New Educational Projects of JINR for University Students

Yu. Panebrattsev

NICA Days 2015

Joint Institute for Nuclear Research

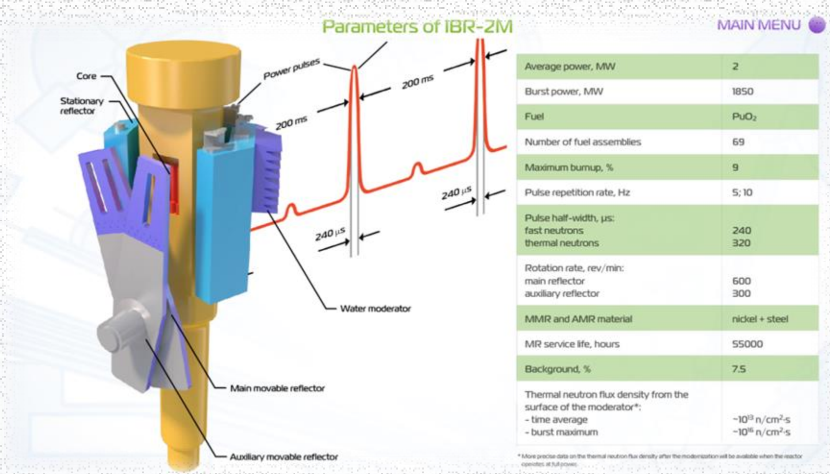
Basic Physical Facilities

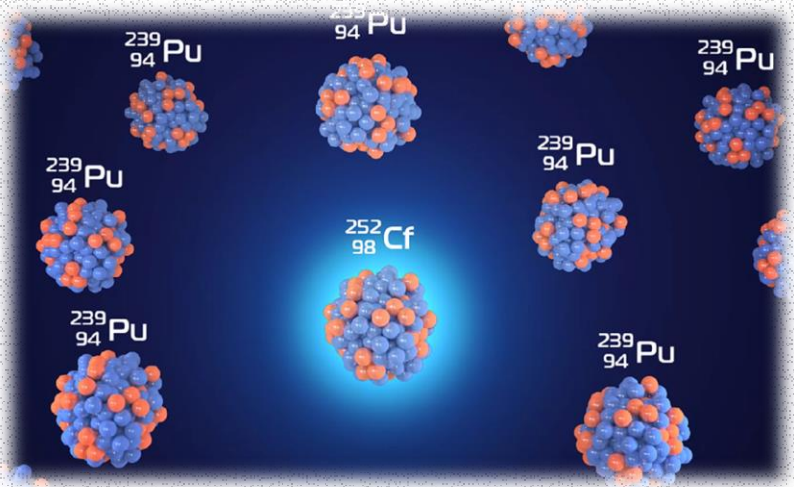
Neutron fast pulsed reactor – IBR-2

Accelerators of heavy ions

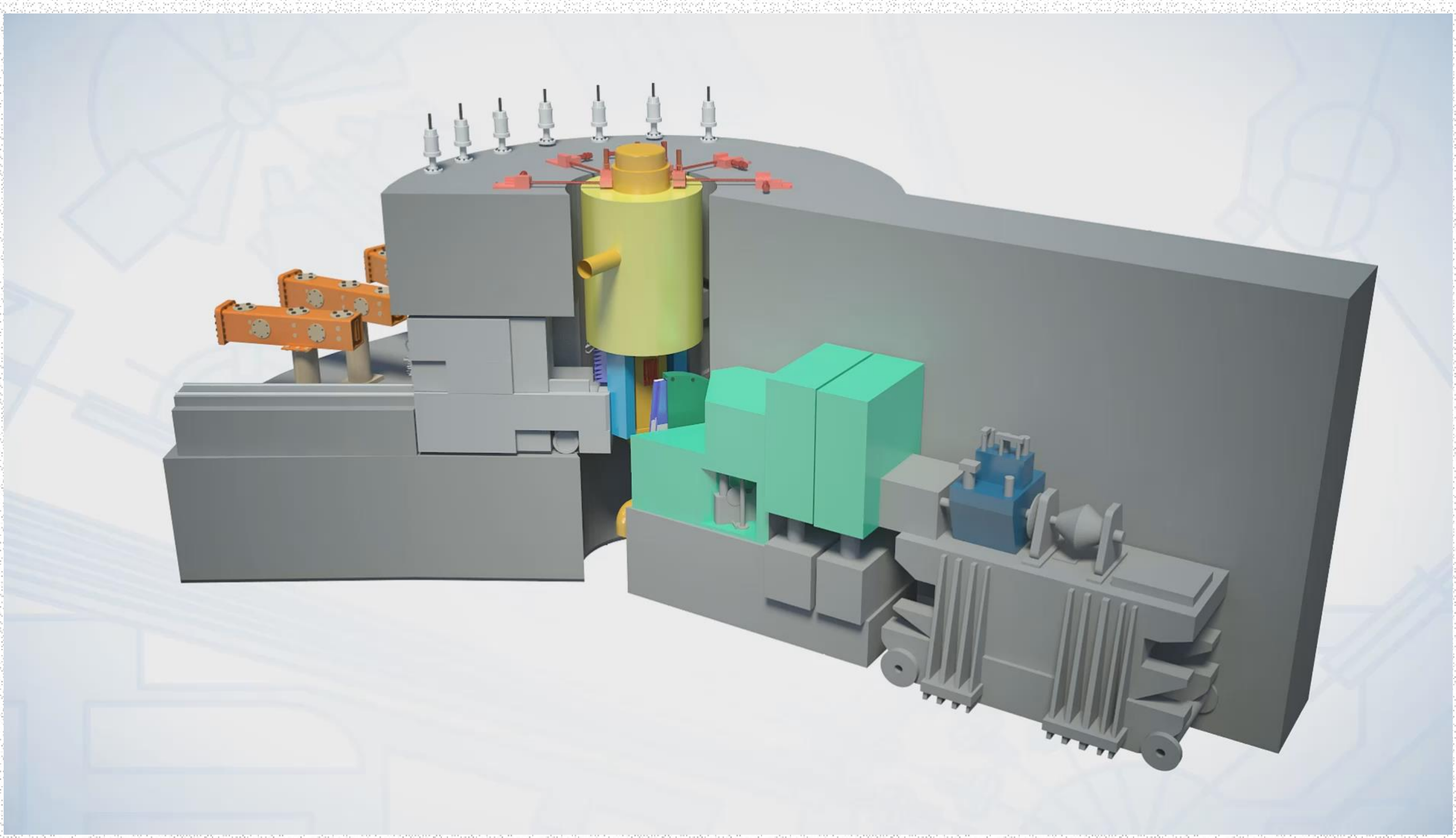
Accelerator of relativistic nuclei – Nuclotron

ИБР-2. Laboratory of Neutern Physics

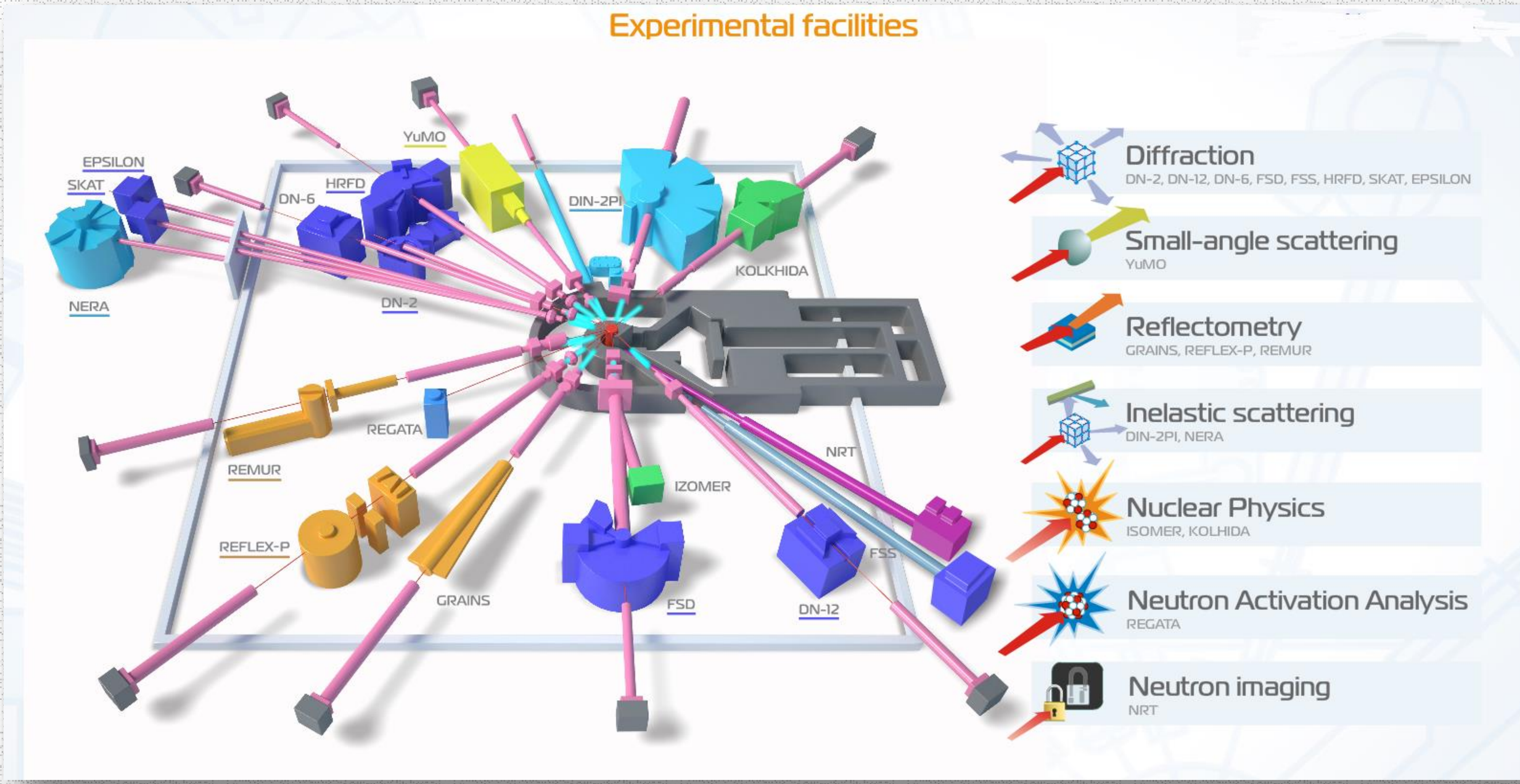




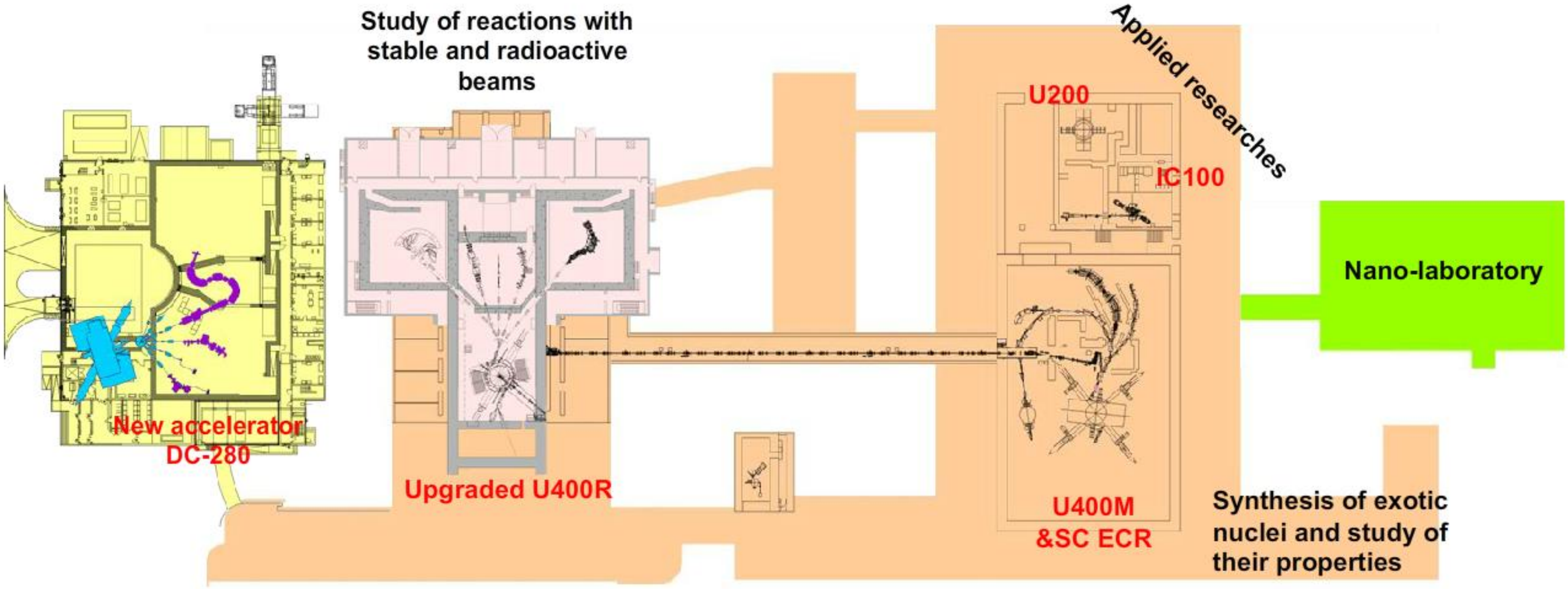
ИБР-2. Лаборатория нейтронной физики



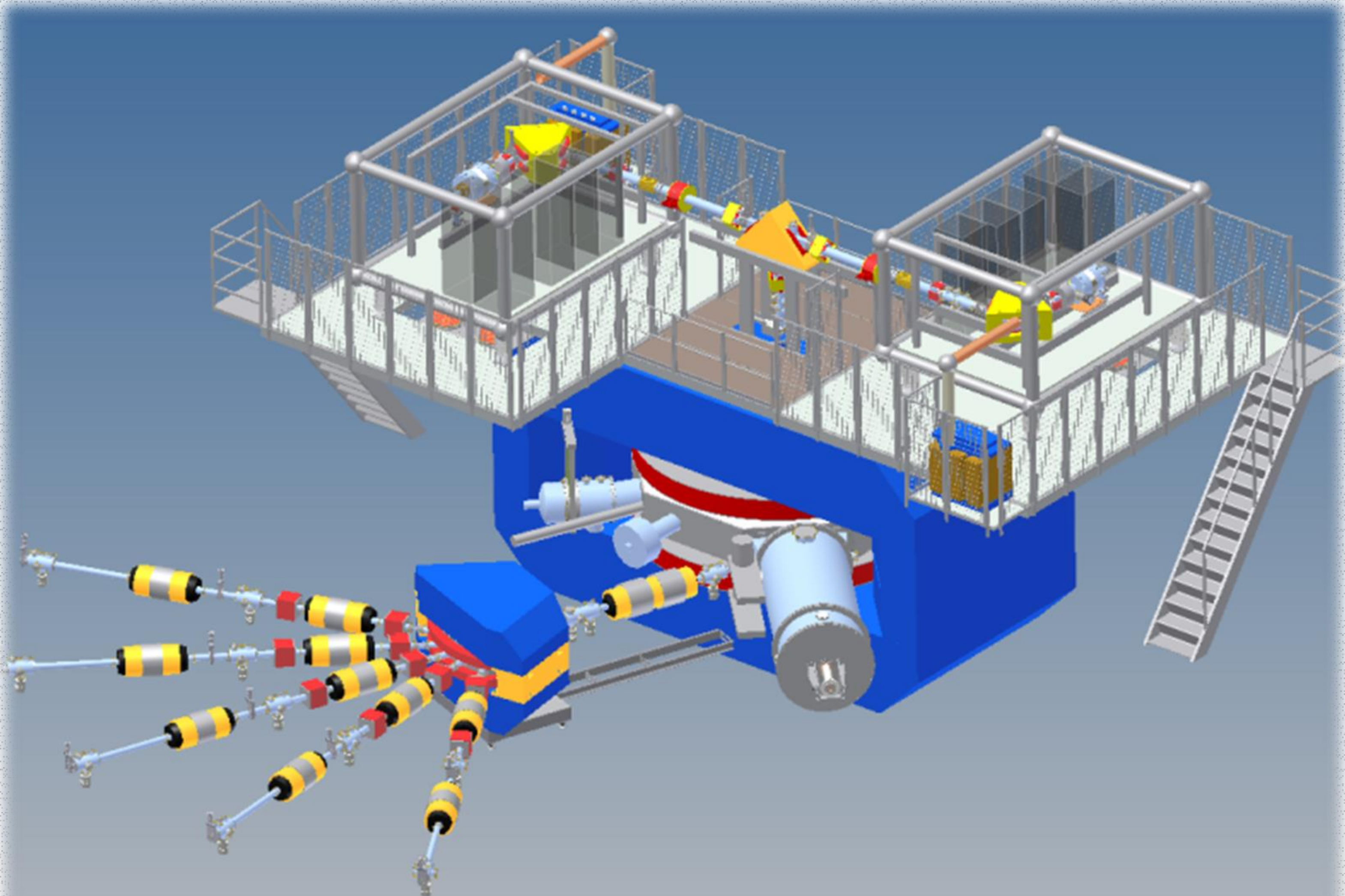
Frank Laboratory of Neutron Physics
JINR



SHE Factory – Фабрика сверхтяжёлых элементов.

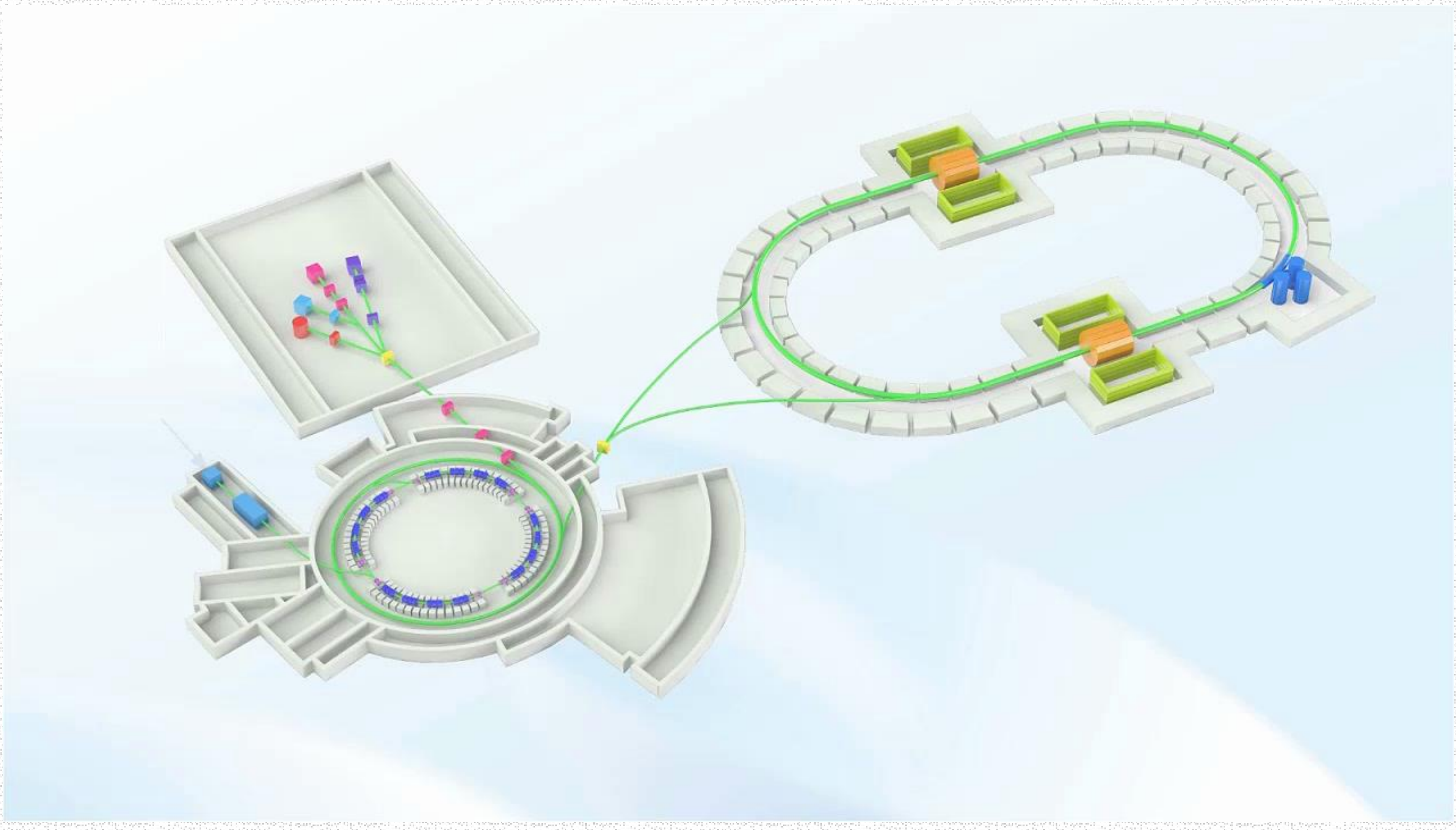


SHE Factory – Фабрика сверхтяжёлых элементов.



Новый ускоритель ДЦ-280

NICA/MPD - Laboratory of High Energy Physics



Educational Project for STAR and NICA/MPD Experiments

Joint Institute for Nuclear Research

The goals of the project

- To attract new students to this exciting field of research and the inclusion of results of experimental studies in the educational process.
- To provide students from various universities of new educational resources appropriated to their level of education about various modern experiments, facilities and international collaborations.
- To create community of students from different countries and universities interested in working on this area of science, will form a community of learners and teachers.

Nuclear Science and Technology

Scientists, Teachers and Students Global Community

Target Group

1. University students of Physics departments
2. Undergraduate students
3. Bachelors and Masters of Physics
4. Science teachers

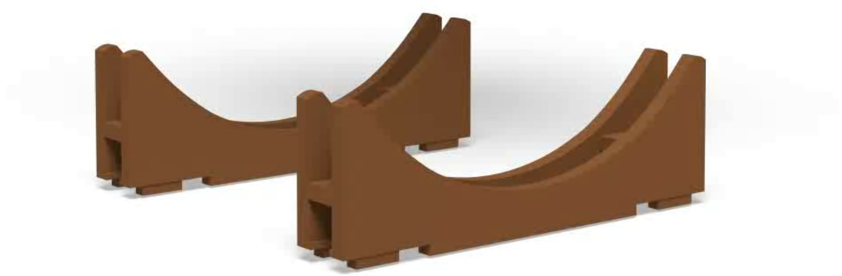
TOPICS

- General information
- Scientific Highlights
- Detectors subsystems
- Instruments and methods for data analysis
- Trigger system
- Control Room
- Virtual labs based on real experimental data
- Analysis Infrastructure. Tools for beginners.
- Contact Information for Students

The STAR Collaboration published in Physical Review Letters, Phys. Rev. Lett. 114, 022301 (2015), the first high statistics measurement of $\Lambda\Lambda$ correlation function in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV and it is also highlighted as PRL editors' suggestion. This research pioneered the venue of using RHIC as a hyperon factory to investigate hyperon-hyperon interactions. The STAR measurement can provide precious data for the understanding of hyperon-hyperon interaction which is an important input to various baryon-baryon interaction potential model as well as for the study of equation of state for neutron stars. The $\Lambda\Lambda$ interaction is also closely related to the existence of the H dibaryon, one of the most searched for exotic hadrons in nuclear collisions.

Official website: www.star.bnl.gov

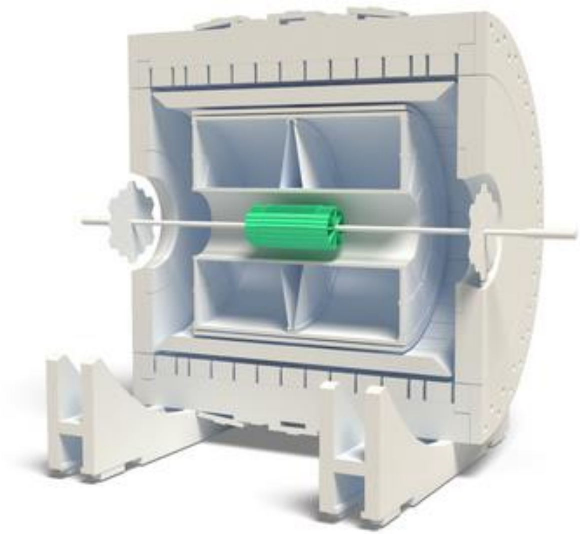
STAR Detectors Subsystems



STAR Detectors Subsystems

HIDE MENU

STAR Detector



- ▶ All systems
- Magnet
- BEMC
- TOF
- TPC
- ▶ HFT
  - SSD
  - IST
  - PXL
- BBC
- MTD

General Info | Technical Info | Operating principle | Photos

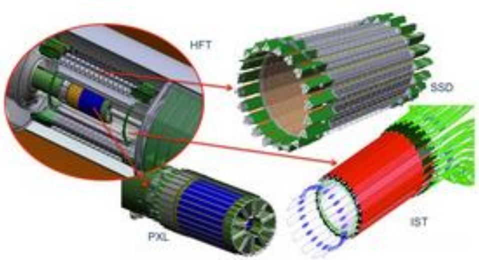


Fig.1 HFT parts

Sub detector	r (cm)	Sensitive units	$\sigma_{R\text{-}\varphi(\mu m)}$	$\sigma_{z(\mu m)}$	X/X_0 (%)
Silicon Strip Detector	22	2 side strips with 95 µm pitch	20	740	1
Intermediate Silicon Tracker	14	600 µm × 0.6 cm strips	170	1800	<1.5
PIXEL	2.5/8	18 µm pixel pitch	12	12	0.4/layer

Trigger System

Trigger system

Event Triggering (educational model) | The STAR Trigger System (manual)

The Solenoidal Tracker at RHIC (STAR) is designed to detect charged and neutral particles produced in relativistic heavy ion collisions. The majority of the STAR data is provided by relatively slow detectors: TPC, SVT, FTPC, EMC. The trigger system must look at every RHIC crossing and decide whether or not to accept that event and initiate recording the data.

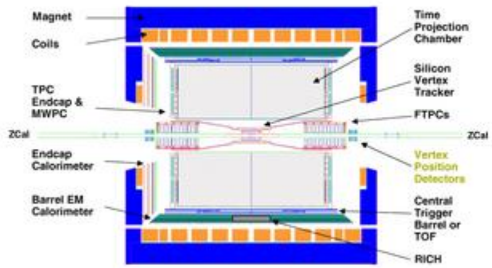


Figure 1. The STAR detector

TRIGGER DETECTORS

A schematic diagram of all the trigger detectors showing how they fit together in the STAR system.

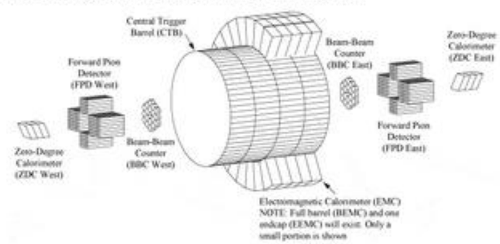
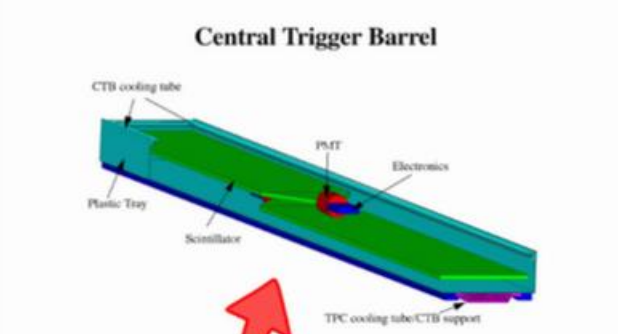


Figure 2. A schematic diagram of all the trigger detectors

- **CTB (Central Trigger Barrel)** – The Central Trigger Barrel consists of 240 scintillator slats arranged around the TPC. Each slat is viewed by one PMT. The CTB covers a region from −1 to +1 in h and 0 to 2p in f. It measures charged multiplicity in this region of phase space.



Analysis Infrastructure. Tools for beginners

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STAR Experiment

- General information
- Scientific Highlights
- STAR detectors subsystems
- Instruments and methods for data analysis
- Trigger system
- Control Room
- Virtual labs based on real experimental data
- STAR Analysis Infrastructure
- Contact Information for Students

HIDE MENU

STAR Analysis Infrastructure. Tools for beginners

"Introduction to STAR software and makers", Leszek Kosarzewski, Warsaw University of Technology (PDF)

The STAR detector tracks thousands of particles (see Fig.1) produced in Au + Au, U + U, Cu + Cu and polarized p + p collisions. While STAR collects physics data, there are always large volumes of accompanying meta-data to track, store and analyze. The STAR detector is composed of over two dozen subsystems operating in concert while RHIC provides colliding beams. Hundreds of scientists and engineers are watching the data-taking process and tuning detector performance by checking meta-data streams produced by detector components. To ease the procedure of collection, analysis and review of that meta-data, STAR software group created an MQ-based MIRA framework.

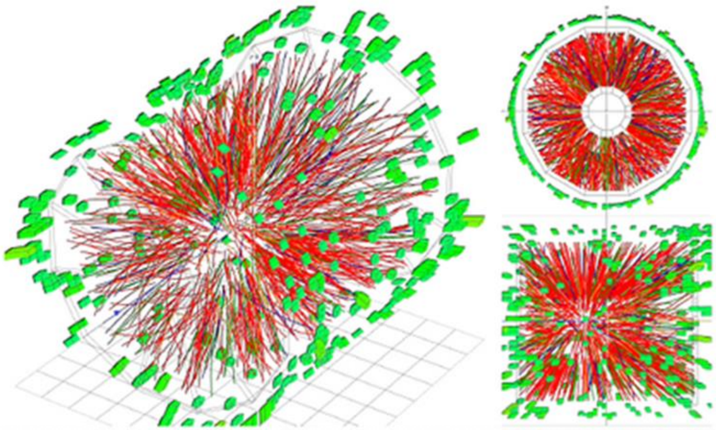

Fig. 1. STAR U + U event at energy 193 GeV per nucleon

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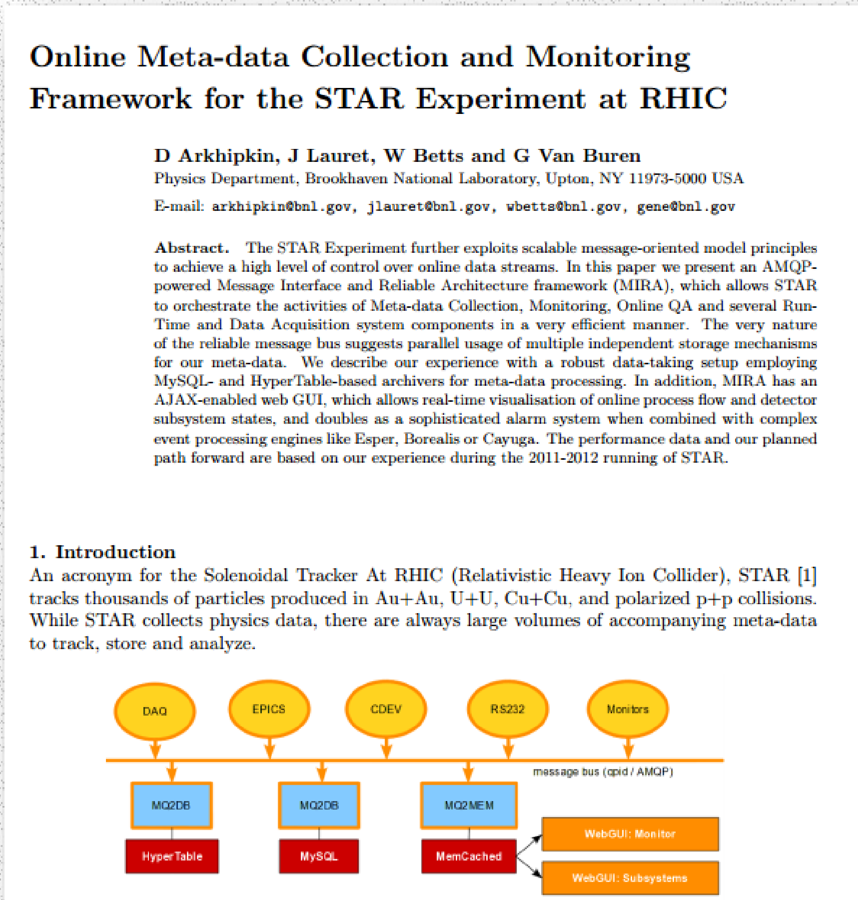

Online Meta-data Collection and Monitoring Framework for the STAR Experiment at RHIC

D Arkhipkin, J Lauret, W Betts and G Van Buren
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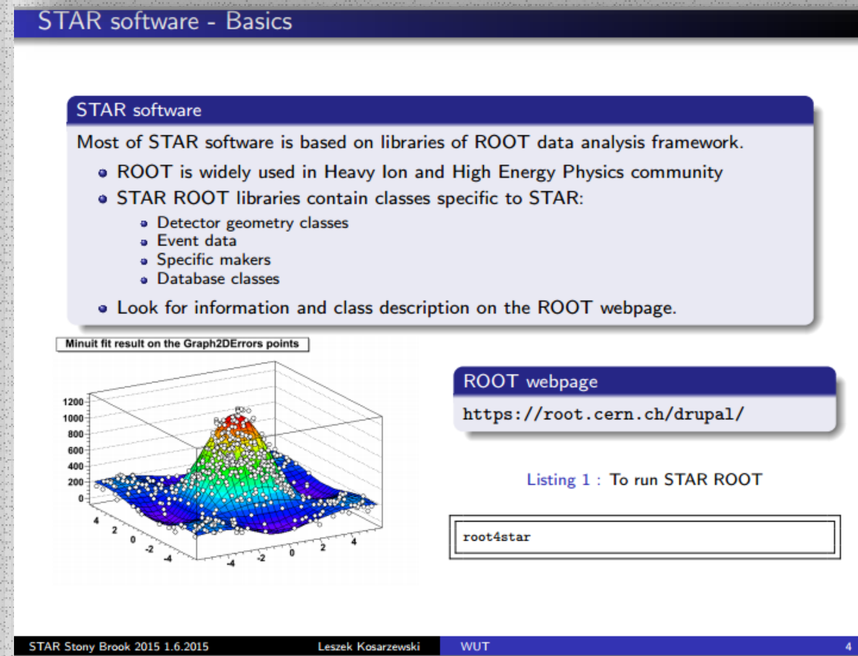
Abstract. The STAR Experiment further exploits scalable message-oriented model principles to achieve a high level of control over online data streams. In this paper we present an AMQP-powered Message Interface and Reliable Architecture framework (MIRA), which allows STAR to orchestrate the activities of Meta-data Collection, Monitoring, Online QA and several Run-Time and Data Acquisition system components in a very efficient manner. The very nature of the reliable message bus suggests parallel usage of multiple independent storage mechanisms for our meta-data. We describe our experience with a robust data-taking setup employing MySQL- and HyperTable-based archivers for meta-data processing. In addition, MIRA has an AJAX-enabled web GUI, which allows real-time visualisation of online process flow and detector subsystem states, and doubles as a sophisticated alarm system when combined with complex event processing engines like Esper, Borealis or Cayuga. The performance data and our planned path forward are based on our experience during the 2011-2012 running of STAR.

1. Introduction

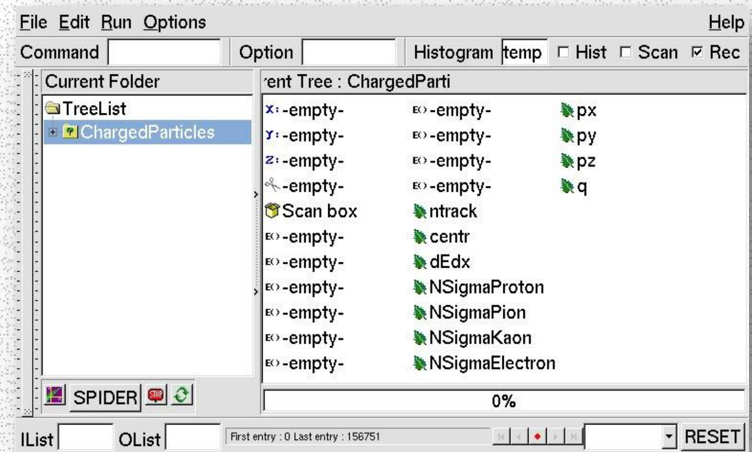
An acronym for the Solenoidal Tracker At RHIC (Relativistic Heavy Ion Collider), STAR [1] tracks thousands of particles produced in Au+Au, U+U, Cu+Cu, and polarized p+p collisions. While STAR collects physics data, there are always large volumes of accompanying meta-data to track, store and analyze.

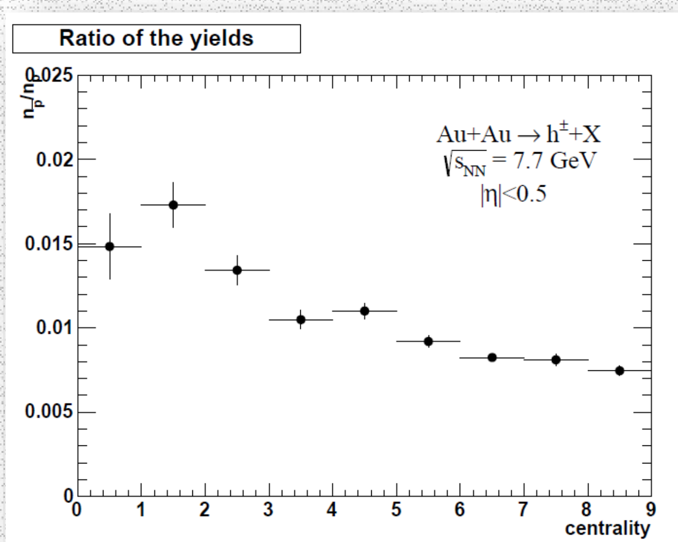


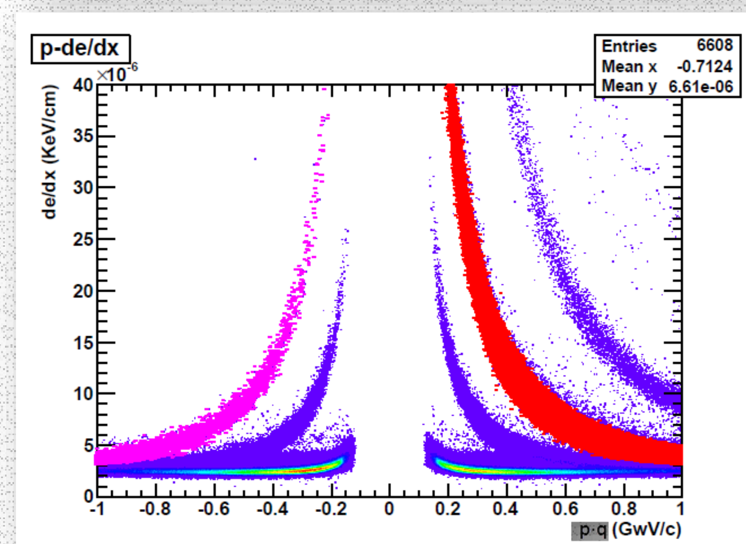
Practicum on Real Experimental Data

Virtual labs based on real experimental data: “Measurement of proton and antiproton yields in the central collisions at RHIC energies”

- ❑ Real data
- ❑ Physical task
- ❑ PicoDST
- ❑ Algorithm
- ❑ Results
- ❑ Analysis
- ❑ Conclusions

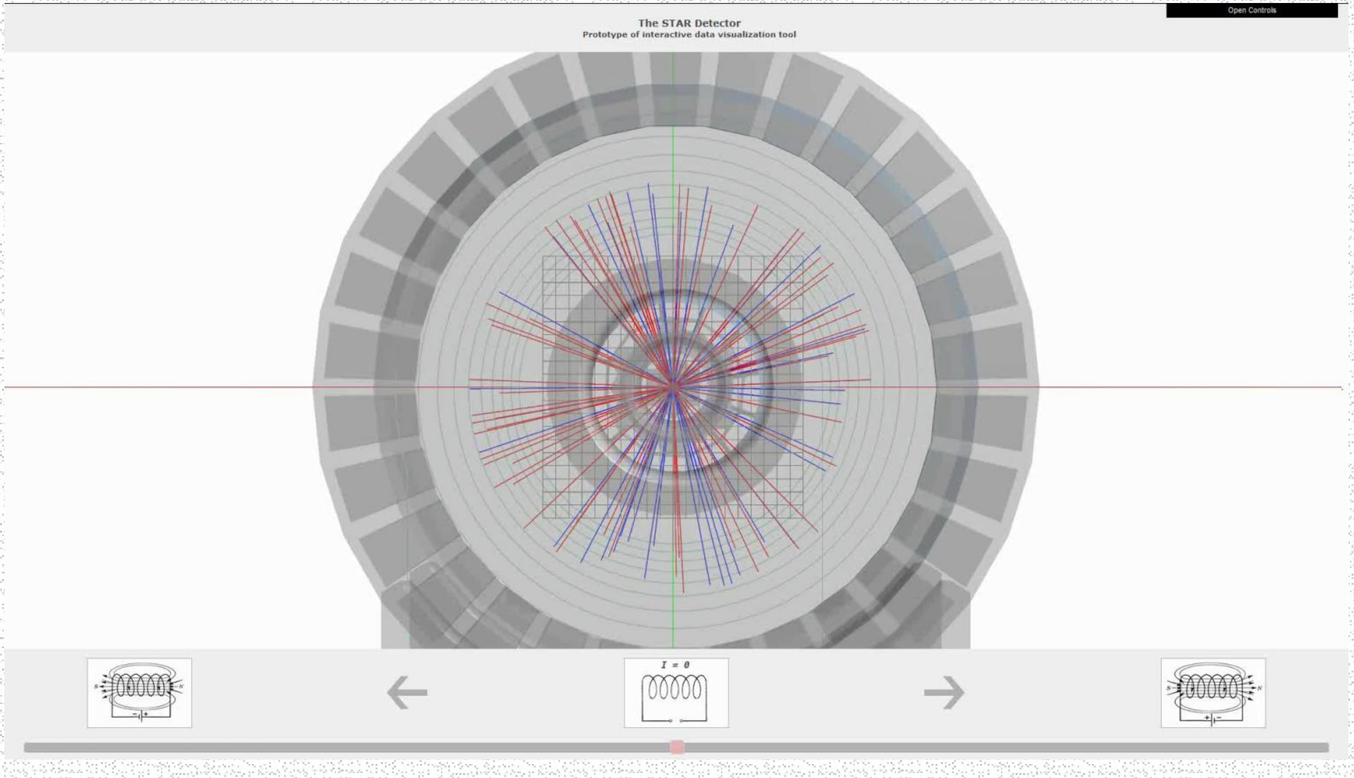






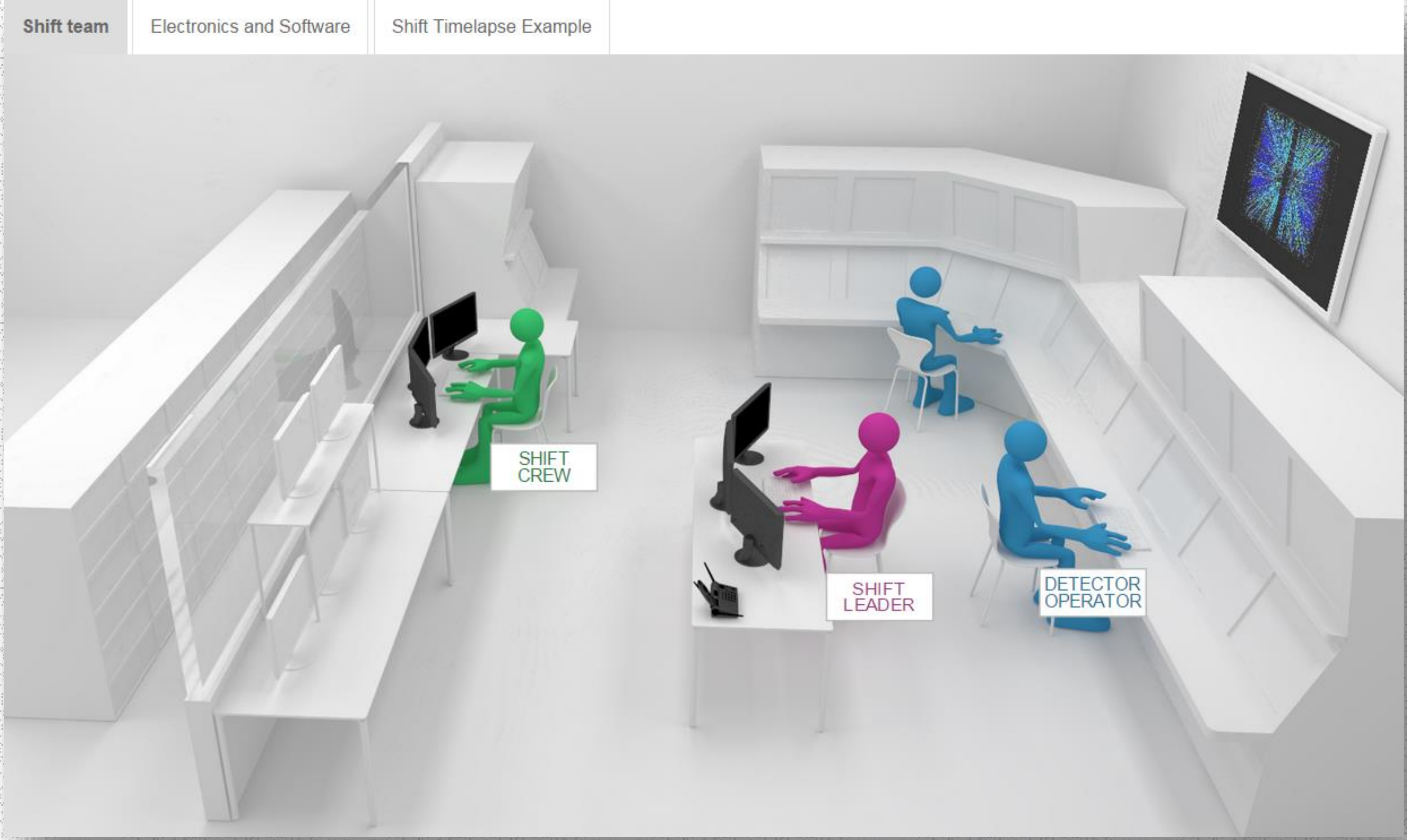
Practicum on Real Experimental Data

- Currently a lab used experimental data on the gold-gold collisions at different energies from 7.7 to 200 GeV to study production of antiprotons at RHIC collider is realized.
- As instrument for the complex study of events it is developed the module to visualize events using interactive 3-D graphics



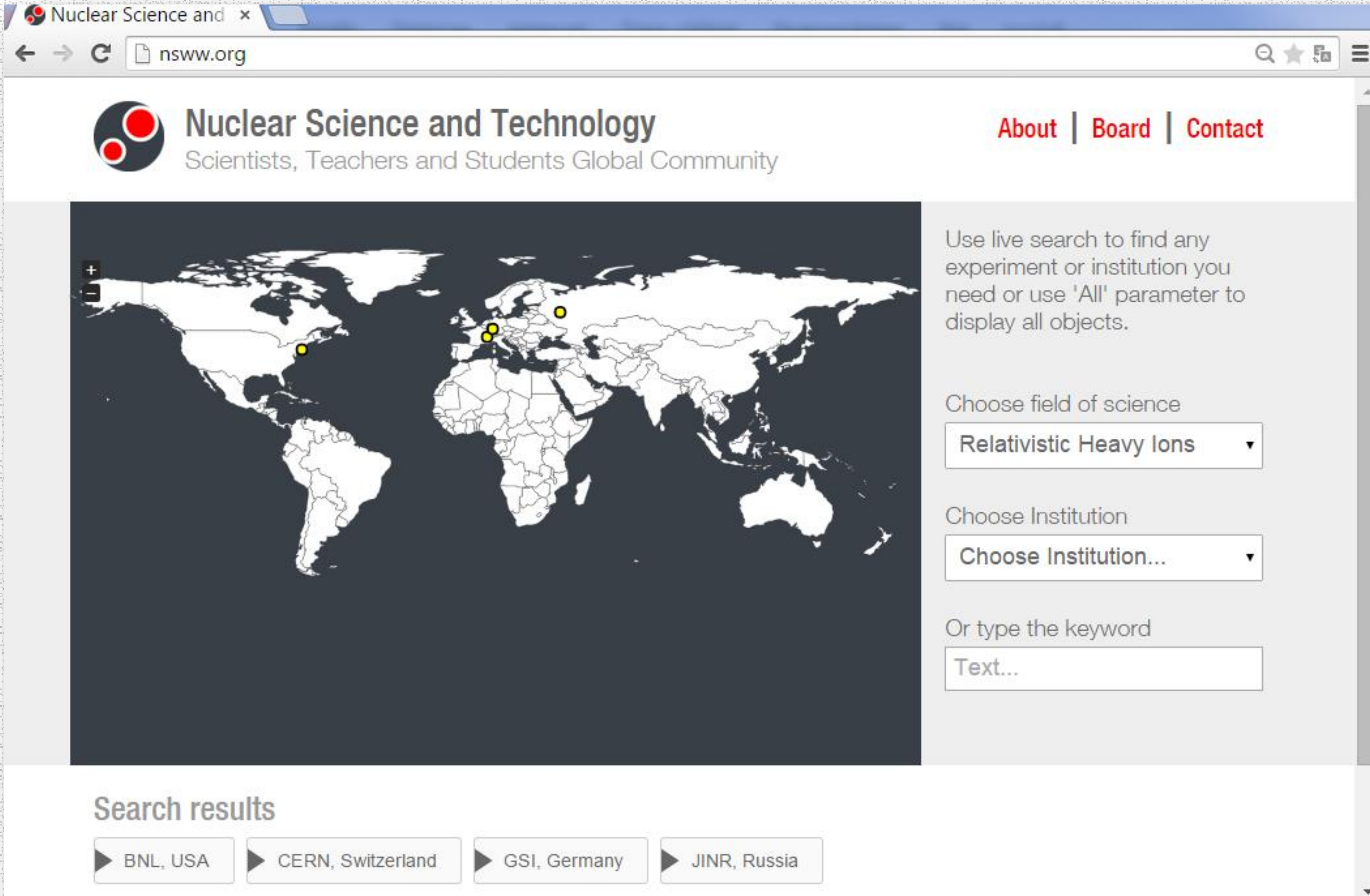
Control Room

Purpose: students, future STAR shift members. Interactive information system of the STAR control room and the shift team. Includes the detailed description of the team member roles, duties, instructions, trainings and practical exercises; description about electronics and software.



Control Room

NSWW.org



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CERN, Switzerland
GSI, Germany
JINR, Russia

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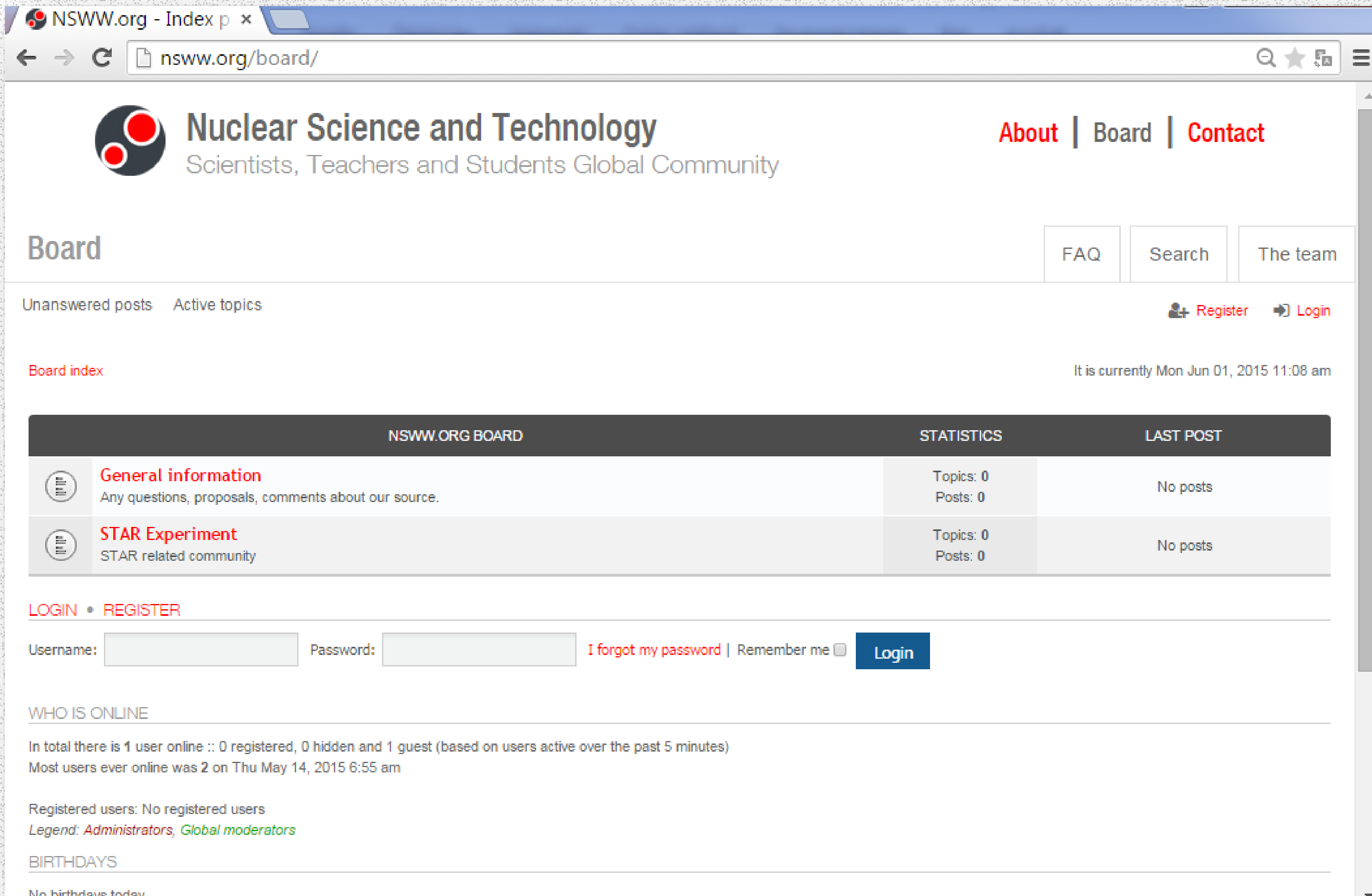
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In total there is 1 user online :: 0 registered, 0 hidden and 1 guest (based on users active over the past 5 minutes)
Most users ever online was 2 on Thu May 14, 2015 6:55 am
Registered users: No registered users
Legend: Administrators, Global moderators
BIRTHDAYS
No birthdays today

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JOINT INSTITUTE FOR NUCLEAR RESEARCH

science & technology

Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

Hardware-Software Complex “Virtual Laboratory of Nuclear Fission”

The goal of the Project

The goal of the project is the integration of technological elements of modern science into the educational process, carrying out labs based on combination of real equipment, virtual and online laboratory research using data obtained from the existing physical facilities.

Light Ions Spectrometer

- As a first step we have chosen an actual scientific problem – the study of spontaneous fission using the spectrometer LIS from Flerov Laboratory of Nuclear Reactions, JINR

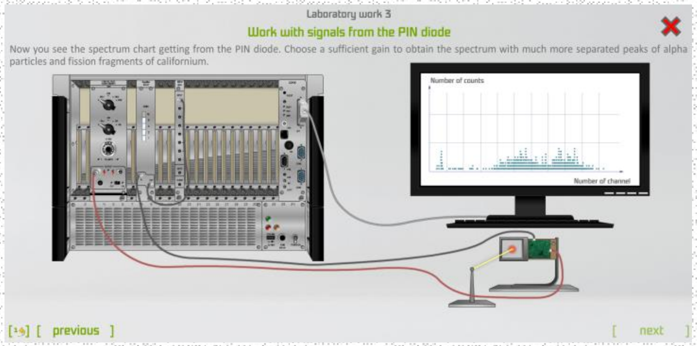
LIS setup with timestamp detectors based on MCP

The project is comprised of three educational levels:

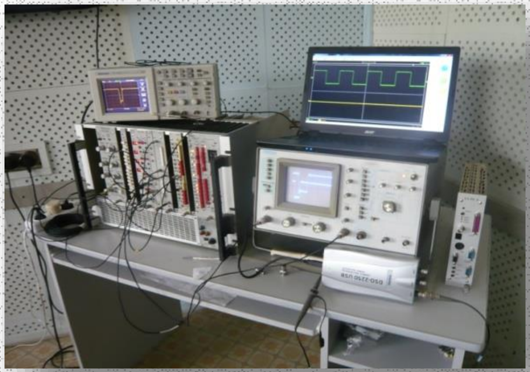
- ***Elementary level***. A typical target group at this level are high school students, science teachers, undergraduate students and participants of summer practices.
- ***Basic level.*** The goal at this level is to study various types of radiation detectors, nuclear electronics & DAQ and some important methods of experimental data processing.
- ***Advanced level***. A typical target group at this level are students who plan to prepare their bachelor and master theses based on the measurements at the LISSA project. This level may be useful as a training before independent work as experimentalists in nuclear physics.

Practicum types

- Virtual labs

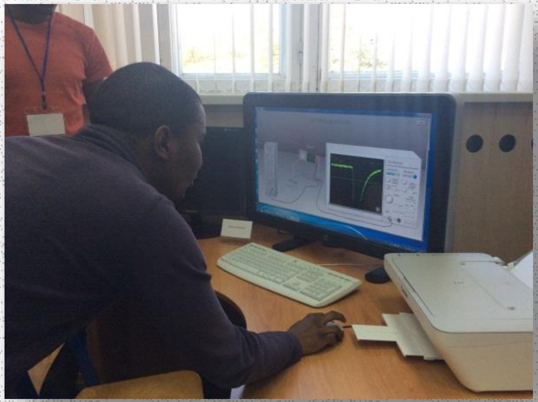


- Real equipment



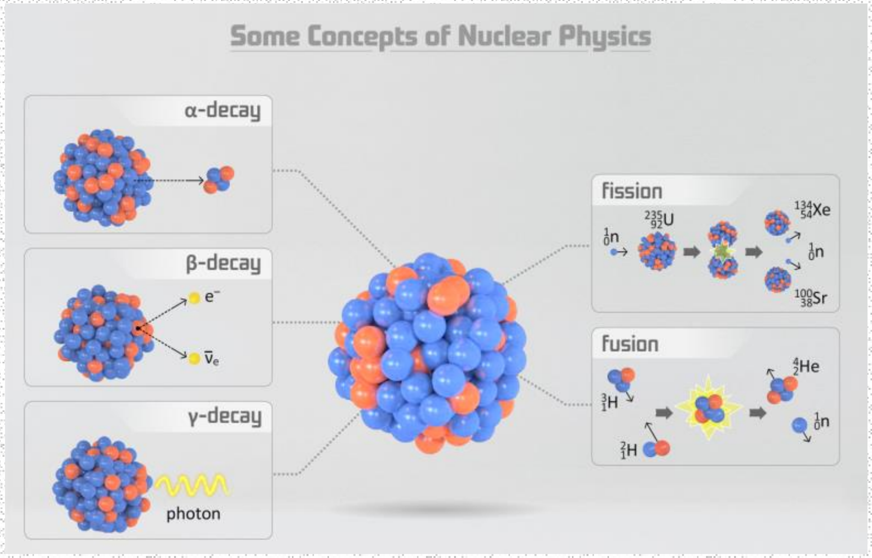
- Remote labs

- LabView

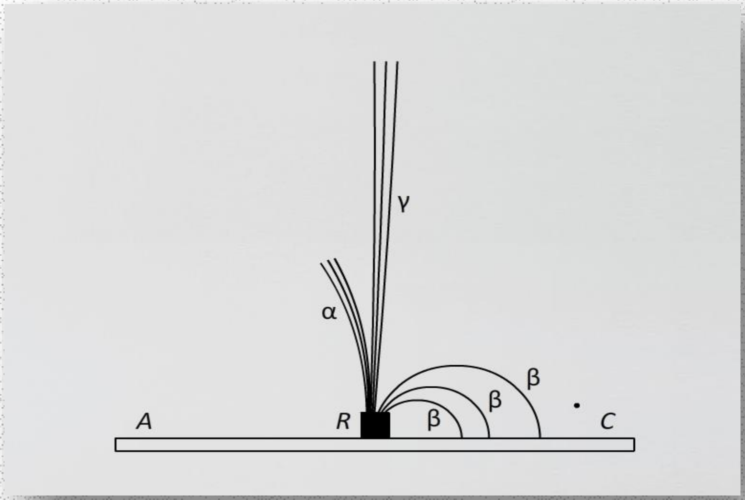


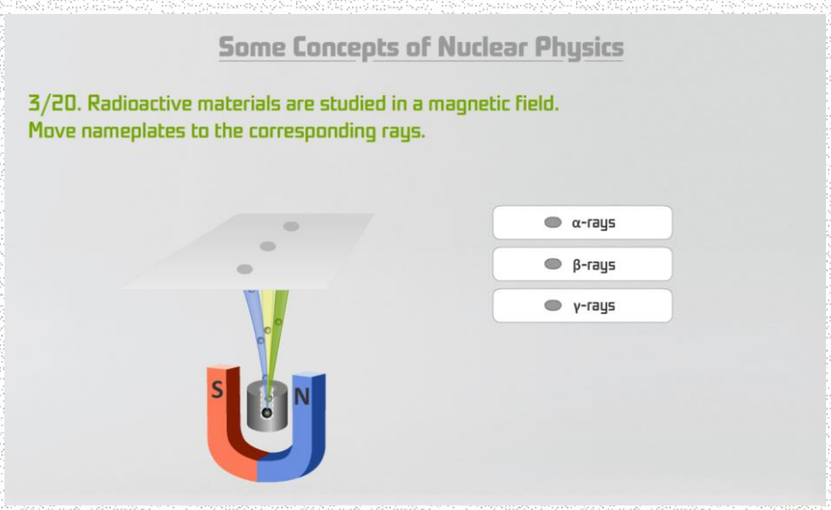
Part 1. Some Concepts of Nuclear Physics

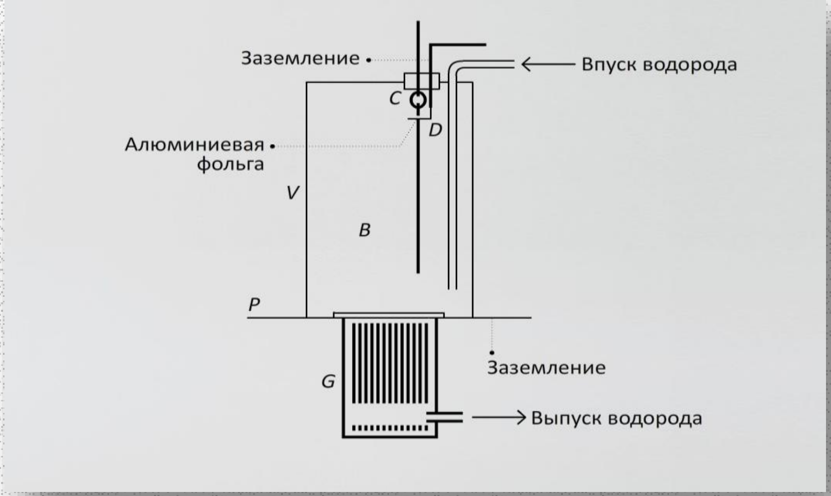
1. Introduction
2. Proton-Neutron Nuclear Model
3. Mass – Energy – Momentum
4. Nuclear Energy: Fusion and Fission
5. Radioactivity:
6. Alpha Decay
7. Beta Decay
8. Gamma Decay
9. Spontaneous Fission
10. Radioactive Decay Law
11. Quiz
12. Exercises



Exercises for experimentalists

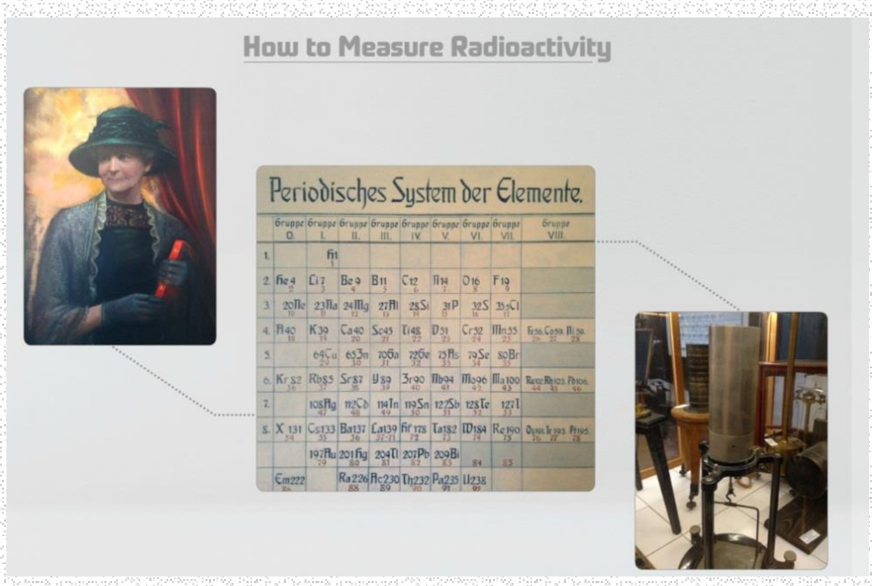




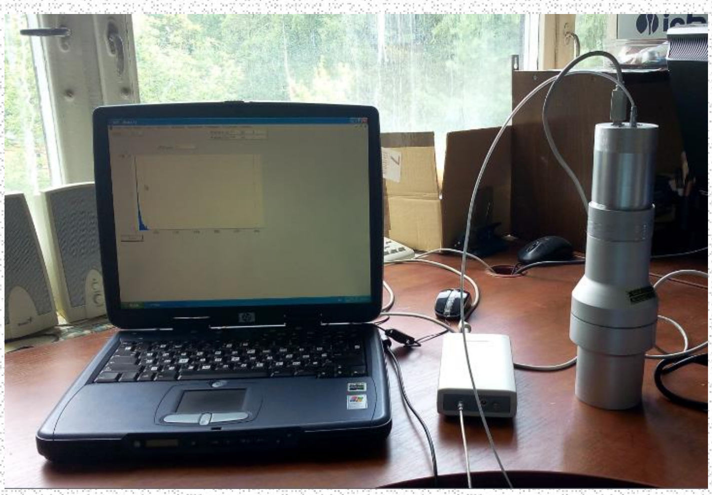


Part 2. How to Measure Radioactivity

1. Introduction
2. Radioactive Sources
3. Interaction of Radiation with Matter
4. Radiation Detectors:
    - Gas-Filled Detectors
    - Scintillation Detectors
    - PIN Diodes
    - Detectors Based on Microchannel Plates
5. Measurement of Radioactivity
6. Quiz
7. Practicum



Practicum

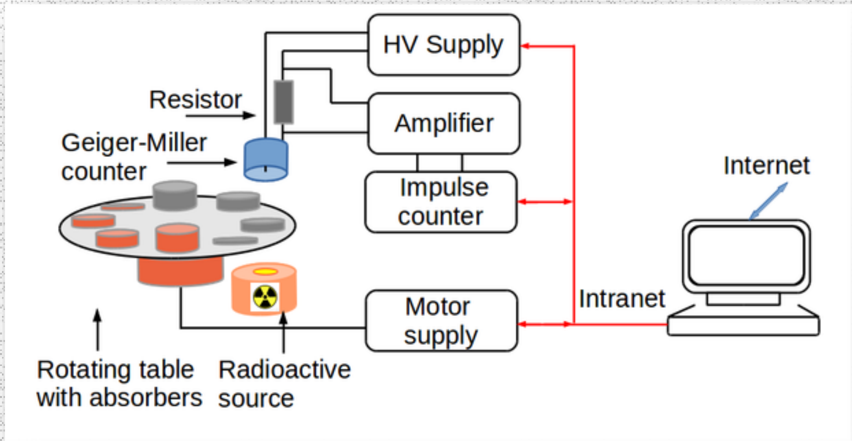


Skills:

1. Work with oscilloscopes and pulse generators
2. Work with scintillation detectors (NaI, CsI, plastic)
3. Measurements and spectrum analysis
4. Coincidence method and registration of cosmic particles

Remote labs

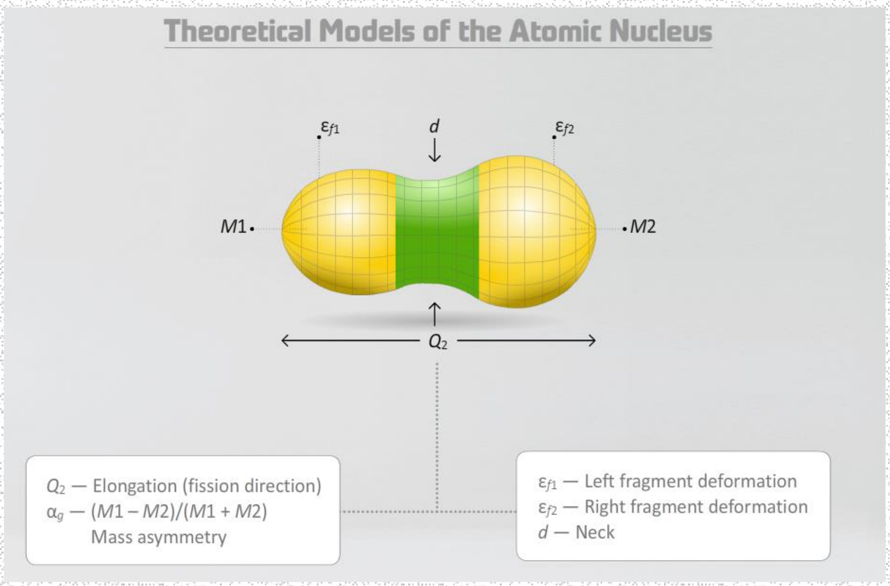
WARSAW UNIVERSITY OF TECHNOLOGY



In collaboration with the Warsaw University of Technology the remote lab for studying of attenuation of gamma radiation was implemented.

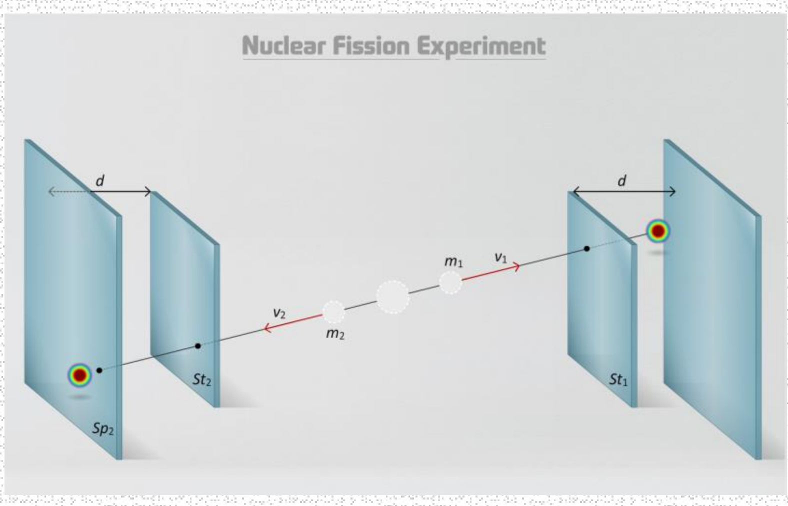
Part 3. Theoretical Models of the Atomic Nucleus

1. Introduction
2. Nuclear Models
3. Quantum Mechanics in Nuclei
4. Fission and Quantum Tunneling
5. Basic Regularities of Spontaneous Fission
6. Collinear Cluster Tri-Partition (CCT)
7. Quiz
8. Exercises



Part 4. How to Measure Nuclear Fission

1. Introduction
2. Physics of Binary Fission
3. Methods of Detection of Fission Fragments
4. Energy Measurements of Fission Fragments
5. Time Measurements of Fission Fragments
6. Quiz
7. Practicum



Part 5. Light Ions Spectrometer – Measurements

1. Physical Motivation
2. LIS Setup
3. Electronics of the LIS Setup
4. Block Diagram and Data Acquisition System
5. CAMAC Practicum
6. PIN Diode Calibration
7. Time of Flight Calibration
8. LIS Manual

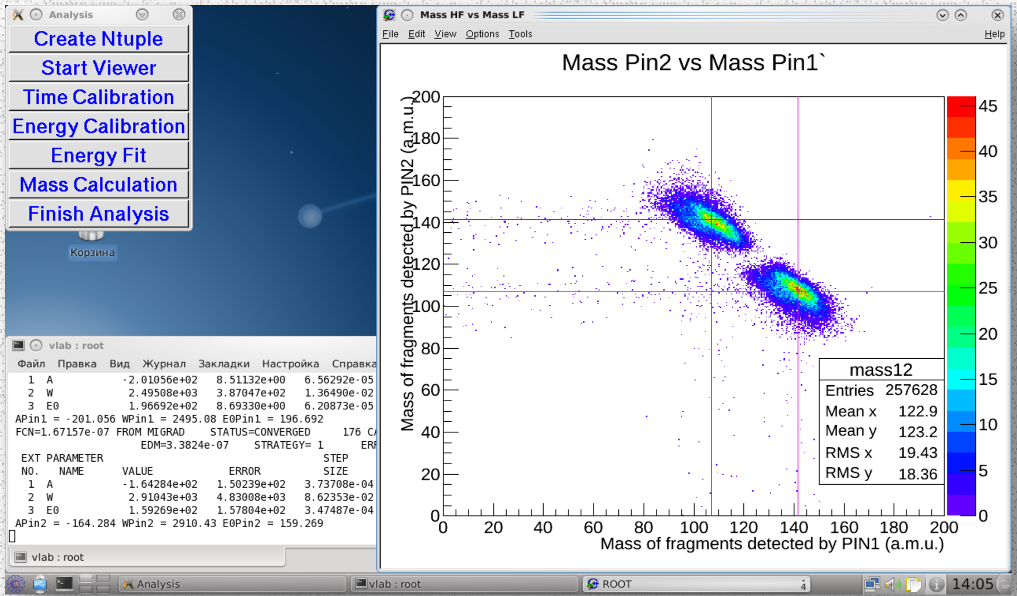
Light Ions Spectrometer – Practicum

Skills:

1. Vacuum system preparation
2. Measurements of PIN diode signals from the alpha source
3. Measurements of thin foil thickness and Bragg's peak obtaining

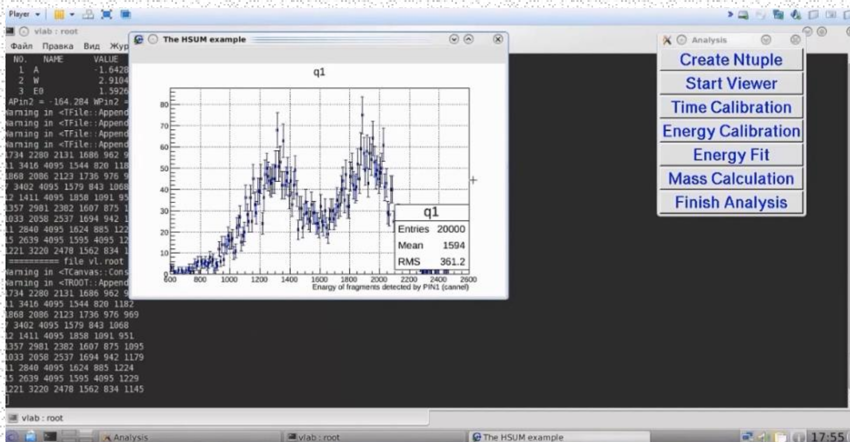
Part 6. Light Ions Spectrometer – Data Analysis

1. Introduction
2. Data Viewer
3. Time and Energy Calibration
4. Energy and Mass Fit
5. Exercises
6. ROOT Manual
7. ROOT Practicum



Data analysis – ROOT Practicum

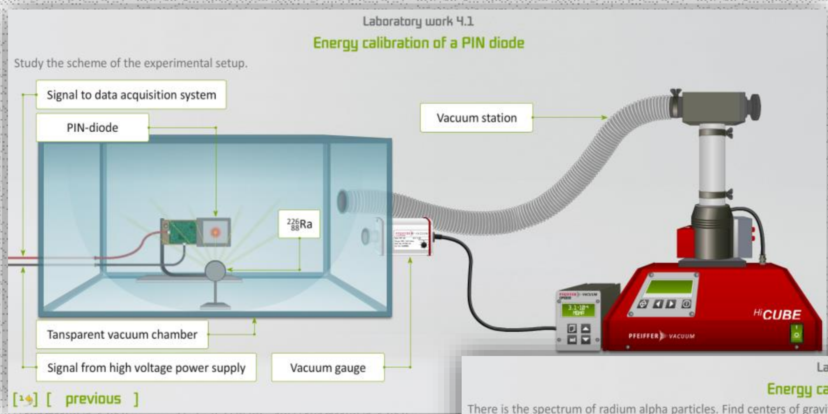
Data analysis from LIS setup



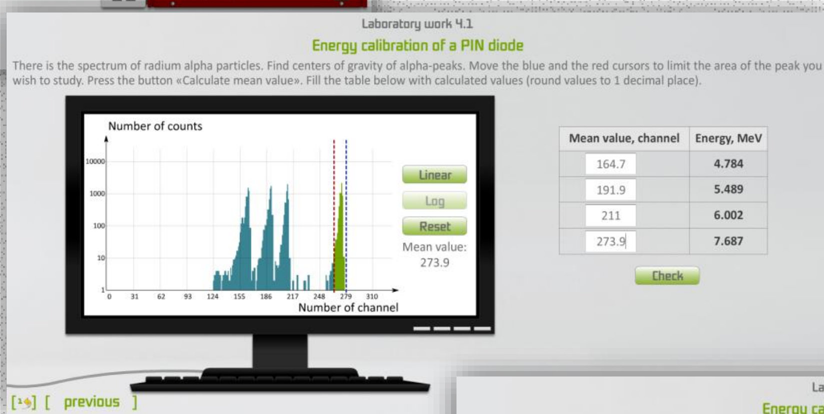
1. Analysis of data obtained from LIS setup using ROOT

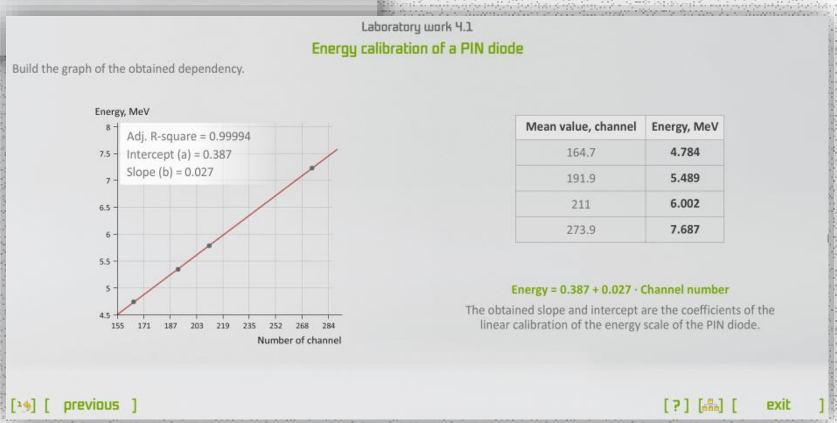
2. Data analysis of signals from 5 GS/s Switched Capacitor Digitizer

«Virtual laboratory of spontaneous fission»



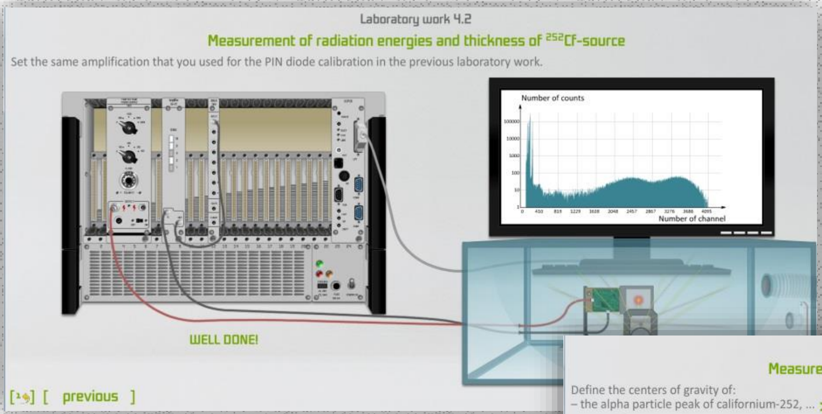
Калибровка PIN-детектора



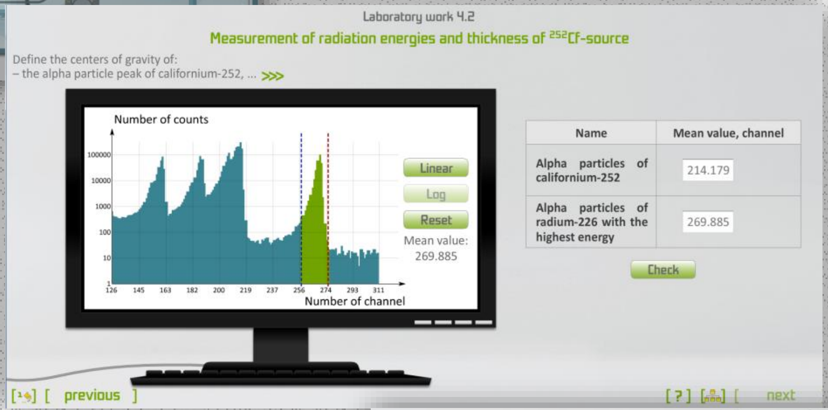


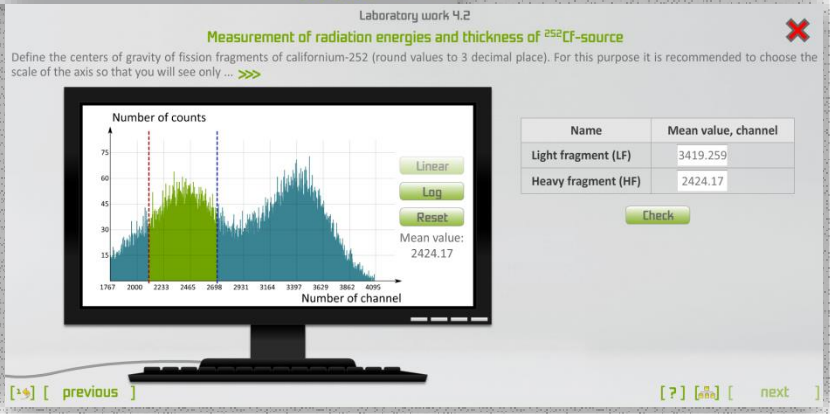
- Изучение спектра от радия-226
- Выбор коэффициента усиления сигнала
- Построение калибровочного графика

«Virtual laboratory of spontaneous fission»



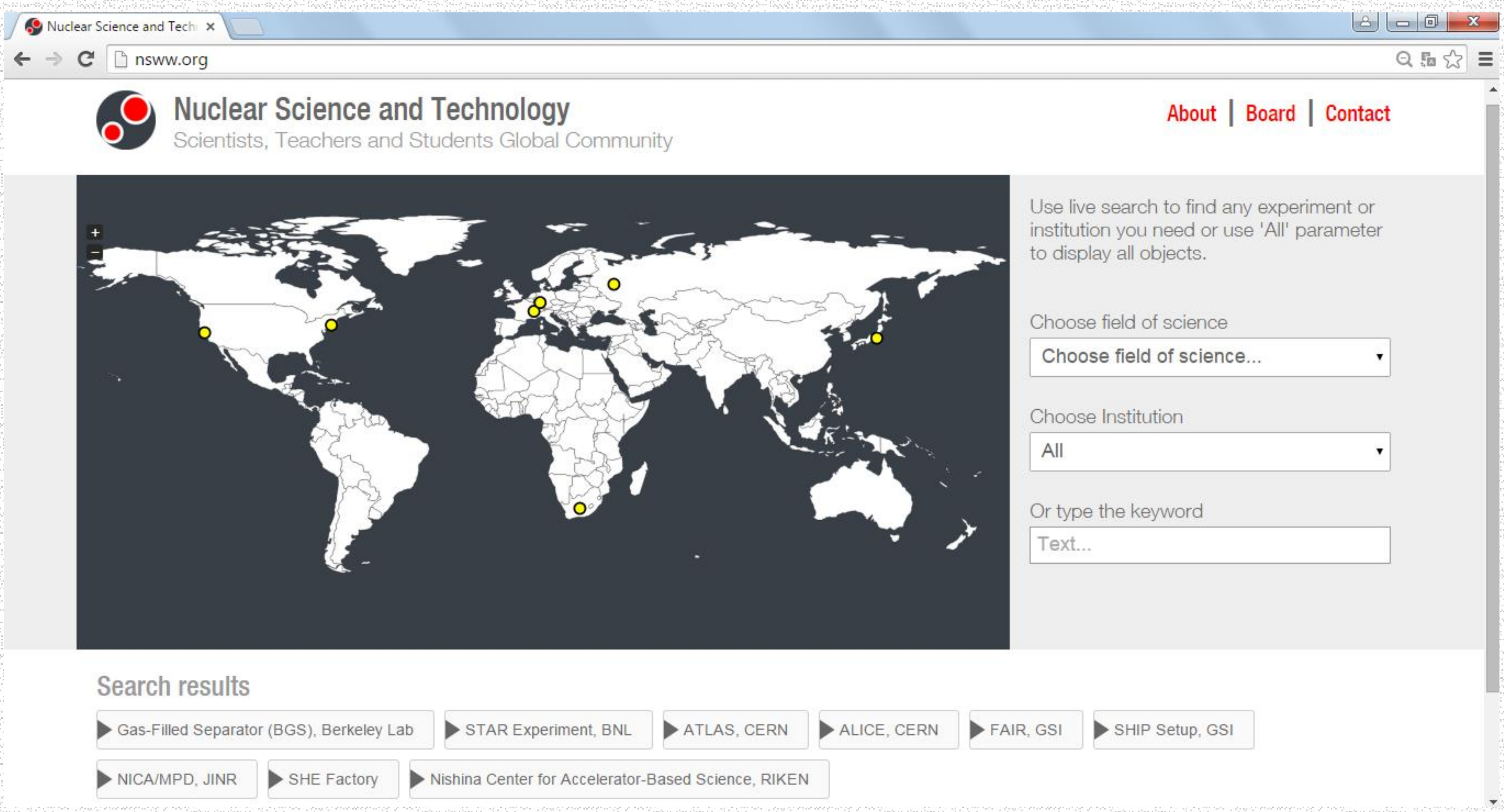
Измерение энергий частиц от калифорния-252 и измерение толщины источника





- Измерение энергетического спектра 252-калифорния
- Расчет потерь энергии альфа-частиц радия в источнике калифорния
- Расчет толщины источника калифорния

Nuclear Science and Technology Community



nsww.org

Massive Open Online Courses

coursera

https://www.coursera.org/mephi

National Research Nuclear University MEPhI

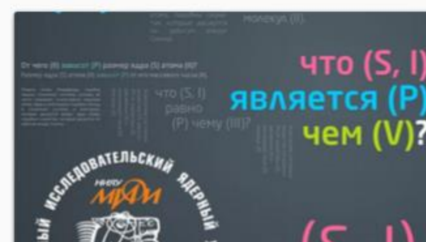
National Research Nuclear University "MEPhI" is one of the most recognized technical universities in Russia. It is the only research nuclear university in Russia. The aim of the university existence is preparing the specialists for nuclear industry, science, information technology and other high-tech sectors of Russian economy. National Research Nuclear University "MEPhI" implements postgraduate professional education curricula (PhD and postdoctoral level), carries out fundamental and applied scientific research in high-priority fields of science and technologies. Among MEPhI graduates are Nobel Prize winners, members of the Russian Academy of Sciences, and winners of national prizes. Its professors and alumni have made major contributions to various fields of theoretical and experimental physics, mathematics, cybernetics, and computer sciences.

Физика как глобальный проект

По требованию

Элементы атомной и ядерной физики

По требованию



Создание научно-технического текста

По требованию

coursera

https://www.coursera.org/mephi

- **Создание научно-технического текста**

  Для иностранных студентов в России

  Запуск курса: 12 октября 2015 года

- **Элементы атомной и ядерной физики**

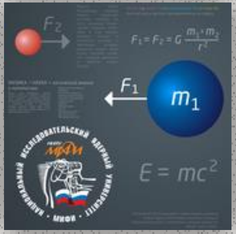
  Для бакалавров

  Запуск курса: 30 ноября 2015 года

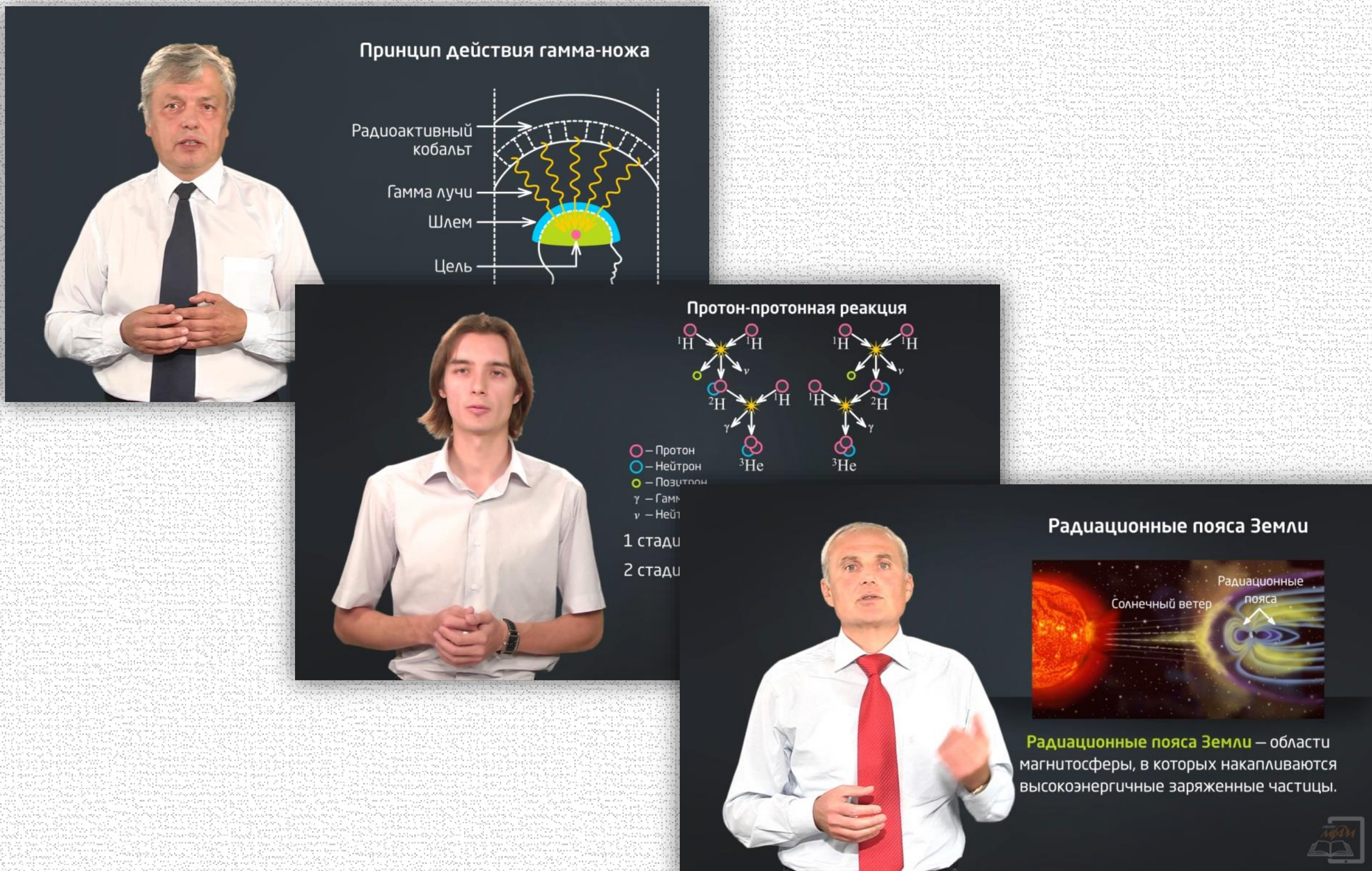
- **Физика как глобальный проект**

  Физика для всех

  Запуск курса: 20 декабря 2015 года



Элементы атомной и ядерной физики



Физика как глобальный проект

Преподаватели

Ольчак Андрей Станиславович

Доцент

Кафедра общей физики

Темы

- Физика от Аристотеля до Ньютона. Основные принципы и подходы глобального проекта "Физика"
- Обобщённая механика. Первая полноценная успешная теория
- Конкретная механика. "Нет ничего практичнее хорошей теории"
- От механики к тепловым явлениям
- Статистическая физика. Как Бог играет в кости?
- Поля и волны. Откуда у природы берутся силы?
- Квантовая физика. Новая физика 20-го века
- Физика высоких энергий. Так как же всё-таки устроен этот мир?

Thank you!