes:

- 1) Acceleration of heavy ions for storage in the collider.
- 2) Acceleration of polarized protons and deuterons for feeding the collider.
- 3) Acceleration of both polarized and unpolarized protons and deuterons and heavy ions for internal target experiments or slow extraction to fixed target experiments.



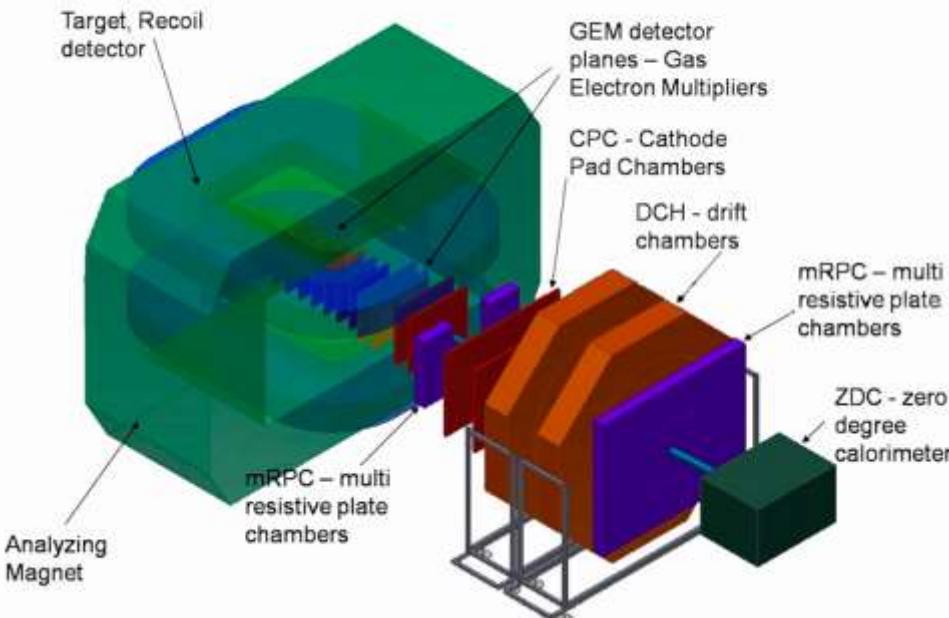
# 1. NICA Multi Purpose Detector



- CD-central detector, and (FS-A, FS-B) - two forward spectrometers
- Superconductor solenoid (SC Coil) and magnet yoke
- inner detector (IT)
- straw-tube tracker (ECT)
- Time-projection chamber (TPC)
- Time-of-flight system (TOF)
- Electromagnetic calorimeter (EMC)
- Fast forward detectors (FFD)
- Zero degree calorimeter (ZDC).

[http://nica.jinr.ru/video/general\\_compressed.mp4](http://nica.jinr.ru/video/general_compressed.mp4)

# 1. Baryonic Matter at Nuclotron (BM@N)



The Nuclotron at JINR will provide beams of heavy ions with energies up to 6A GeV for isospin symmetric nuclei, and 4.65A GeV for Au nuclei. In central heavy-ion collisions at these energies, nuclear densities of about 4 times nuclear matter density can be reached.

Physics for the first stage of the BM@N spectrometer (start in 2015):

- In-medium effects for strangeness and vector mesons decaying in hadron modes;
- Flows, polarizations, azimuthal correlations of hadrons, vorticity;
- Femtoscopy for different hadrons;
- pp and pA interactions as the reference for AA collisions.

Physics for the BM@N spectrometer with silicon inner tracker (start in 2017):

The measurements of the (sub)threshold cascade-hyperons production in order to obtain the information on the nuclear matter EOS.

**NICA** - Nuclotron Ion Collider fAcility

**BM@N** - Baryonic Matter at Nuclotron

**MPD** - Multi-Purpose Detector

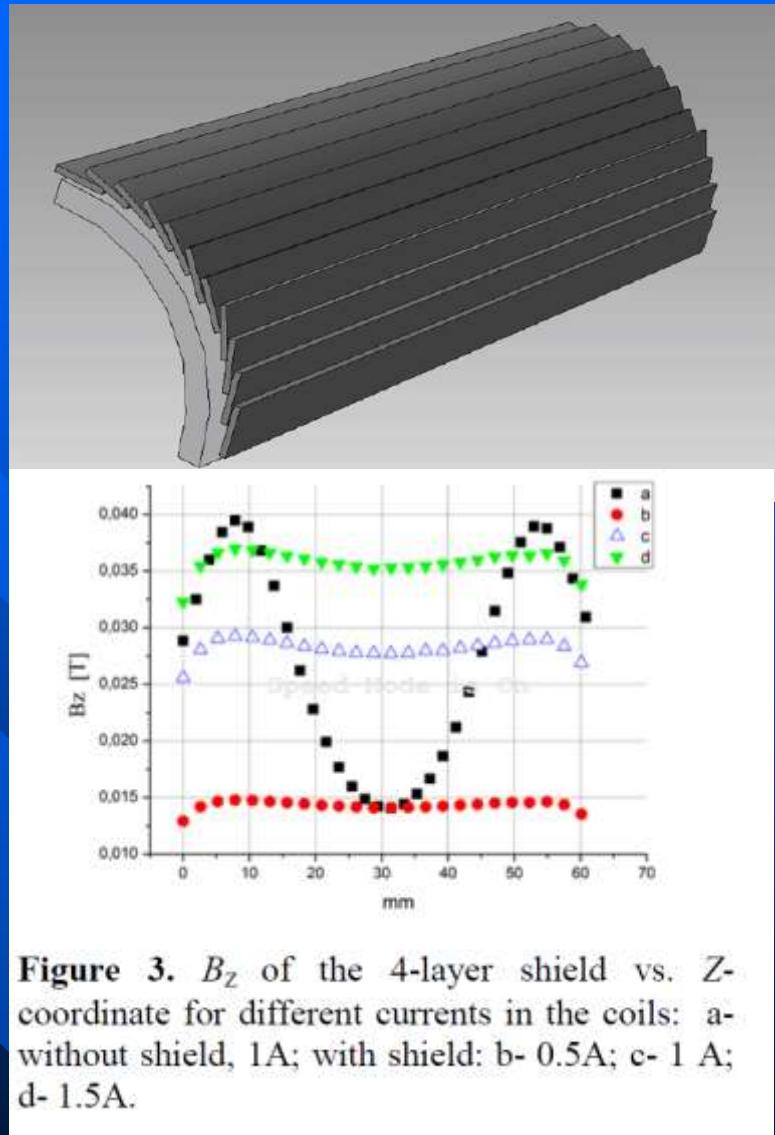
**DCS** - Detector Control System

**EqDb** – Equipment Database

**SC** – Slow Control

## 2. Polish activity - cryogenic

- Termometria – skalibrowany czujnik do temperatur helowych to koszt ok 400\$, nieskalibrowany - kilkanaście. Do Samego nuklotronu zużyto 4k czujników. Żeby obniżyć koszt czujników do NICA sami kalibrujemy czujniki. Dopuszczalny błąd jest na poziomie 0,002 %.
- Projektowanie kriostatów
- Zabezpieczenia przed wystąpieniem stanu rezystywnego, przepusty prądowe
- Badania w zakresie ekranów nadprzewodnikowych do wykorzystania przy skupianiu wiązki



## 2. Slow Control System

Suggestions:

DEFINITION

### DEFINITION:

The Slow Control System (SCS) is an electronic system, which is intended to support and enable operation of complex equipment for any physical experiment, e.g. for detectors in high energy physics experiments.

Elektroniczny System sterowania procesami powolnymi (milisekundy i dłużej)

Umożliwia eksploatacje urządzeń elektronicznych w dowolnym eksperymencie

Np. detektorami lub urządzeniami kontrolnymi/sterującymi Ustawianie napięć dla wszystkich komponentów (np. tysiące detektorów) Ustawienia zapisane w bazie danych, i automatycznie ustawiane przez komputer . Bieżąca kontrola tych parametrów i korekta

# 2. Slow Control System

Suggestions:

CHARACTERISTICS

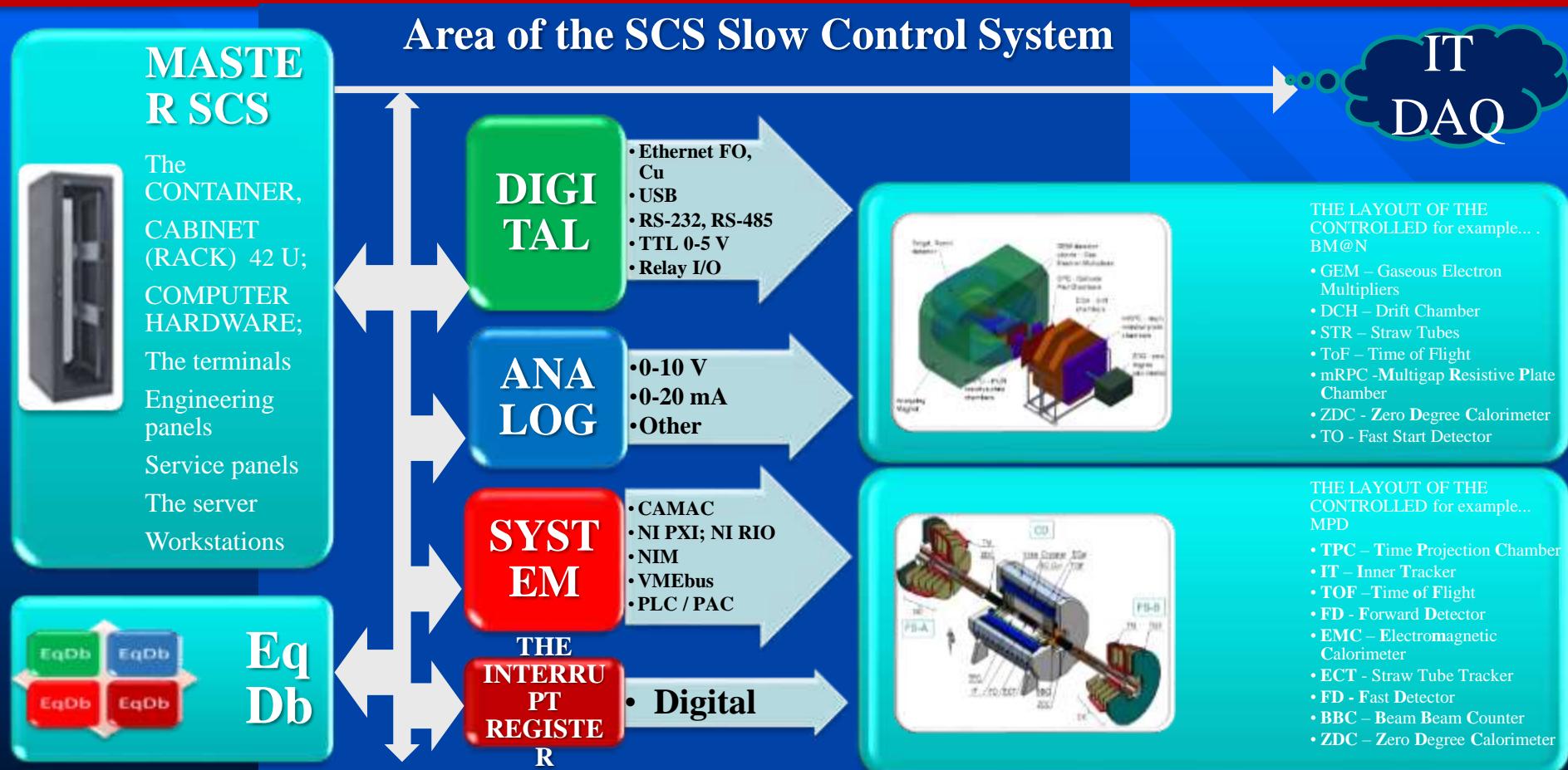
CHARACTERISTICS of the SCS:

- Modular
- Scalable
- Multiuser
- Open
- EqDb (Database)

# 2. Slow Control System

Suggestions:

## BLOK DIAGRAM SCS



## 2. Slow Control System

- IMPLEMENTATION; BASE UNIT 42U;

WUT-JINR VPN



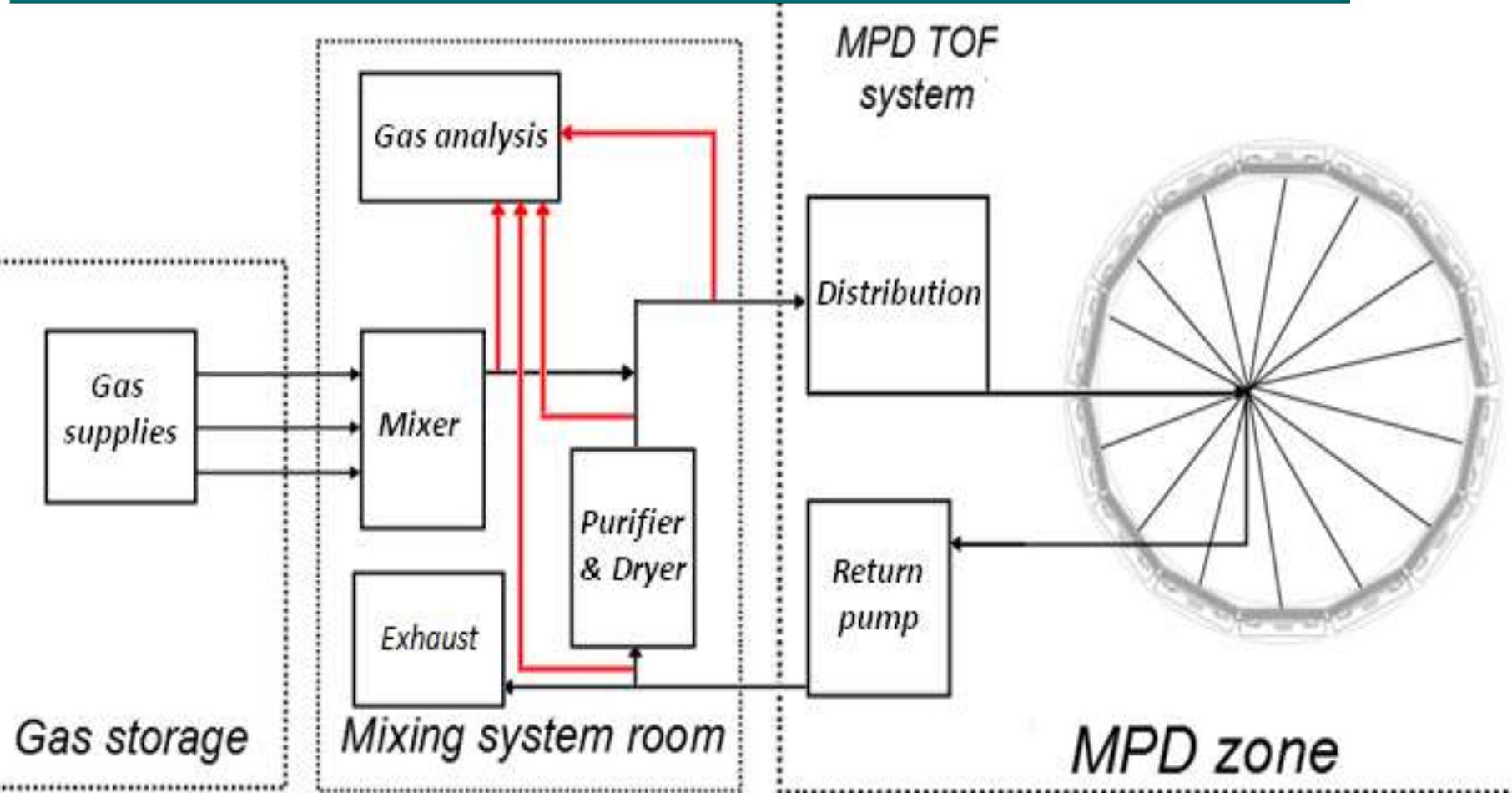


## 2. System gazowy dla detektorów TOF (Time-of-Flight detector)

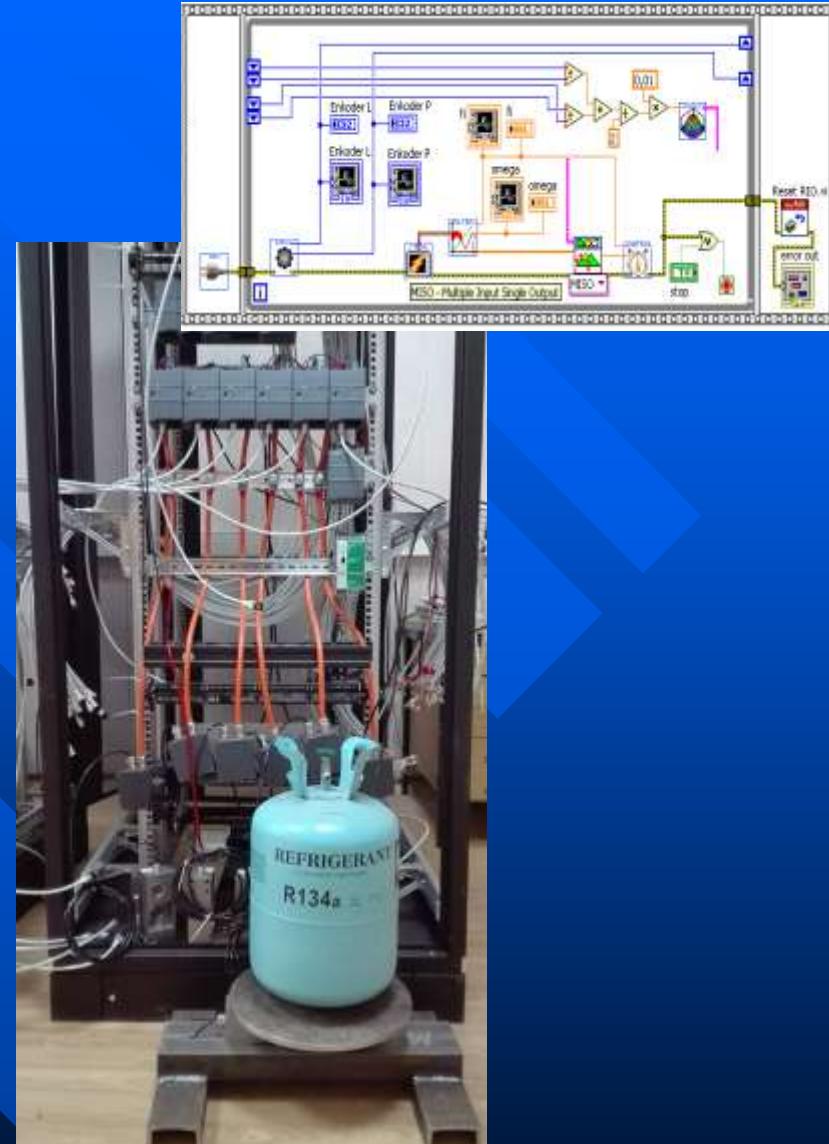
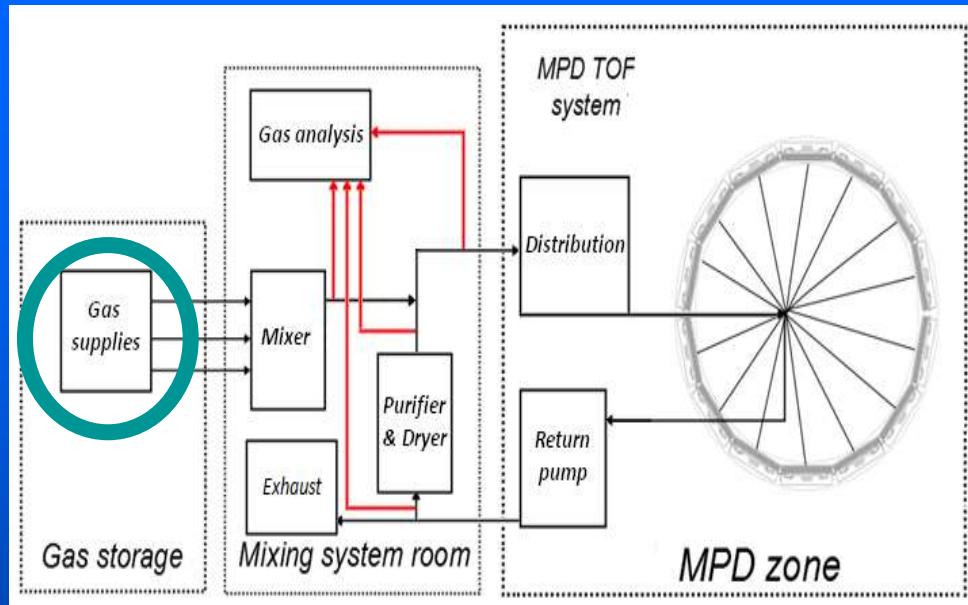


## 2. Gas system - Gas Mixture

90% C<sub>2</sub>H<sub>2</sub>F<sub>4</sub> + 5% i-C<sub>4</sub>H<sub>10</sub> + 5% SF<sub>6</sub>



## 2. System uzupełniania i kontroli



### 3. Students practice

1. *Pomiar wielkości transmutacji w podkrytycznych reaktorach jądrowych sterowanych akceleratorem ADS – wykorzystywanie jądrowych reakcji progowych do wyznaczania gęstości strumienia neutronów prędkich*
2. Dedykowany zestaw do pomiaru energii wydzielanej w zestawie eksperymentalnym naświetlanym wiązką z akceleratora - metodą pomiaru temperatury.
3. Badanie wpływu radiacji na działanie urządzeń elektronicznych - testowanie modułów pomiarowych na przykładzie pomiaru temperatury.

Publikacje dla chętnych studentów w materiałach Dubieńskich.



### 3. Students practice

<http://nica.fizyka.pw.edu.pl/do/view/Main/SlowControl>

[https://indico.cern.ch/event  
/629532/contributions/](https://indico.cern.ch/event/629532/contributions/)

<https://indico.cern.ch/event/472093>

Slow Control System Dubna 2017

2-22 July 2017  
JINR DUBNA  
European Nuclear Research Center

REJESTRACJA NA PRAKTYKI SLOW CONTROL DUBNA 2017 !!!

O Projekcie...  
LISTA PRZEJĘTYCH NA PRAKTYKI DUBNA 2017  
Informacje praktyczne  
Dodatekowe info...  
Procedura rejestracji...

Contribution List

28 / 25  Enter title or search string

0. TEMAT 01: Testowanie SCS, układu zdalnego startu dla detektora MPD – NICA  
M. Marek PERYT (Institute of Physics)

16-20 November 2016  
Centre for Innovation and Technology Transfer Management  
Warsaw University of Technology

NICA days 2015

3-7 November 2015, Warsaw  
Centre for Innovation and Technology Transfer Management  
Warsaw University of Technology

#### 4. Termistory PT100 (Резистивные термодатчики PT100)



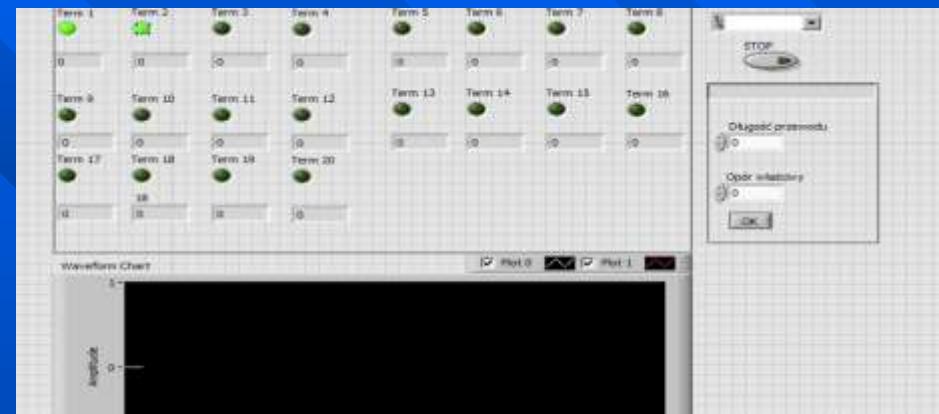
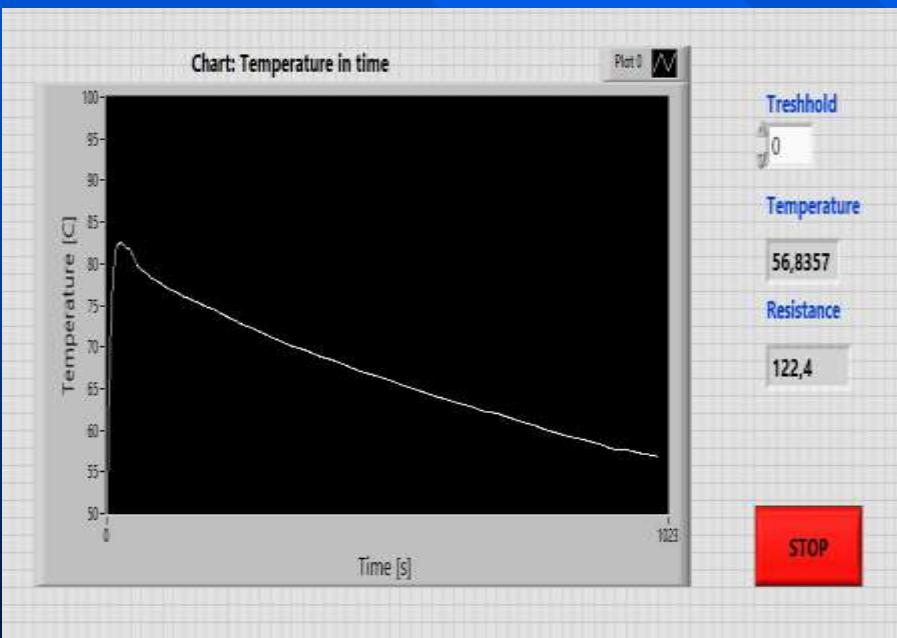
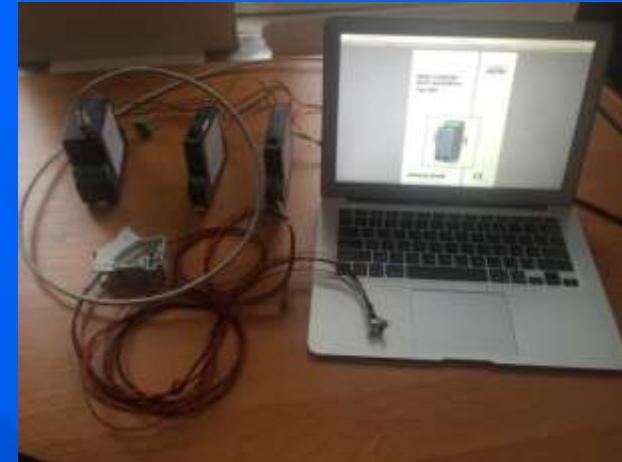
Digital-Analog converter SM1 LUMEL



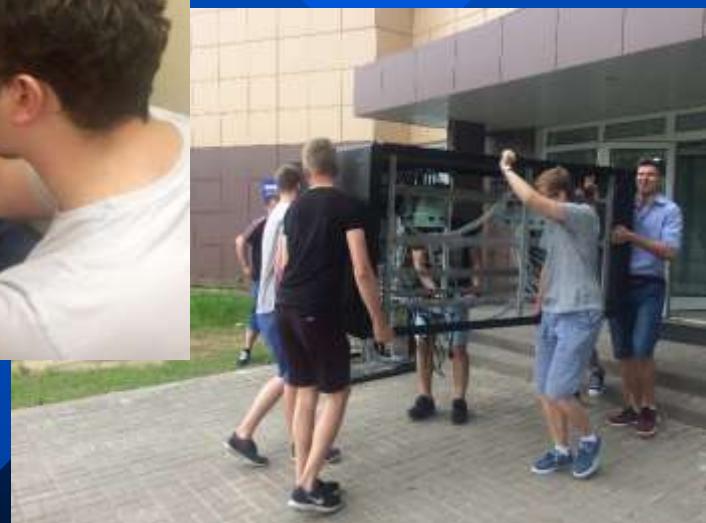
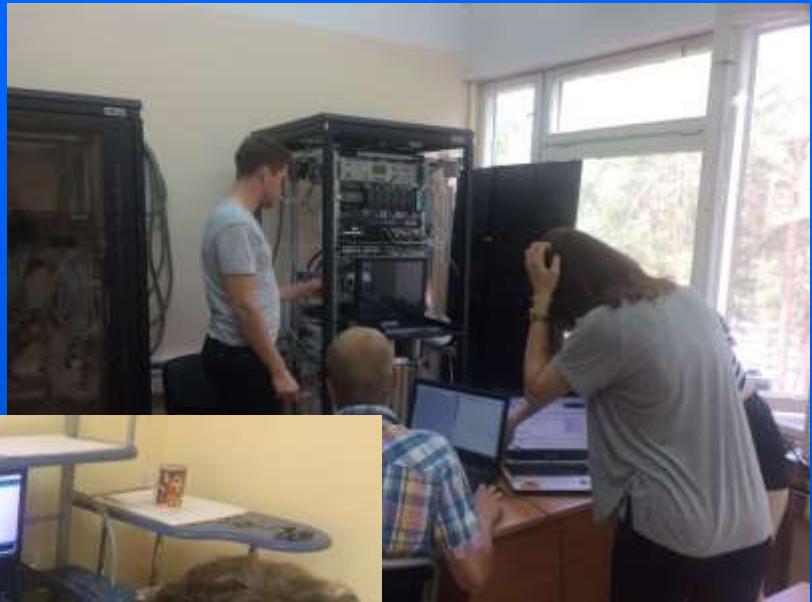
Data logger with WWW server - SM61 LUMEL



## 4. System kontrolny



### 3. Students practice



# Thank you for the cooperation

<http://nica.jinr.ru/>

<http://mpd.jinr.ru/>

<http://poland.jinr.ru/pl/>

