

## **JINR EDUCATIONAL PORTAL («EDU.JINR.RU») — OPEN EDUCATIONAL RESOURCES AND MODERN VISUALIZATION TOOLS**

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Today open online courses have shown their effectiveness for further education in various fields. We have created new courses devoted to JINR research projects: NICA/MPD, SHE Factory, applied researches with heavy ions and neutrons. The open educational portal of JINR is being developed for university students of the JINR Member States and Associate Members, young specialists and science teachers. The portal hosts the MOOC format courses connected with priority JINR activities. The portal also contains links to digital materials, that overview the basic JINR physical facilities using 3D modeling tools, as well as to the Virtual Laboratory project devoted to the experimental nuclear physics. Another section of the portal – “Scientists for schools” which could be used as additional educational materials for the course of school physics. The materials of the portal could be used for student trainings before and during the JINR student practices, to train students for their research work and for conducting the specialized courses at the universities of JINR Member States and Associate Members.

**Keywords:** Open online courses, educational portal, virtual laboratory, 3D modeling tools

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## **1. Online courses for professional training of specialists of research centers**

In the past few years, people often talk about the “revolution in education,” which was accomplished by the massive open educational resources that appeared in 2014. Over the past few years, the number of students studying at MOOC platforms, the number of new online courses, and the number of new platforms have grown rapidly and continue to grow.

According to the Class Central resource for 2018, the total number of MOOC students worldwide reached 100 million, and by the end of the year, more than 900 universities around the world announced the launch or opening of 11.4 thousands of MOOCs [1, 2, 3].

The world's most popular MOOC platforms publish online courses of experts from leading universities, or courses developed in collaboration with universities and their business partners. At the same time, an analysis of existing courses shows that among them there are quite a few courses devoted to the topics and problems of modern physical experiments developed by scientists and specialists personally involved in these experiments. Therefore, the task of creating online courses from leading JINR specialists dedicated to various aspects of priority research conducted at this international scientific center seems actual [4].

The JINR educational resource helps to solve the following tasks:

- popularization of modern scientific research, achievements in science and technology,
- increasing the attractiveness of scientific and scientific-technical careers for students and graduates,
- attracting young scientists and specialists to participate in specific research projects,
- professional development of school and university teachers,
- possibility to include materials related to modern achievements in science and technology in traditional educational courses.

The choice of topics for the online courses being developed at JINR is determined primarily by the need for young specialists to work at the Accelerator complex NICA (Nuclotron-based Ion Collider fAcility), in experiments on the synthesis of new superheavy elements (SHE Factory), in research in the field of the physics of condensed state of matter and environmental science carried out at a high-resolution neutron source IBR-2, in Deep-water Baikal Neutrino Telescope experiment and computing for megaprojects. Working in these and other experiments, students need to gain additional knowledge in the following areas:

- experimental physics
- accelerator physics and technology
- distributed computing and working with big data
- cryogenic technique
- biomedical physics
- radiation material science
- radiobiology
- use of neutrons and synchrotron light in applied research

Of course, online courses on these topics can hardly be widespread – a relatively small number of students need them. Nevertheless, these courses can play an important role in training specialists for modern research centers. The same courses can be useful for remote student trainings for various universities, if these universities do not have enough specialists of this profile.

## **2. Online courses at the JINR Educational Portal**

The JINR educational portal consists of four sections (fig. 1):

1. Online courses in MOOC format on priority JINR activities,
2. Multimedia resources using the capabilities of 3D modeling and augmented reality, which popularize experiments conducted in JINR laboratories,
3. Virtual Laboratory on Experimental Nuclear Physics,
4. Scientists to schools.

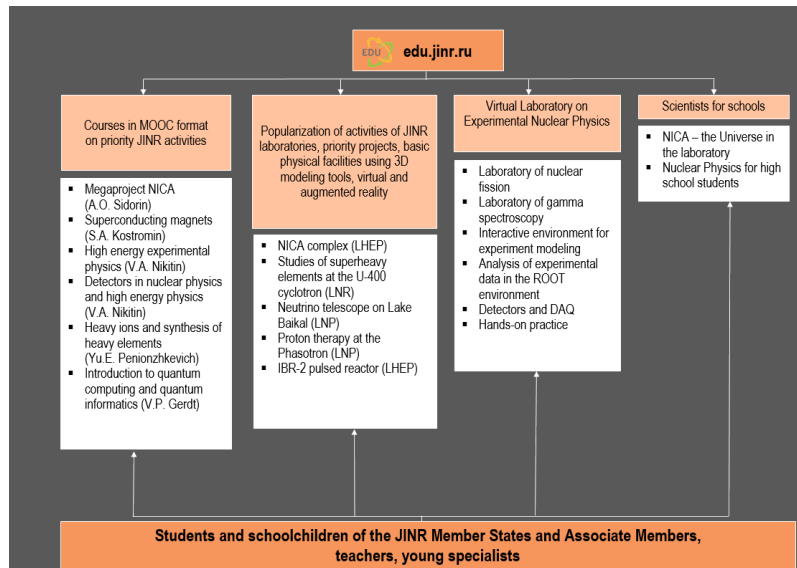


Figure 1. Structure of the JINR educational portal

The first online courses in Russian and English have already been created. The first of them tells about the NICA megaproject. The leading specialists of the project A.O. Sidorin, S.A. Kostromin and A.V. Konstantinov took part in the creation of these courses. Two courses from V.A. Nikitin on experimental high-energy physics and detectors in nuclear physics and high-energy physics were also created. Yu.E. Penionzhkevich wrote a course on the physics of heavy ions and the synthesis of heavy elements. An online course on basics of quantum computing and quantum informatics was given by V.P. Herdt (fig. 2).

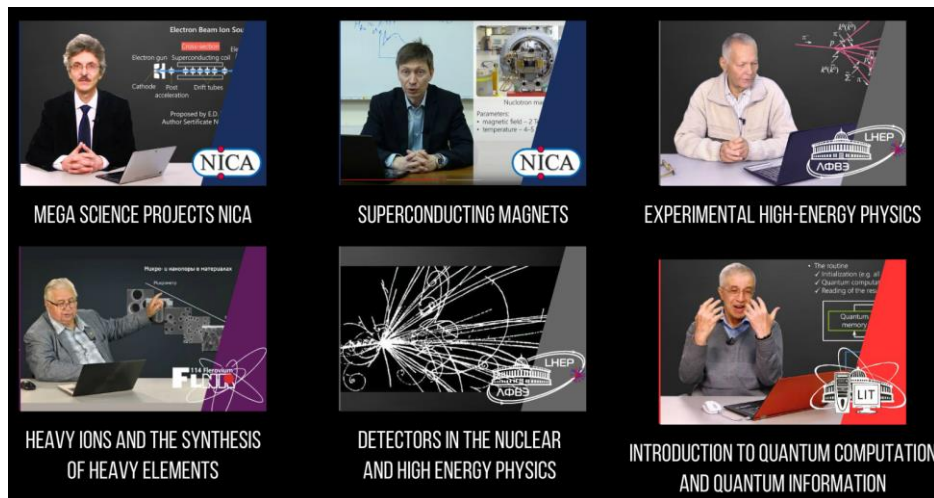


Figure 2. Online courses published at the JINR Educational Portal

Now new several online courses are under construction, and there are agreements with leading experts from various JINR laboratories on recording new educational courses.

The team of specialists working on the creation of online courses and interactive multimedia educational resources includes specialists of various profiles: content developers, computer methodologists, editors, designers and programmers. Moreover, in conditions of high competition and increasing quality requirements for digital educational materials, it is necessary to use the widest range of modern information technologies (fig. 3).



Figure 3. Information technologies used to create online courses and interactive multimedia educational resources

JINR specialists, representatives of universities of JINR Member States and Associate Members, and representatives of the basic departments of the JINR University Centre expressed their desire to create educational content for online courses.

To organize the learning process, the MOODLE learning management system was deployed on the portal. Using the system capabilities, the following tasks are easily solved:

- learning planning,
- role distribution,
- organization of knowledge and competency testing,
- opportunities for various training material support,
- user interaction opportunities in the system.

### 3. Multimedia resources, with use of opportunities of 3D modeling and augmented reality, popularizing experiments carried out in JINR laboratories

In recent years, JINR has been developing multimedia educational resources using the opportunities of 3D modeling and augmented reality, popularizing experiments conducted at JINR laboratories. These resources are used in organizing various events, such as student schools and practices, exhibitions and open door days. There is a special section dedicated to such resources on the JINR Educational Portal, which currently presents educational modules about the NICA collider, IBR-2 reactor, the synthesis of new superheavy elements and SHE Factory, Baikal neutrino experiment (fig. 4).

Great interest in these resources is shown by physics teachers participating in annual international schools for teachers, which take place in Dubna and CERN. Since all modules are freely available, teachers can use them in physics classes, or when conducting specialized classes and electives, with an explanation of the relevant topics.

The developed models help clarify the operation of a particular facility.

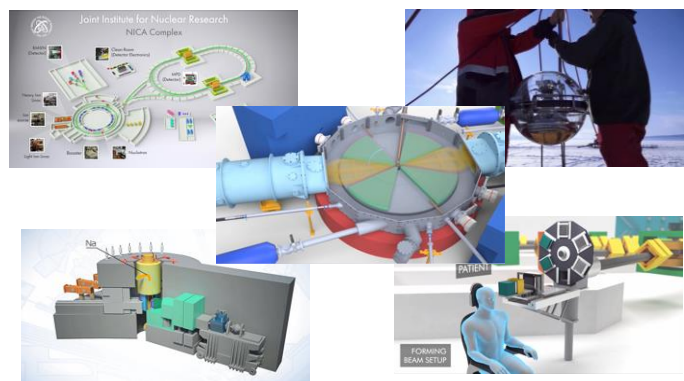


Figure 4. Multimedia resources about JINR basic facilities

The mission of any major scientific center along with scientific research is to solve a wide range of educational problems. Since the system of school and university education is very conservative, it is scientific centers that can become an objective source of knowledge about the latest achievements in science and technology

Another example of such a multimedia educational resource is the lesson for school students “NICA — The Universe in the Lab”, located in the section “Scientists for Students”. The lesson was based on a lecture given by academician Grigory Trubnikov (fig. 5).



Figure 5. Open Lesson «Collider NICA – the Universe in the Lab»

#### 4. Future plans

In the nearest future, the development of JINR educational portal is expected in several directions. The first involves the creation of new online courses and the expansion of materials for existing ones, the creation of new models of facilities and new educational materials for students. The second direction is the inclusion of portal materials in the educational process. A lot of work is to be done in this direction together with universities interested in using the materials of the portal as a component of their distance education. The third direction is the promotion of the portal in terms of relevant search queries.

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