JOINT INSTITUTE
FOR NUCLEAR RESEARCH

BIG SCIENCE — BUSINESS

DUBNA | 2024

WWW.JINR.INT

JOINT INSTITUTE
FOR NUCLEAR RESEARCH

The strategic GOAL

of the innovative development of **JINR** up to **2030**

is to become one of the leading centers for knowledge transfer in the JINR Member States, able to ensure the achievement of landmark results in accordance with their technological priorities, increase interest in expanding the applied agenda at the JINR basic facilities, and demonstrate the significance of the results of fundamental science for society.

The Institute's flagship initiative in the development of R&D infrastructure **is the creation of an Innovative Center for Nuclear Physics Research** in the field of **radiation biology, biomedical technologies, radiation materials science, as well as ecology and information systems.**

Researchers and developers will have at their disposal:

- specialized channels for applied research at the NICA complex (Life Science, electronics testing, nuclear energy of the future);
- DC–140 heavy-ion accelerator complex (radiation materials science, radiation resistance of electronic components, track membrane technologies);
- a radiochemical laboratory of the first class and a 40-MeV electron accelerator (research on medical radioisotopes);
- a superconducting proton cyclotron with an energy of 230 MeV (flash therapy, "pencil" beam, use of radio modifiers).

Grigory TRUBNIKOV
JINR Director

R&D based on these new capabilities, strengthening the application segments of user programs of basic facilities, as well as further development of the already known success stories in the field of detector technologies, superconducting energy storage technologies, laser metrology, artificial intelligence, and track membrane-based products are the basis of JINR's innovation agenda.

One of the priorities in its implementation is joint work with industrial partners, interaction with "branch science" to develop the JINR R&D infrastructure as an open space for creativity and advanced research (Open Research Space @ DUBNA).

This booklet includes some of the joint projects with business from a variety of areas, sometimes very far from fundamental nuclear and particle physics, where the competencies, research and development infrastructure and specific results of the Institute were in demand from the real sector.

JINR is open to implementing various directions and formats of cooperation. I hope the booklet will serve as an invitation to fruitful interaction between Big Science and Business.




DOKAGENE Group of Companies

Research and production technology companies united by LLC **“Doka-Gene Technologies”** realize a full cycle “from test tube to shelf”, produce micro-plants and mini-tubers of their own and licensed potato varieties in the latest biotechnological complex; seed potatoes of higher reproductions, protected from viruses and diseases; table potatoes; vegetable products and grain crops in crop rotation.

The in-house research and development program includes the following directions:

- Genetics, breeding, seed production of potatoes
- Phytopathology, plant protection, biopharming
- Development and production of biomolecular drugs based on RNA/peptide technologies for plant protection
- Remote diagnostics of potato diseases, precision agriculture, and agricultural stewardship

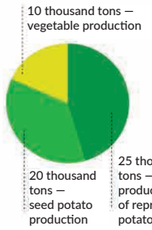
The companies have formed a unique experimental base for developments in the field of remote diagnostics, including an automated test bench for year-round generation of data arrays for statistical training using various optical sensors (RGB and hyperspectral cameras, Vis-NIR spectrometer), as well as special modules for placement on inspection vehicles of the agronomic service, providing data collection in production sites.

The success story of DokaGene Group of Companies is the story of the pioneering introduction of innovative biotechnologies into practical potato seed production

NUMBERS

MORE THAN **100** VARIETIES AND LINES OF DOMESTIC AND FOREIGN BREEDING

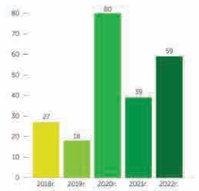
MORE THAN **250** EMPLOYEES ENGAGED IN PROJECTS



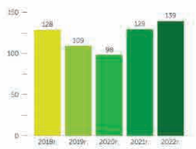
1500 HECTARES OF POTATOES

150 HECTARES OF VEGETABLES

930 HECTARES OF GRAINS



OWN FUNDS INVESTED IN R&D, MLN. RUB.



AMOUNT OF TAXES PAID, MLN. RUB.

1612 MLN. RUB. REVENUE OF THE GROUP OF COMPANIES IN 2022

MACHINE LEARNING

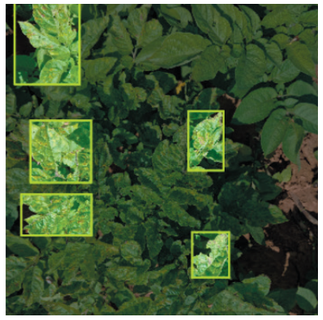
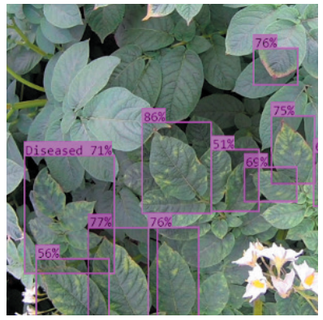
Specialists from JINR are developing a service for remote diagnostics of viral and other potato diseases at the request and on the experimental basis of the DokaGene Group of Companies.

The work is based on the Institute’s experience in creating a plant disease detection platform **pdd.jinr.ru**

The software and hardware complex being developed, which is placed on agricultural machinery, thanks to the use of neural network models, will make it possible to quickly identify anomalies and build maps of their distribution in the surveyed area. The current version of the system provides work with RGB data. In the future, its capabilities are planned to be expanded by using spectral information.

The network models are trained using data collected both in production sites (high-resolution cameras are placed on agronomists’ inspection vehicles) and under controlled conditions on the test bench (RGB cameras, a hyperspectral camera, and Vis-NIR spectrometer).

For a number of varieties with characteristic visual symptoms, the trained neural network model confidently copes with the detection and segmentation task. The next steps include generalizing the results to other varieties as well as using the information from a hyperspectral camera and/or Vis-NIR spectrometer to provide earlier diagnosis.




CONTACT PERSON

Alexander Uzhinskiy
auzhinskiy@jinr.ru

Hydrogen Technology Center

Hydrogen Energy Center

A company that combines
research, educational expertise
to create new hydrogen technologies and train personnel.

- Identification of areas of scientific and technological value
- Re-engineering of advanced hydrogen technology samples for the purpose of import substitution
- Creation of new technologies to outpace imports

- **Advanced higher education in the field of hydrogen technologies and alternative energy**
- **Educational work among schoolchildren, non-core specialists, managers of leading Russian companies**

Fuel cell UAVs have clear advantages (multiple increase in flight time, accelerated refueling time) over battery-powered UAVs for long-distance cargo transportation in the harsh Russian climate. It is expected that a unit with an electrochemical generator based on a fuel cell with a power of up to 200 kW will be able to lift an unmanned cargo helicopter with a take-off weight of 750 kg.

Energy solutions for fleets of electric warehouse equipment.

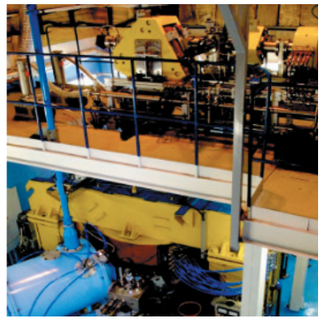
Environmentally friendly electric transport for megacities. Electric vessels powered by electrochemical fuel cell generators provide the necessary lifting capacity, transportation range and accelerated refueling time.

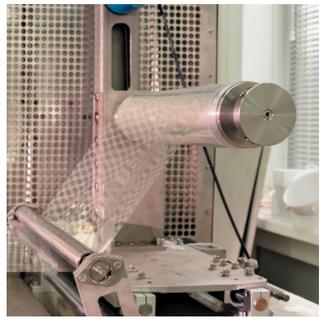
Backup and autonomous power supply systems based on low-temperature fuel cells with a power of up to 50 kW. Safe and compact hydrogen storage and purification systems based on metal hydrides. Backup and main power sources based on the hydrogen cycle.

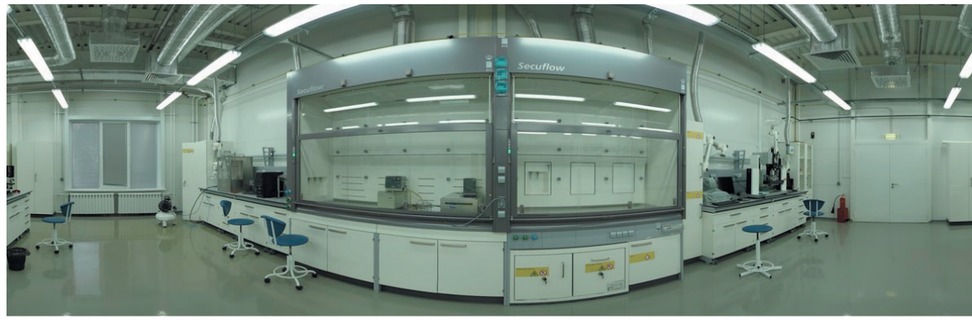
The R&D infrastructure formed at the JINR Laboratory of Nuclear Reactions on the basis of a cyclotron complex and a modern nanolaboratory is in demand in the development of innovative materials for a wide range of applications.

The joint project of the Hydrogen Energy Center (HEC) and JINR is aimed at developing new materials for hydrogen energy and overcoming the drawbacks of existing commercial proton-conducting membranes.

The HEC and FLNR JINR are studying the possibility of **creating hybrid membranes** based on modified fluorinated films for application as proton-conducting membranes for hydrogen-air and methanol fuel cells.

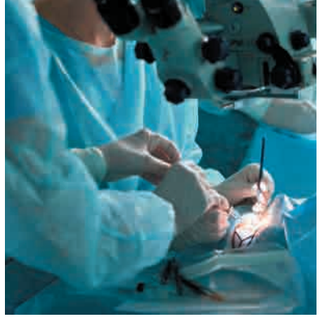


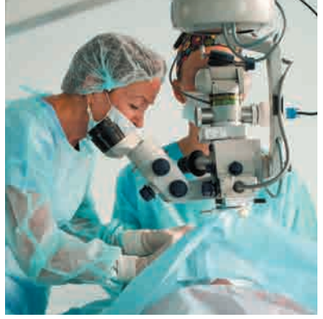




CONTACT PERSON

Alexander Nechaev
nechaeffalexander@jinr.ru





Innovations in ophthalmology

"Many years of experience in ophthalmological practice have allowed us to formulate the "Dubna – Biopharm" research and development program aimed at solving the most urgent problems, such as:

- *development and pilot production of bioplastics, nanofillers for photoconverting materials used in the production of intraocular lenses;*
- *development and pilot production of corneal protectors;*
- *development of new treatment methods and medical devices, conducting laboratory tests,"*

says **Sergey Igorevich ANISIMOV**, Doctor of Medical Sciences, Professor, founder and Director of the Eye Center "Vostok-Prozrenie", member of the European Society of Cataract and Refractive Surgeons (ESCRS), titular member of the French Society of Ophthalmology (SFO).

ГЛАЗНОЙ ЦЕНТР ВОСТОК-ПРОЗРЕНИЕ
Мировое качество офтальмологии в России

The Eye Center "Vostok-Prozrenie" is one of the oldest (since 1995) **and most famous private medical ophthalmological clinics in Moscow and Russia.**

Dubna Biopharm

LLC "Dubna–Biopharm", a resident of the Dubna Special Economic Zone, has been developing and producing drugs and materials for ophthalmology and dentistry since 2010.

PROBLEM

Corneal transplantation (keratoplasty) is the only solution for many pathologies in ophthalmology.

According to world statistics, only one out of seventy patients in need of corneal transplantation receives this procedure.

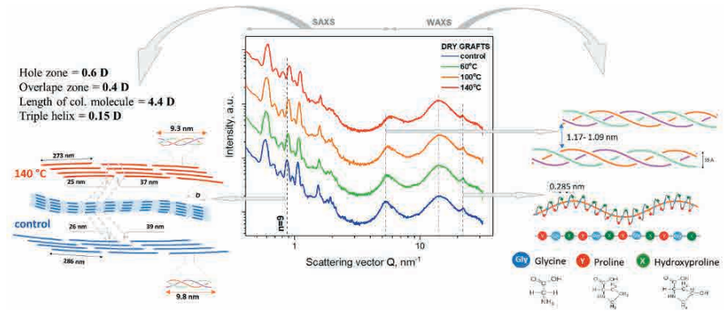
The main barrier is that the use of human donor material is limited, and the semi-synthetic or synthetic materials used have low biocompatibility.

SOLUTION

The creation of affordable biosimilar corneal grafts with long-term storage, suitable for the main types of keratoplasty and having a high degree of biocompatibility, will fully replace human donor material.

The prospects for using mammalian cornea in keratoplasty are associated with the ability to control the degree of hydration of collagen as its main component.

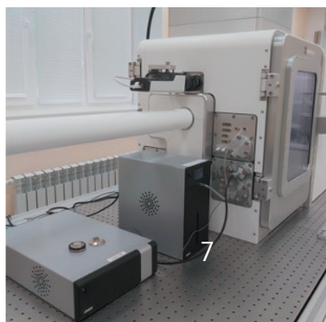
This possibility is provided by the **method of dehydrothermal crosslinking (DTC)** — the formation of cross-links in biomaterials when they are heated under vacuum. Anisimov S. I. // The Eye. 2023 (in press).



The optimization of the method parameters was performed on the basis of the results of small-angle X-ray scattering (SAXS) experiments at the USAXS/SAXS/WAXS Xeuss 3.0 station in **the JINR Laboratory of Neutron Physics.**

CONTACT PERSON

Yulia Gorshkova
gorshk@jinr.ru

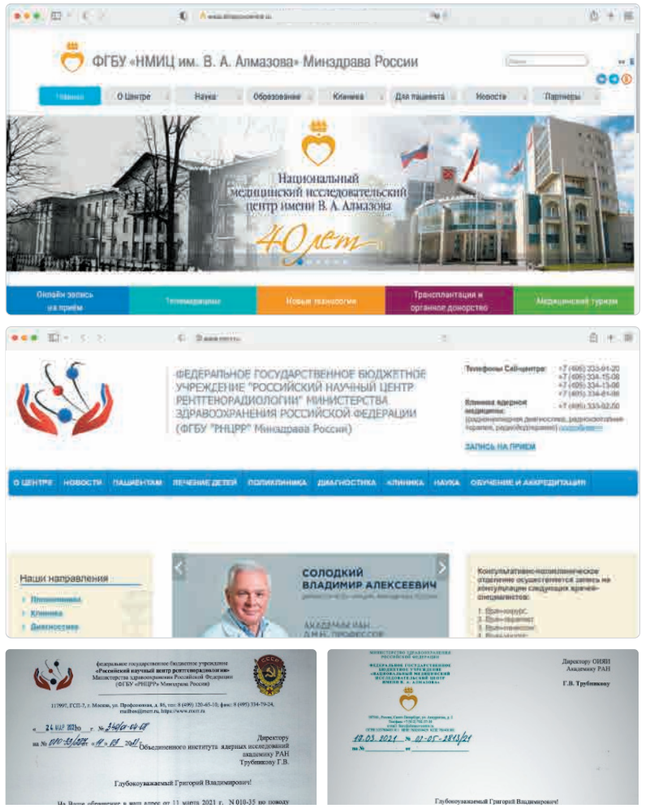


Creation of an accelerator complex

in cooperation with the D. V. Efremov Scientific Research Institute of Electrophysical Apparatus

JSC “NIIEFA”, Rosatom State Corporation

ROSATOM



Leading research and medical centers, as well as experts in the field of radiation medicine and proton therapy, expressed interest in close cooperation both at the stage of creating a new medical accelerator, and during the formation and implementation of a research program based on the modern infrastructure being created at JINR.

According to experts, the machine under construction will be in demand by medical centers.

The creation of the accelerator complex based on the MSC–230 superconducting cyclotron for proton radiation therapy of oncological diseases is carried out in collaboration with the D. V. Efremov Scientific Research Institute of Electrophysical Apparatus (JSC “NIIEFA”, Rosatom State Corporation).

JINR has many years of experience in the development of medical accelerators and their practical use in the treatment of oncological diseases.

NEW FACILITY

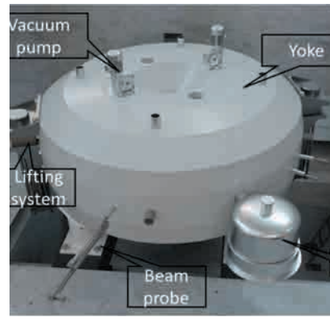
A 230-MeV superconducting medical cyclotron designed in JINR

- Low power consumption and reasonable dimensions
- Minimal feasibility risks
- Use of proven solutions
- High beam quality
- Current — not less than 10 μA
- Possibility of implementing the flash therapy mode: not less than 5 Gy per target with a volume of 1 L in a 50-ms pulse

INNOVATION

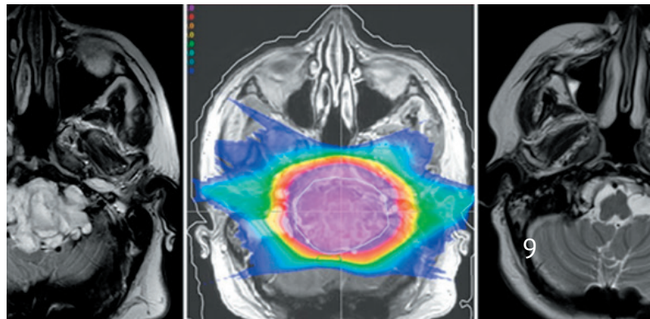
- Testing of high-temperature superconductors (HTS).
- Superconducting magnet technologies developed for NICA will be used to create the MSC–230 windings
- The magnetic field in the center of the machine is 1.7 T

NICA



CONTACT PERSON

Sergey Yakovenko
yakoven@jinr.ru



Reatrack

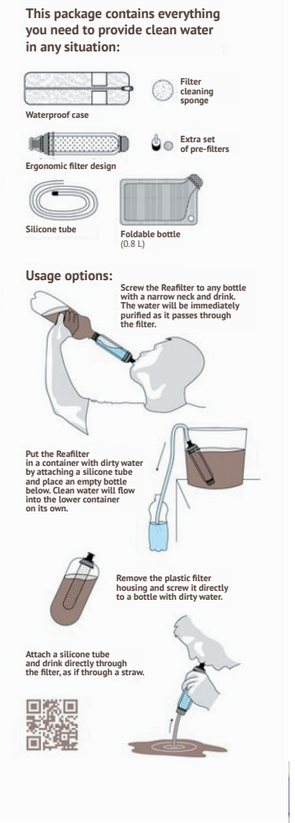
LLC “REATRACK-Filter”
is a research and production enterprise that has existed since the early 2000s and is located in the first science city of Russia — Obninsk.

The company specializes in the development and production of state-of-the-art filtration products.

FILTRATION for elimination of

- Mechanical particles, turbidity
- Algae, plankton, harmful impurities of biological origin
- Total iron, heavy metals, radionuclides, pesticides, etc.
- Pathogenic bacteria and viruses, harmful impurities of chemical origin

At the same time, all the microelements necessary for the body remain in the water.



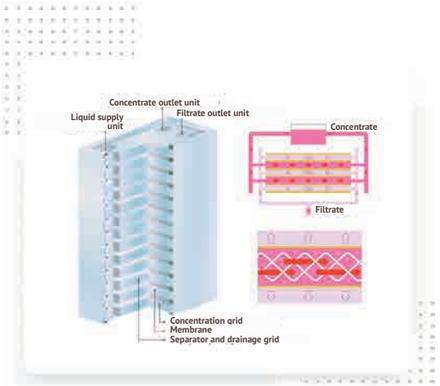
ВЛАДИСАРТ
VLADISART

CJSC “Vladisart”
is a diversified enterprise with more than 28 years of experience in the market, specializing in the development, manufacture, trade and services of the filtration equipment and consumables. Own manufacturing site for the production of filters and filtration plants is located in the city of Vladimir.

For the “REATRACK-Filter” company, JINR manufactures track membranes (TM) with the structural parameters necessary for sanitary, parasitological and microbiological analysis of water quality, as well as for water filtration.

The flat surface of the track membrane makes it ideal for identification of particles and biological objects by microscopy, and its small thickness improves transport characteristics. The minimum deviation of the pore diameter from the specified value ensures the capture of 100% of particles exceeding the pore size (sieve mechanism).
For these purposes, track membranes are available in the form of disks and as part of filter sets.

Portable filters based on TM effectively purify water from bacteria and algae, protozoa, suspended particles and harmful impurities of various origins adsorbed on them.



For CJSC “Vladisart”, JINR produces track membranes for cassette modules used in tangential filtration systems.

The “Vladisart” company has developed a membrane cassette module based on a track membrane. Possible application is the production of immunoenzyme medications, including various vaccines.

CONTACT PERSON

Nikolay Dmitriev
ndmitriev@jinr.ru

LLC **“BRS”**

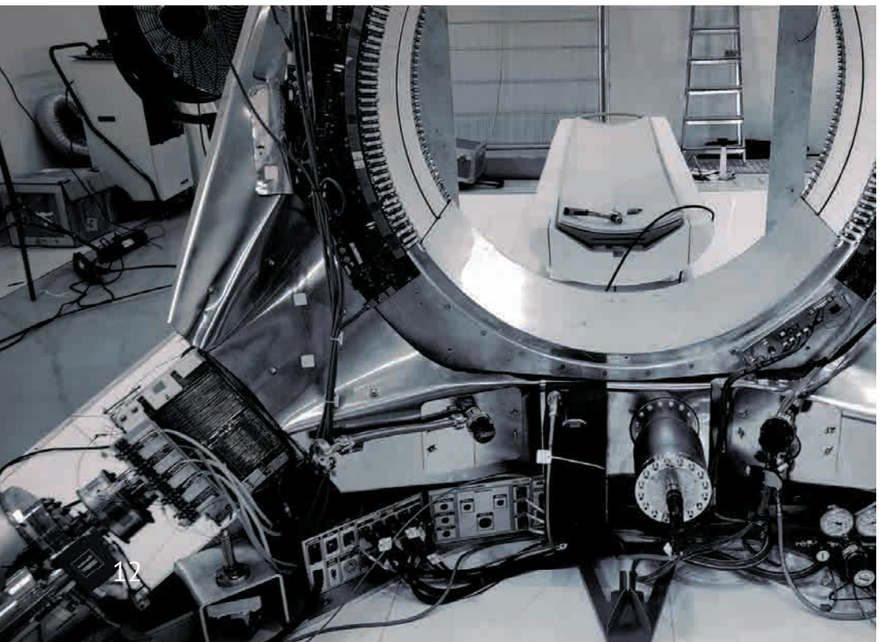
Participates in the project of the Rostec State Corporation (project company — JSC “RZM Technologies”) on the creation of a new dual-source electron beam computed tomograph (DSEBCT).

Advantages of DSEBCT

- **High speed (x10)**
- **Unique clinical applications (e.g., 3D-cine imaging for the vascular system)**
- **No moving mechanical parts**
- **Scalable architecture**

The current version uses photodetectors based on a GOS scintillator manufactured by Detection Technology (Finland/China).

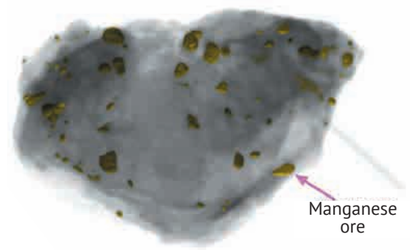
The total number of channels is 594432, combined on 16 reading boards (developed by LLC “BRS”) with a high-speed data transmission channel (optics) to the data acquisition server. All channels are read at a clock cycle of 16 μs, resulting in a total of 1875 X-ray projections for a full beam rotation of 30 ms. In this configuration, the data flow is up to 189 GB per second.

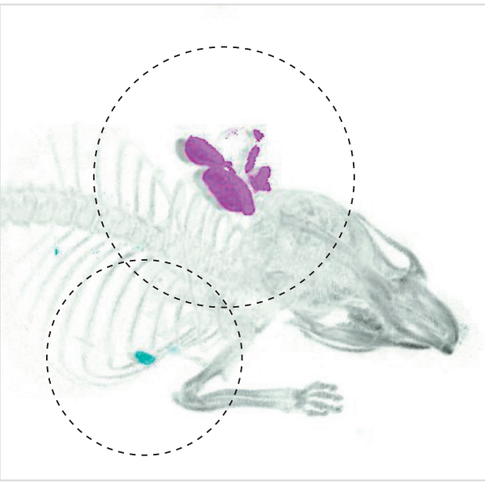


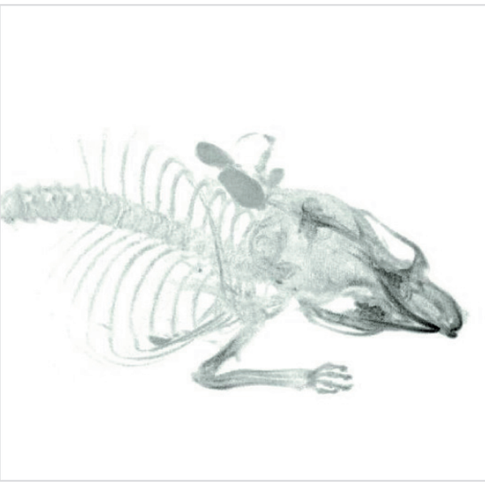
As a promising option, the possibility of creating an energy-dispersive detector system based on hybrid semiconductor detectors operating in the single quantum registration mode is being studied.

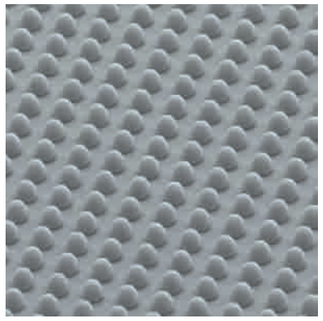
JINR has considerable experience in creating and using hybrid matrix semiconductor X-ray detectors in the mode of counting single quanta with energy thresholds. Such detectors open up the possibility of implementing “color” computed tomography, which allows distinguishing areas not only of different densities, but also of different elemental composition. The creation of such systems is at the forefront of CT development.

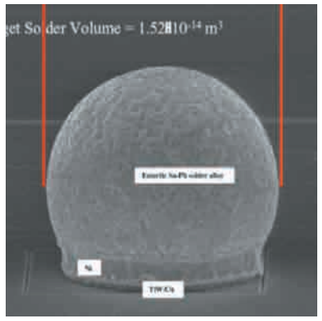
The basic idea of cooperation with LLC “BRS” lies in the creation of a hybrid pixel detector consisting of a GaAs:Cr sensor (available technology; CdTe, etc. — very interesting options for the future as we gain access to the appropriate technologies) and a specially developed ASIC chip connected by bump-bonding.

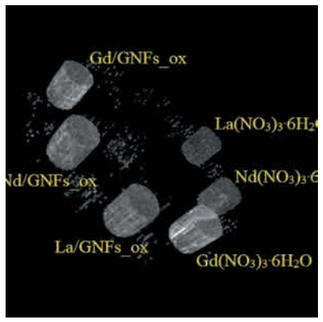


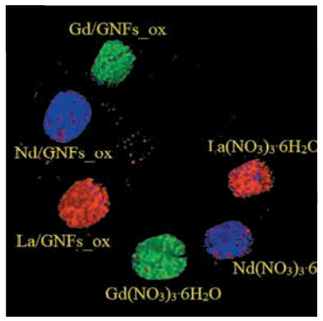


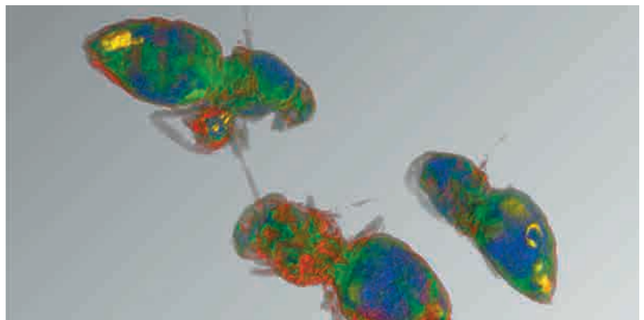












CONTACT PERSON

Georgy Chelkov
chelkov@jinr.ru

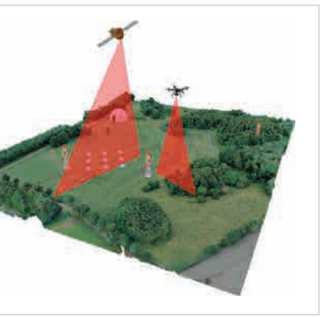
MINISTRY OF SCIENCE
AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION

Today, the issue of the environmental and, in particular, the "carbon" footprint of products is gaining more and more "practical" importance. The country's position in many of the world's most important markets directly depends on its solution.

The Ministry of Science and Higher Education is implementing a project to create a network of so-called carbon polygons, where the control of emissions and absorption, sequestration of carbon dioxide is studied, the state of natural systems, the quality of water resources and other parameters are assessed.

Soil is one of the largest natural carbon reservoirs. Monitoring of soil organic carbon (SOC) is a crucial task in the global climate change problem, in the development and implementation of measures aimed at reducing greenhouse gas emissions.

A new level of detail and updating of SOC data is needed to develop agricultural technologies that simultaneously increase the sequestration potential of soils and their productivity.

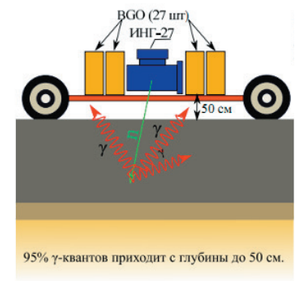


JINR has many years of experience in developing the tagged neutron method (TNM) for various applications.

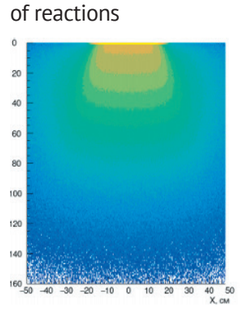
"In soil carbon monitoring, the future lies in different spectroscopy options. And in this regard, the main expectations from the tagged neutron method are the analysis of a sample of a significant volume, located not only in a thin surface layer, without "extracting it"," says N. D. Durmanov, Deputy Chairman of the Expert Council under the Ministry of Science and Higher Education of the Russian Federation on Carbon Balance Control Technologies.

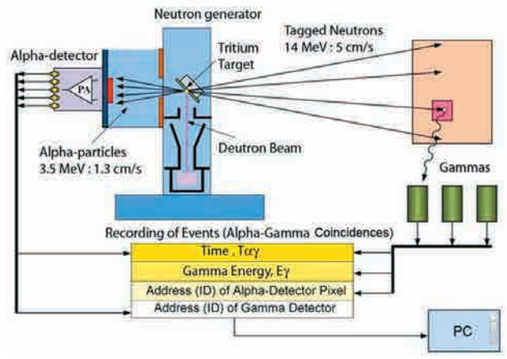
- "Volumetric method" – the signal is collected from a significant volume: 0.1–0.5 m^3
- The presence of a "mark" (time of emission and direction of the alpha particle) allows determining the depth distribution of carbon
- Neutron tagging provides improved signal-to-background ratio
- Induced activity is negligible

Sketch of the measuring setup

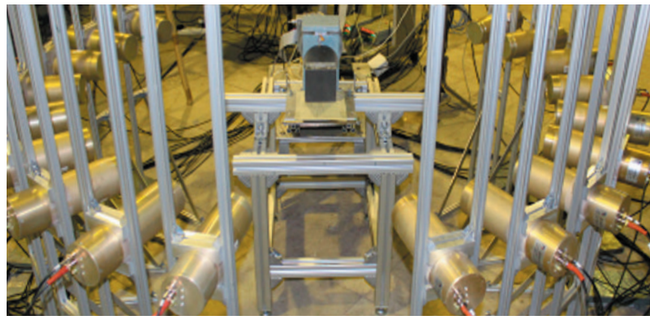


The depth distribution of reactions





The TANGRA experimental setup



CONTACT PERSON

Yuri Kopatch
kopatch@nf.jinr.ru

For cooperation, please contact
the Innovations and Intellectual Property Department of JINR

CONTACT PERSON

Igor Lensky
iflensky@jinr.ru

NOTES

BIG SCIENCE — BUSINESS

International Intergovernmental Organization
JOINT INSTITUTE FOR NUCLEAR RESEARCH

6 Joliot-Curie St
Dubna Moscow Region
Russia 141980

post@jinr.int **+7 (496) 216-50-59** **www.jinr.int**

JINR Press Office &
International Communication

To subscribe to the JINR Newsletter, please contact
press@jinr.int