Multifunctional Information and Computing Complex

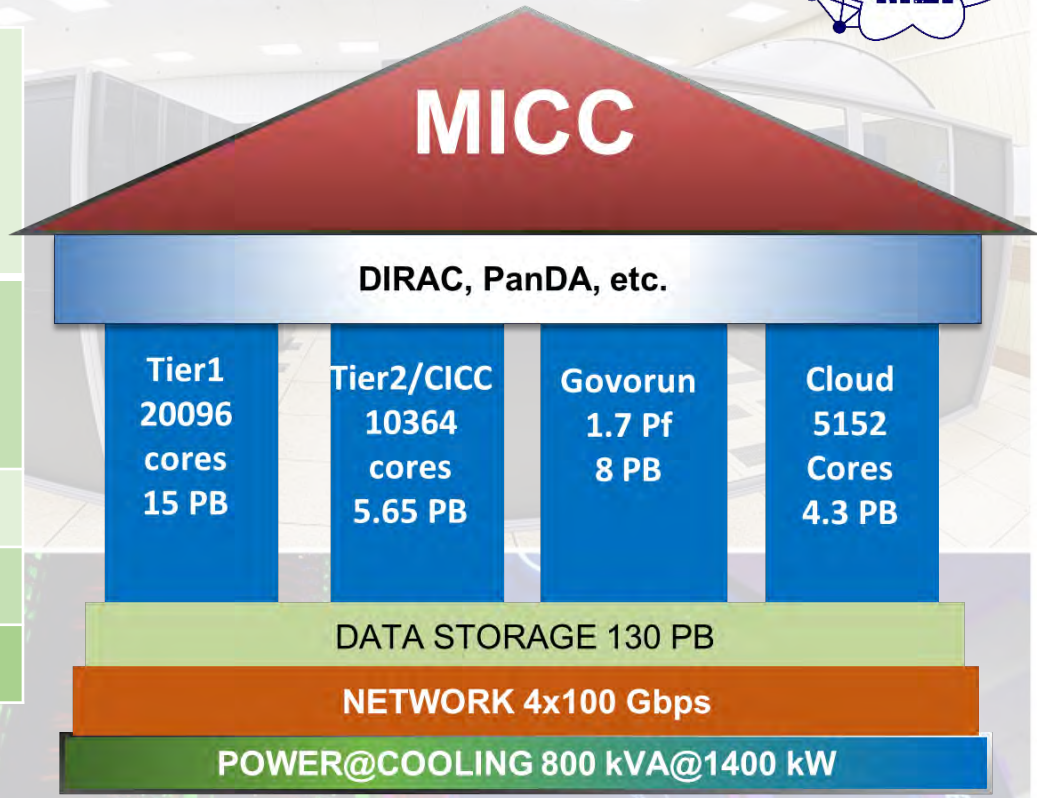
Nikolay Voytishin

Meshcheryakov Laboratory of Information Technologies
JINR

Meshcheryakov Laboratory of Information Technologies

Scientific IT ecosystem:
coordinated development of interconnected IT technologies and computational methods

Scientists Doctors of Science Candidates of Science	**115** 21 62
Specialists (engineers, programmers)	**136**
Management	**18**
Workers	47
Total	316



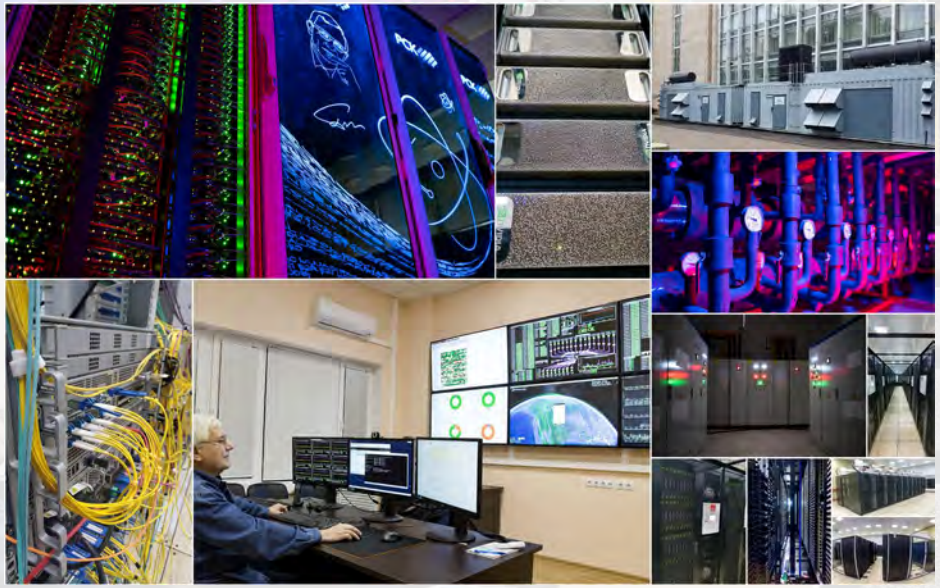
Multifunctional Information and Computing Complex

- **Provide IT services** necessary for the fulfillment of the JINR Topical Plan on Research and International Cooperation in an efficient and effective manner
- **Building world-class competence in IT and computational physics**
- **24/7 support of computing infrastructure and services** such availability is called nonstop service

Critical basic scientific infrastructure project

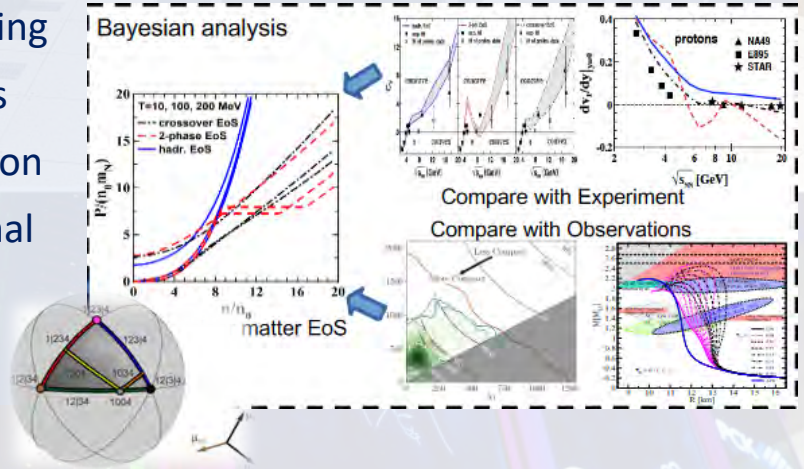
JINR Multifunctional Information and Computing Complex (MICC)

- High-throughput computing (Grid Tier1 and Tier2)
- High-performance computing ("Govorun" supercomputer)
- Cloud Computing
- Distributed Data Storage (long-term and middle-term Data lake)
- Engineering infrastructure (electricity and cooling)
- Networking (local and worldwide connectivity)



Research projects

- **Mathematical methods, algorithms and software for modeling physical processes and experimental facilities, processing and analyzing experimental data**
  - implementation of ML/DL methods in data processing and analysis
- **Methods of computational physics for the study of complex systems**
  - High-Performance Computing for Complex System Studies
  - Development and application of methods of computational mathematics in quantum information theory



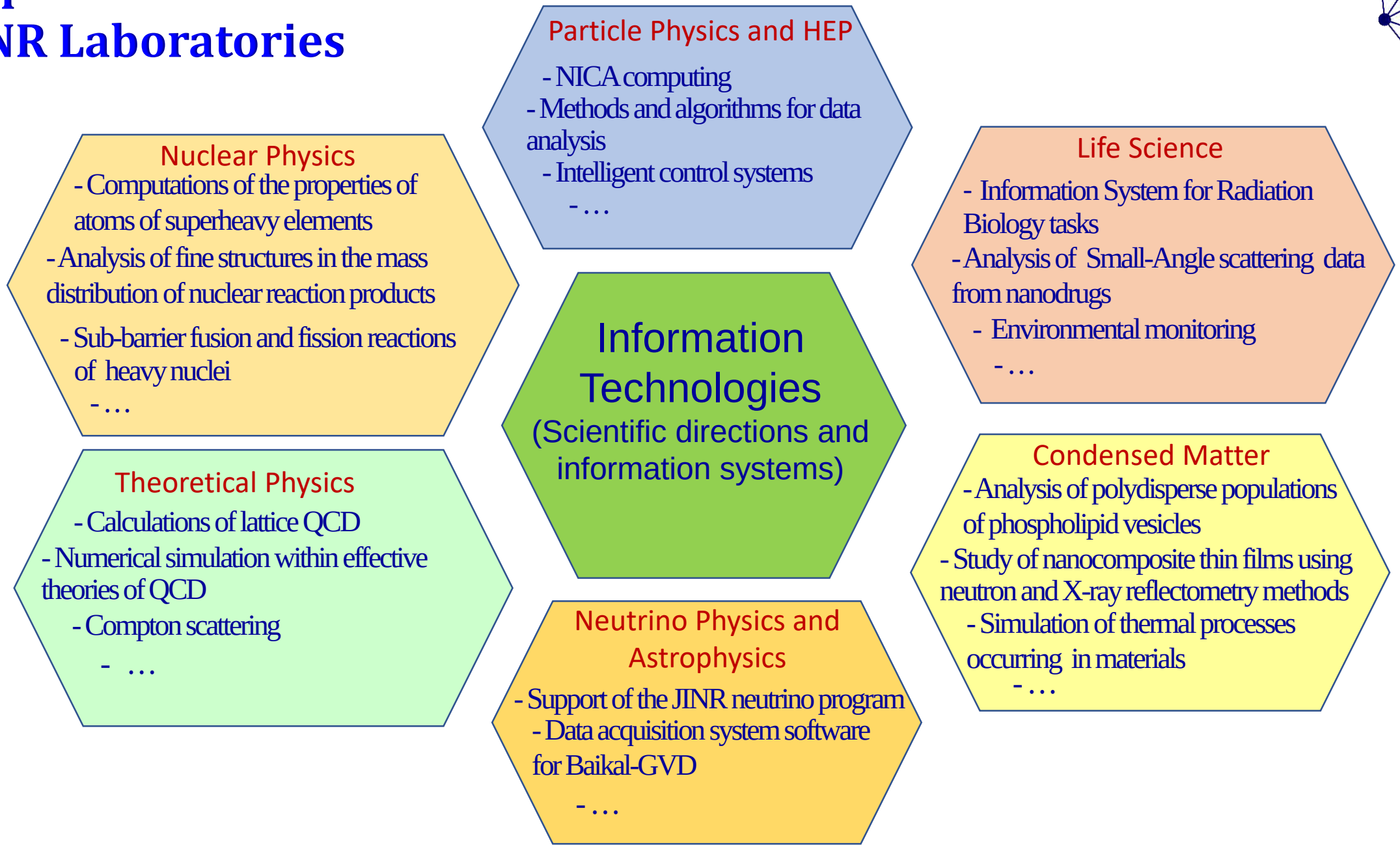
Activities

- Big Data Analytics
- Digital JINR
- IT-school

IT SCHOOL JINR

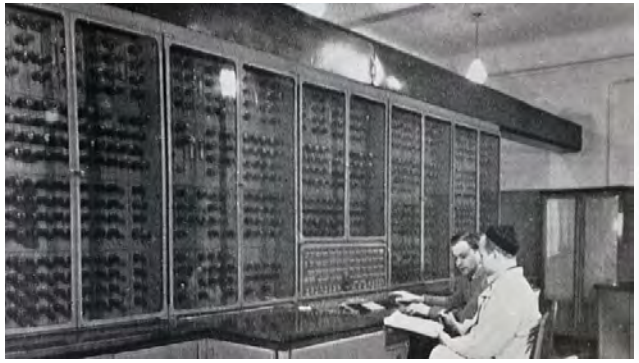
JINR Digital Eco System

Cooperation with All JINR Laboratories



Meshcheryakov Laboratory of Information Technologies

M.G. Meshcheryakov
(17.09.1910 - 24.05.1994)

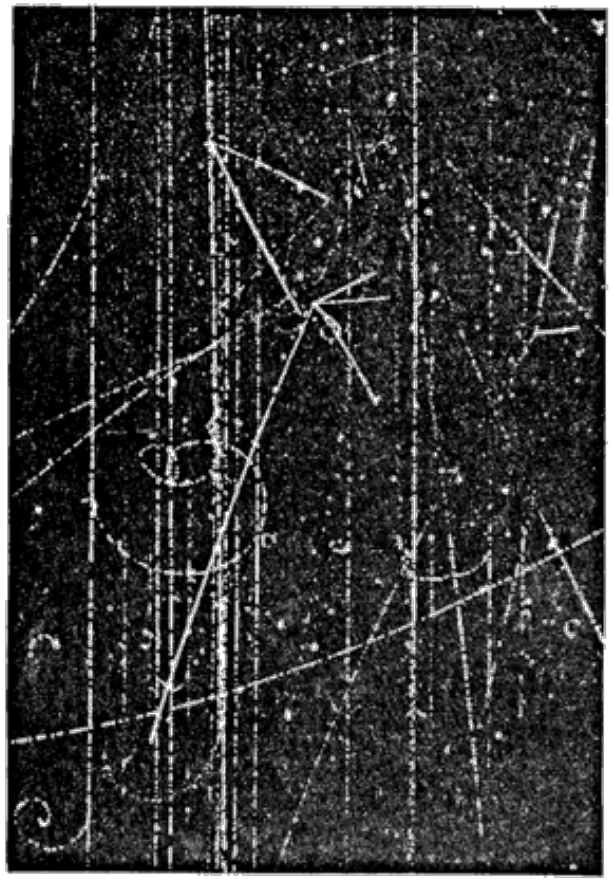


The Laboratory of Computing Techniques and Automation (now MLIT) was founded in August 1966.

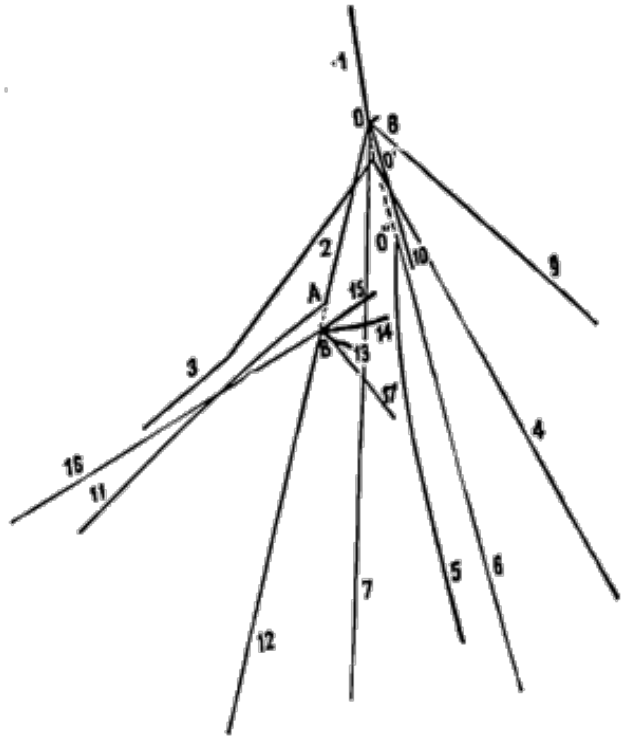
The main directions of the activities at the Laboratory are connected with the **provision of networks, computer and information resources**, as well as **mathematical support of a wide range of research at JINR** in high energy physics, nuclear physics, condensed matter physics, etc.

N.N. Govorun
(18.03.1930 - 21.07.1989)

Bubble chambers



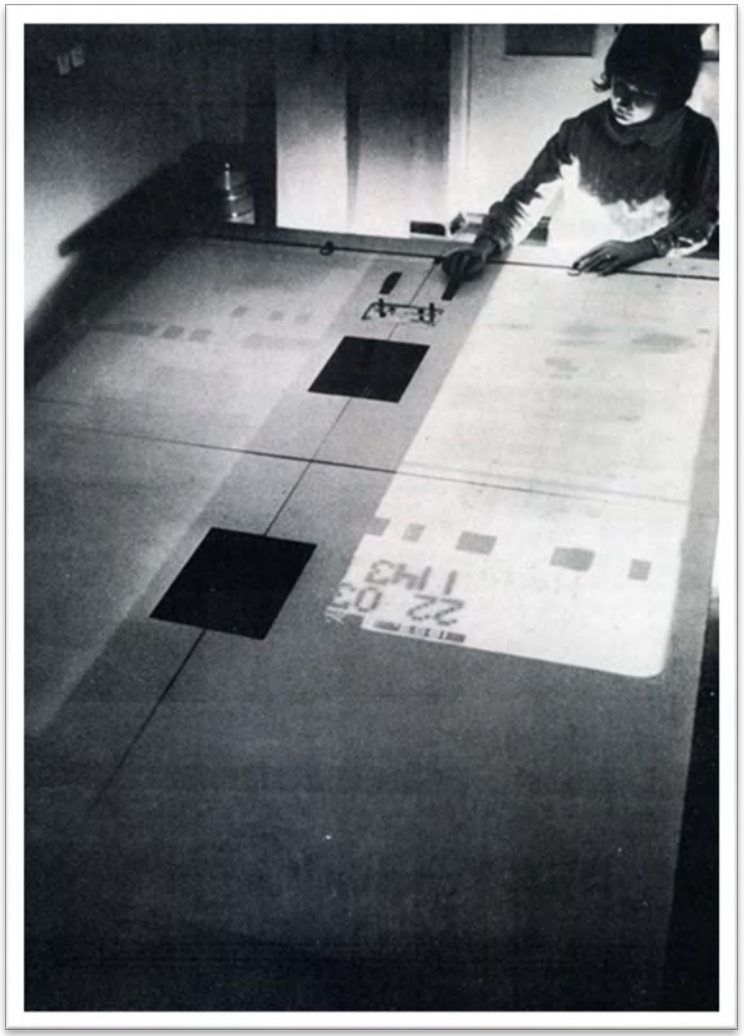
40000 stereo images
viewed 2-3-more times



A bubble chamber is a device for recording traces (or tracks) of fast charged ionizing particles, the operation of which is based on the boiling of superheated liquid along the trajectory of the particle.

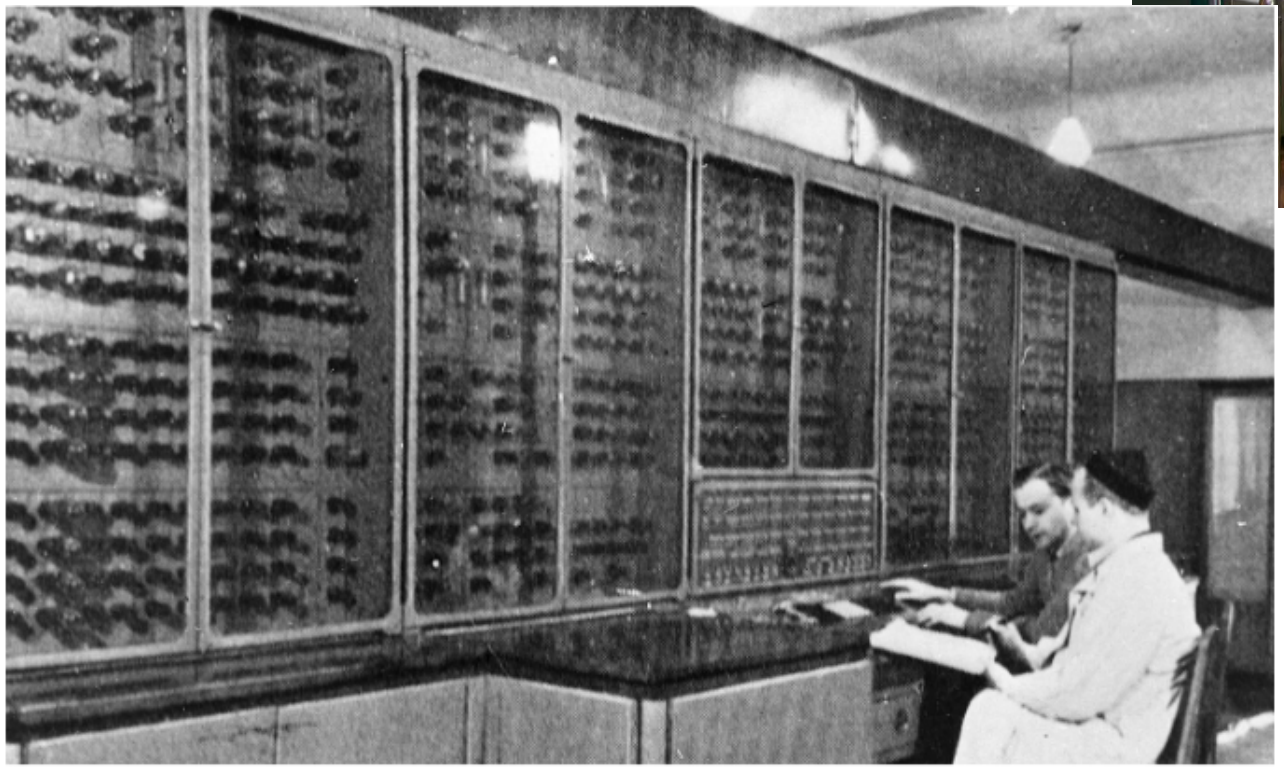
was invented by
Donald Glaser
(USA) in 1952

Bubble chambers picture processing



First computers @ JINR – URAL-1

The first electronic computer Ural-1 appeared at JINR in 1958. On it, the employees of the JINR Computing Center gained their first experience in creating software for scientific calculations for analyzing film information from a bubble chamber.

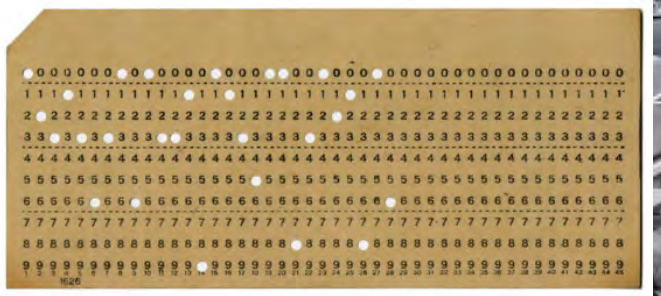


Ural-1
Area: 75 m²
Number of lamp bulbs: 1000
Consumption: 7-10 kW
Productivity: 100 operations/s

First computers @ JINR – BESM-6

BESM-6 (Russian: БЭСМ-6, short for *Большая электронно-счётная машина*, i.e. 'Large Electronic Calculating Machine') was a Soviet electronic computer.
The first Soviet supercomputer based on second-generation components – transistors.

Commissioned at JINR in 1968. Creation of a translator from the Fortran language, the Dubna monitor system, which were then installed on all BESM-6 computers in the USSR and abroad (GDR, India). Creation of the Dubna operating system.



Area: 225 m²
Number of lamps: 1000
Consumption: 50 kW
Productivity: 10^6 op/s

MICC History

Old LCTA building

The construction of the new LCTA building

20.04.1977

Machine hall in the new LCTA building (16.01.1980)

01.04.1986

MICC History

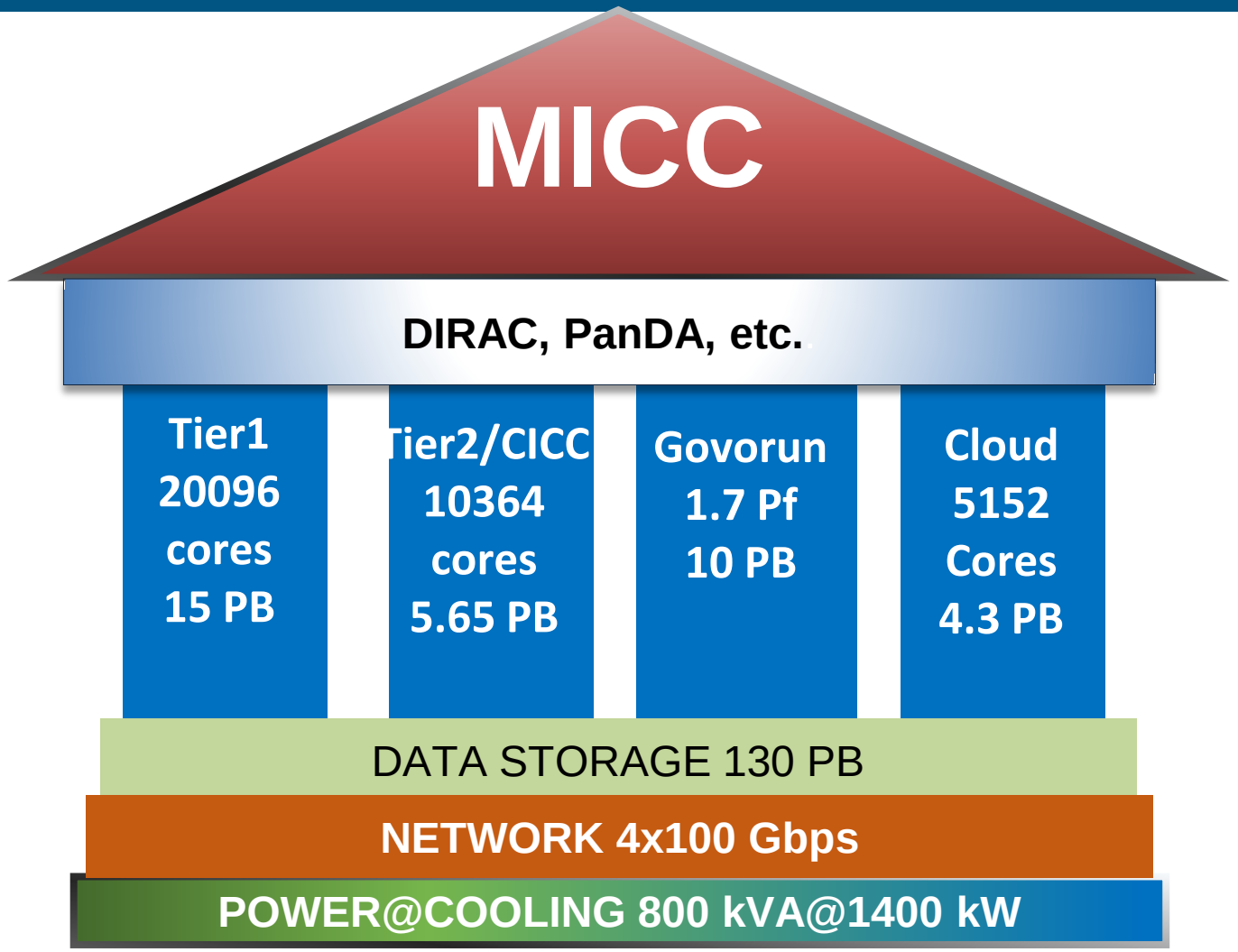
The technology of the data transmission network environment, which appeared in the early 80s, gave impetus to the construction of the first local terminal network in Russia, JINET, at LCTA, the creation of a high-speed telecommunications channel Dubna-Moscow and the subsequent entry of the Institute into international global computer networks for science and education.

1980x – 2000x

In 2000, LCTA was renamed the Laboratory of Information Technologies (LIT)

MICC History

Multifunctional Information and Computing Complex



Four advanced software and hardware components

- Tier1 grid site (distributed data processing)
- Tier2 grid site (distributed data processing)
- hyperconverged “Govorun” supercomputer
- cloud infrastructure

Distributed multi-layer data storage system

- Disks
- Robotized tape library

Engineering infrastructure

- Power
- Cooling

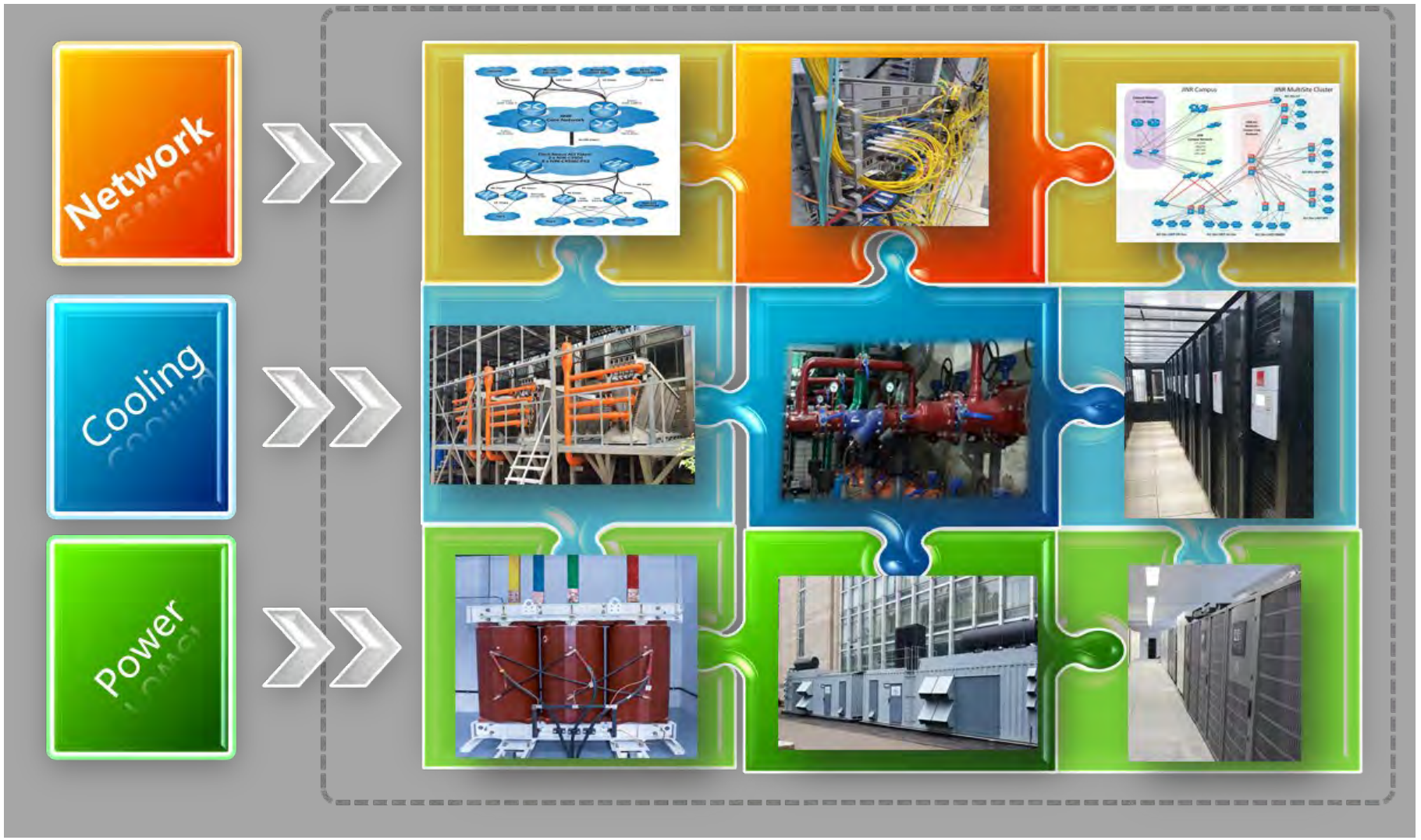
Network

- Wide Area Network
- Local Area Network

micc.jinr.ru

The main objective of the project is to ensure multifunctionality, scalability, high performance, reliability and availability in 24x7x365 mode for different user groups that carry out scientific studies within the JINR Topical Plan

MICC Power @ Cooling @ Network

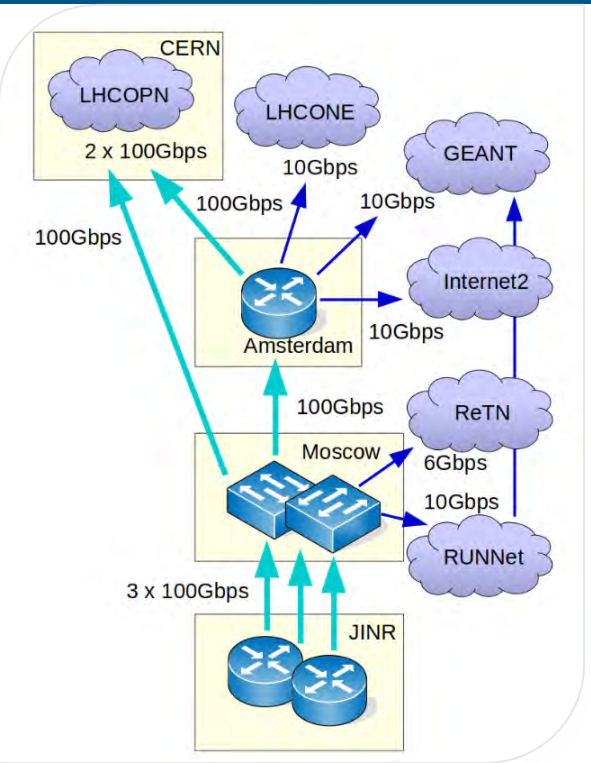


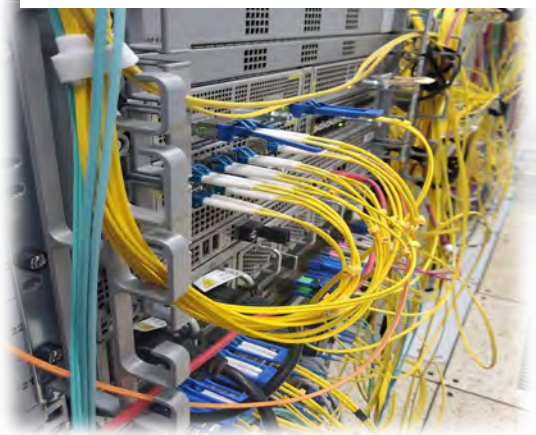
Wide Area Network 3x100 Gbps
Cluster Backbone 4x100 Gbps
Campus Backbone 2x100 Gbps

Dry chillers
In-Row systems
Total cooling 1400 kW

Uninterruptible power supplies (UPS) 8x300 kVA
Diesel-generator units (DGU) 2x1500 kVA

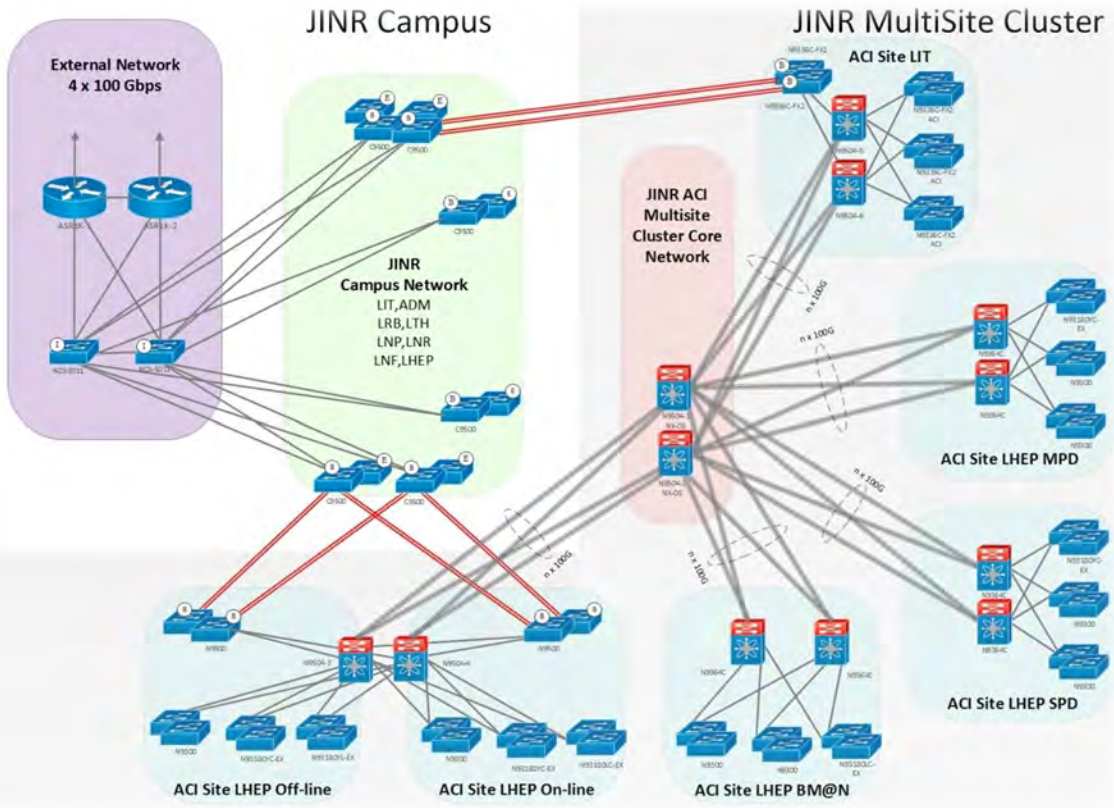
Network Infrastructure





MLIT ensures the reliable and fault-tolerant operation of all components of the network infrastructure:

- JINR-Moscow 3x100 Gbit/s
- JINR-CERN 100 Gbit/s and JINR-Amsterdam 100 Gbit/s
- multi-site cluster network with a bandwidth of 4x100 Gbit/s for the NICA megaproject
- local area network with a bandwidth of 2x100 Gb/s



The JINR LAN comprises:

13395 network elements
23850 IP-addresses
5750 users registered within the network
4785 *.jinr.ru service users
1165 digital library users
920 remote VPN
140 EDUROAM users

Network traffic in 2024

43.45 PB - input
27.28 PB - output

JINR Tier-1 Connectivity

Refrigeration system

Dry cooling towers of the MICC cooling system

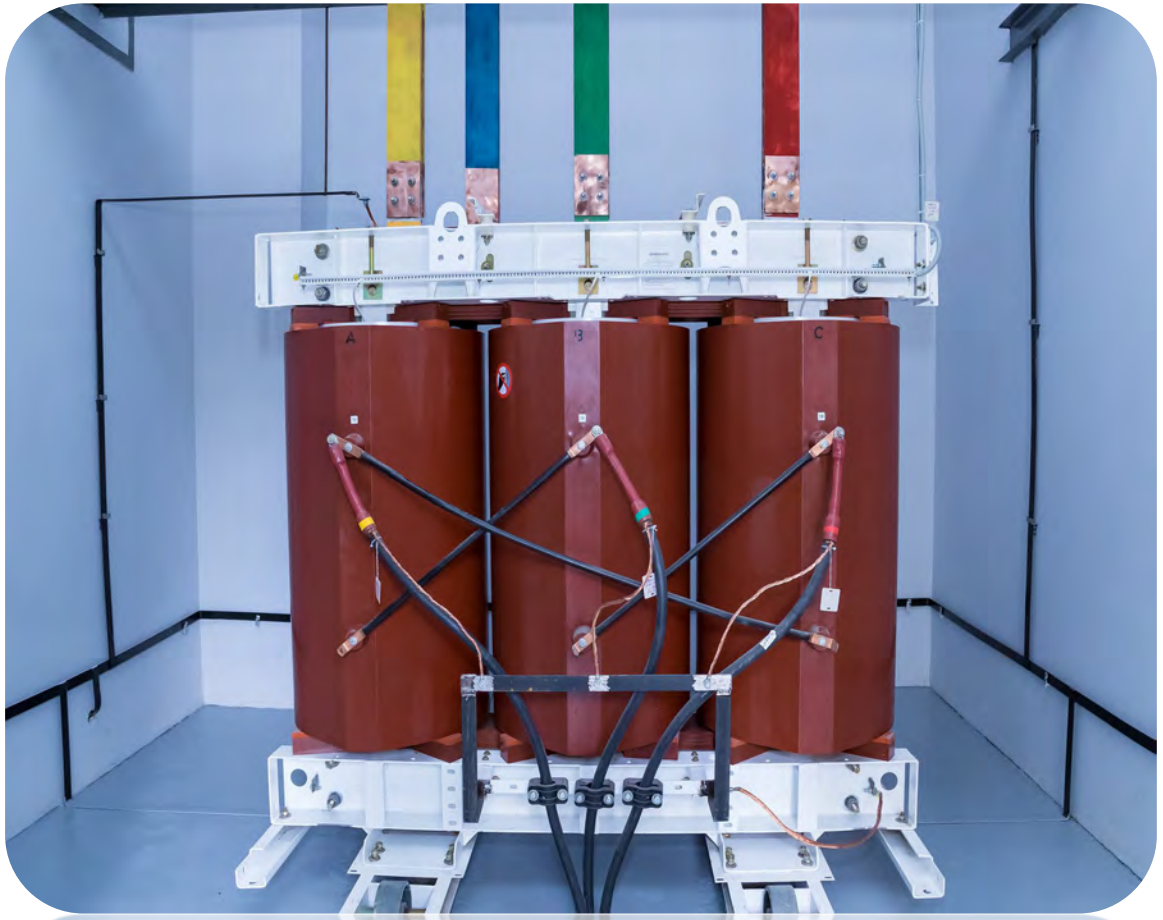
Cooling of the MICC hall (underground floor)

Refrigeration machines of the MICC hall

Dry Cooling Tower Pump and Heat Exchanger

Inter-row air conditioners for server equipment cooling systems

Power supply system



Dry transformers at the power supply input to the LIT building (2x 2500 kVA)

Main switchboard

Uninterrupted power supply system

APC Galaxy 7000

300 KVA

APC Symmetra PX

160 KVA

Riello

MHP 250

250 kVA

Riello

MHP160

160 kVA

Batteries

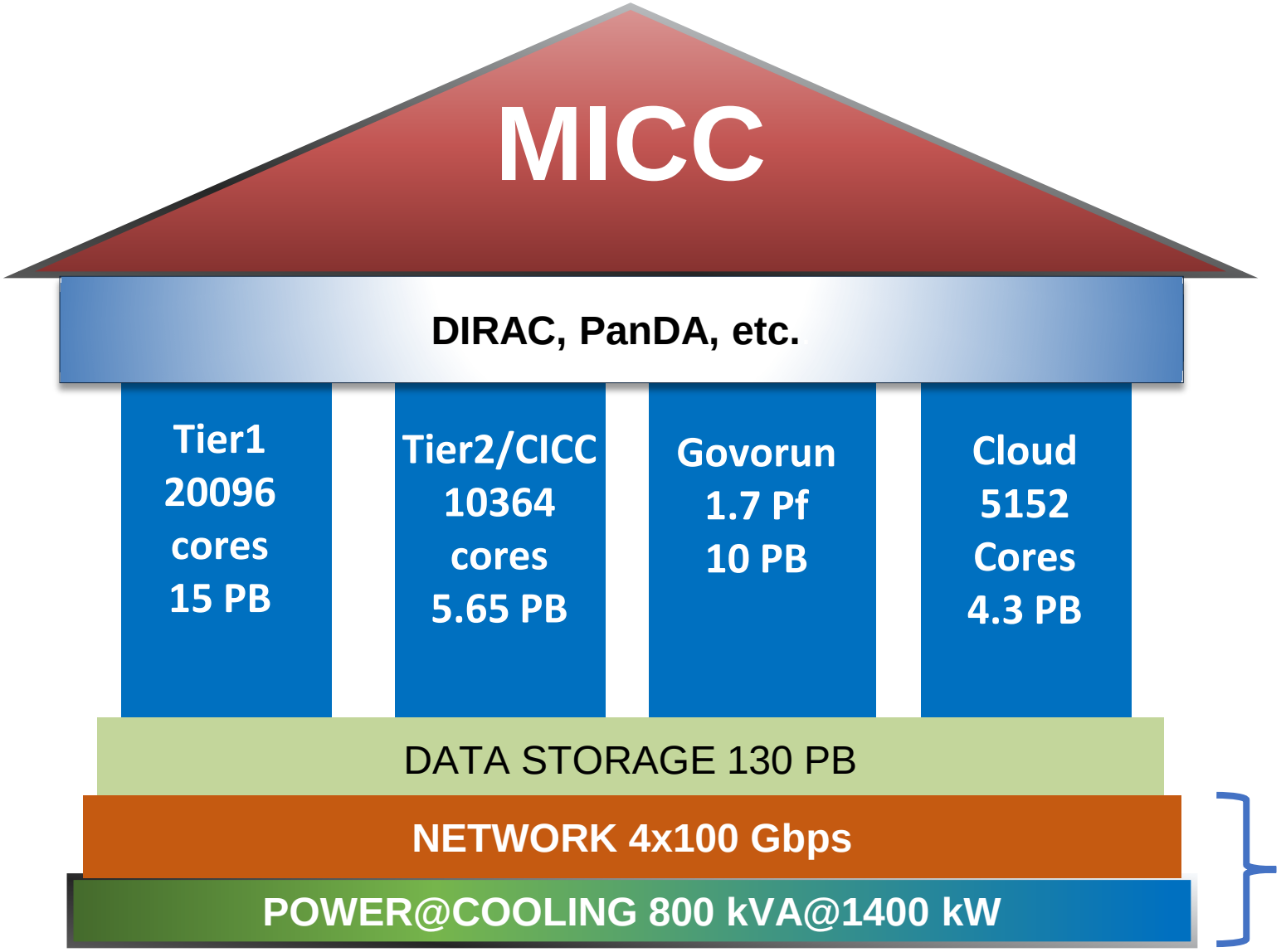
Uninterrupted power supply system

Containers with diesel generator units (DGU) to ensure uninterruptible power supply to the Multifunctional Information and Computing Complex LIT

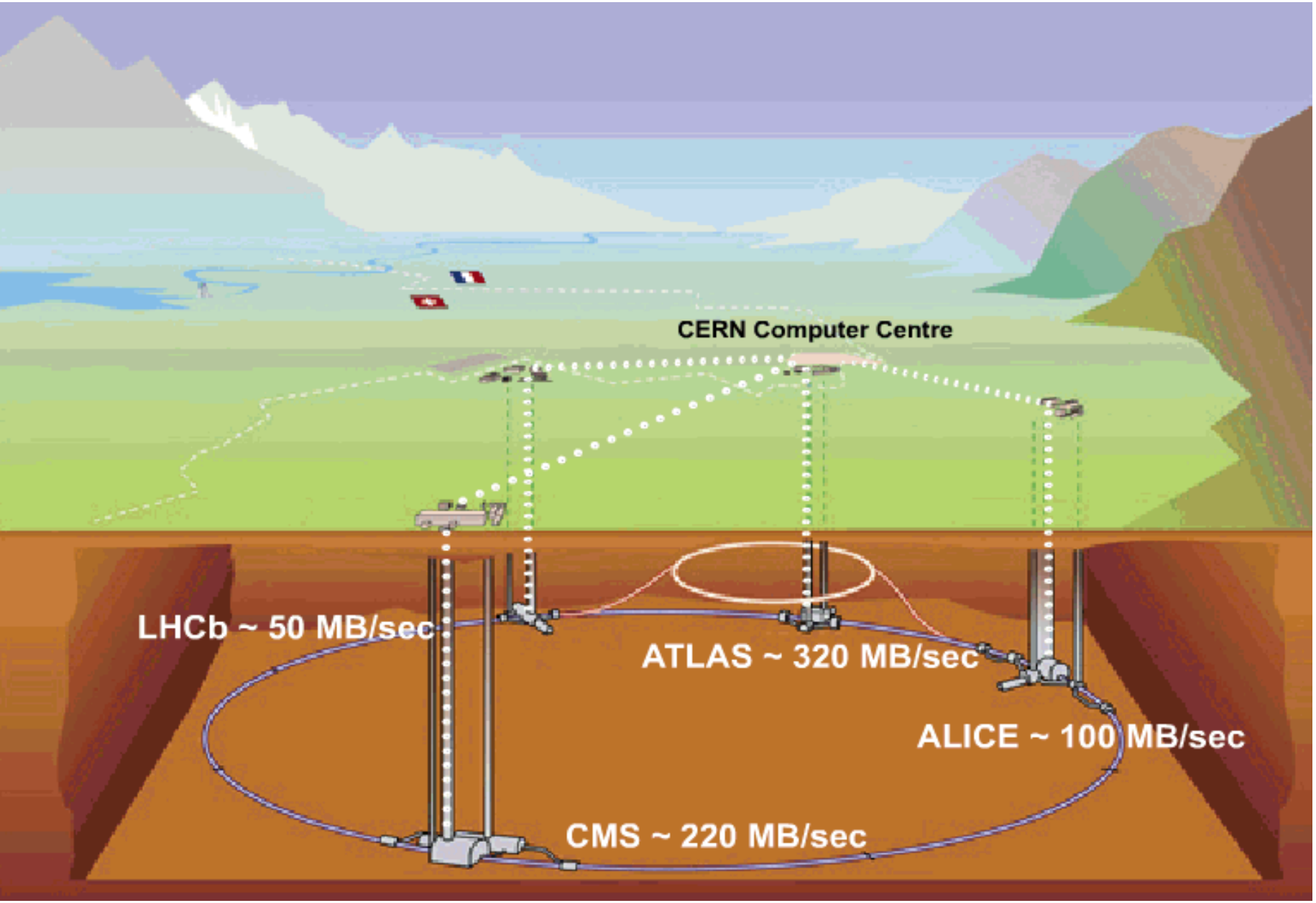
Inside a DGU container

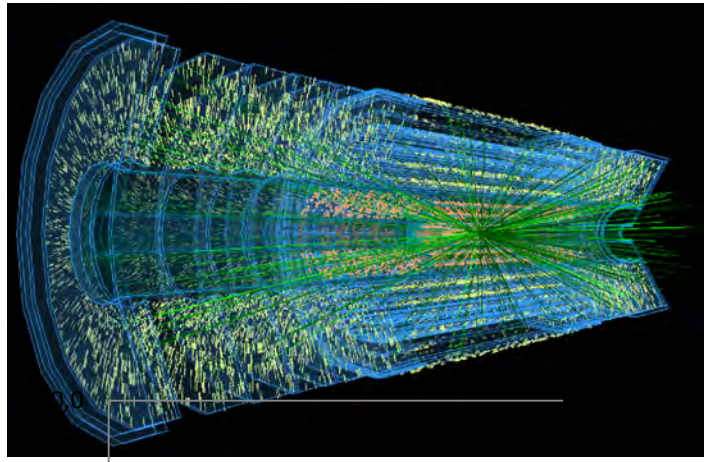
Main tank – 1 ton
Additional tank – 2 tons
Consumption – 335 l/h at 1 MW
Operating time with a full tank ~ 8 h

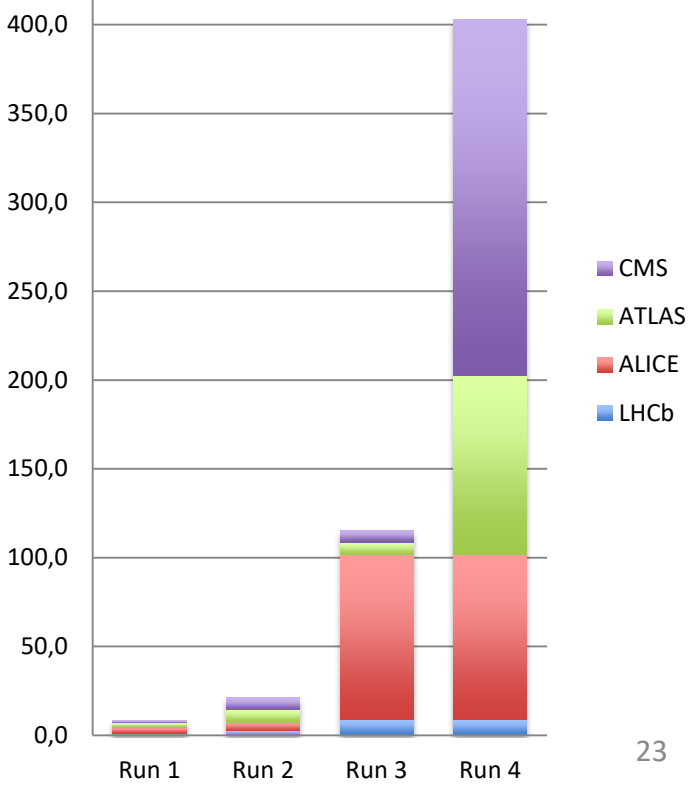
MICC structure

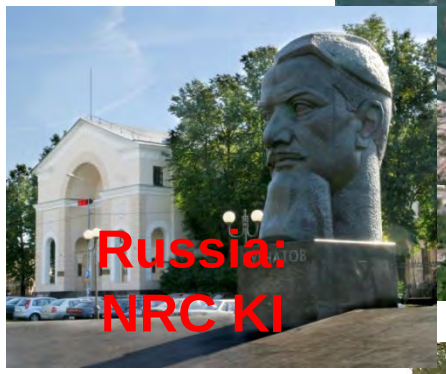


Grid technologies








Russia:
NRC KI


US-BNL

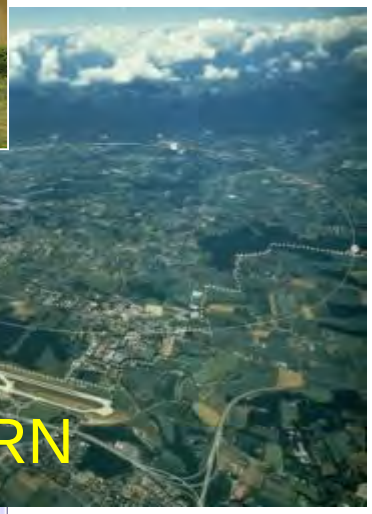

Amsterdam/NIKHEF-SARA

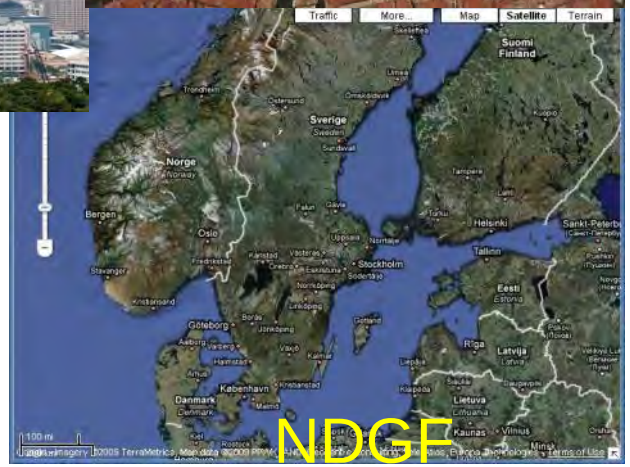

Taipei/ASGC


Bologna/CNAF


Ca-
TRIUMF


JINR


CERN


Traffic
More...
Map
Satellite
Terrain
Suomi
Finland
Sverige
Norge
Helsinki
Stockholm
Eesti
Latvija
Riga
Lietuva
Kaunas
Vilnius
Danmark
Kobenhavn
Göteborg
Bergen
Oslo
Tallinn
NDGF


US-FNAL

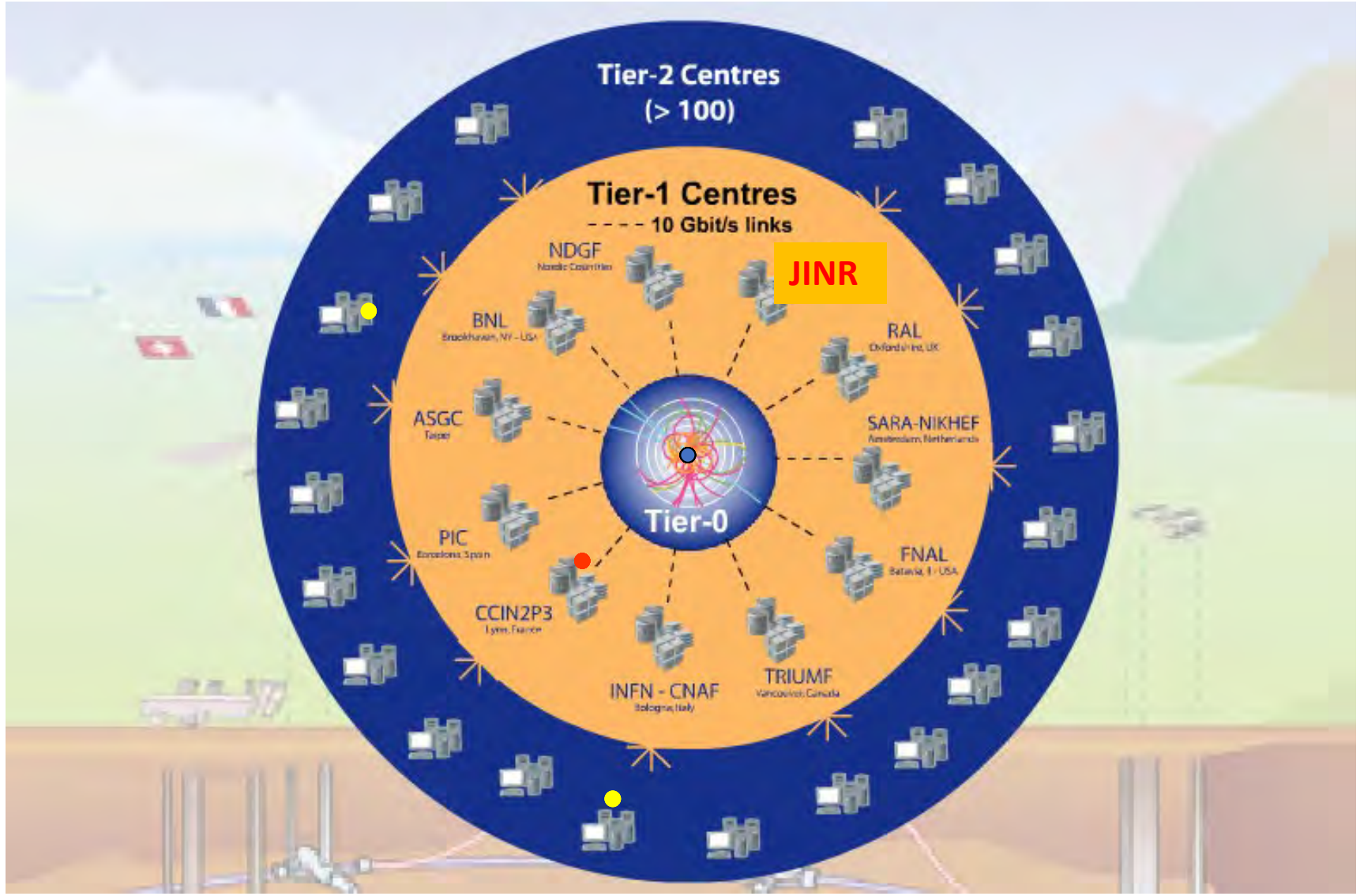

Barcelona/PIC


Lyon/CCIN2P3


UK-RAL


De-FZK

The Worldwide LHC Computing Grid



Tier-0 (CERN):

- Collects data from LHC experiments Online Data Acquisition and Trigger Systems
- Archives RAW data
- First step of reconstruction and data calibration
- Distribution of accumulated data between Tier-1 centers

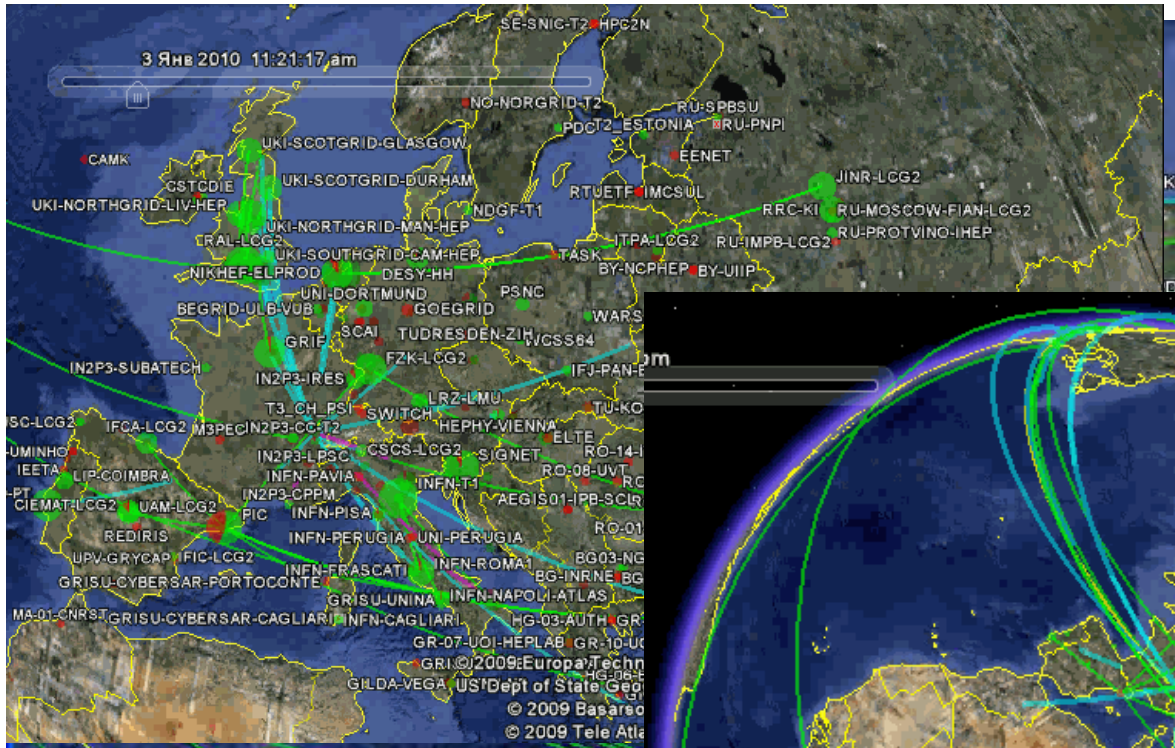
Tier-1 (11 centers):

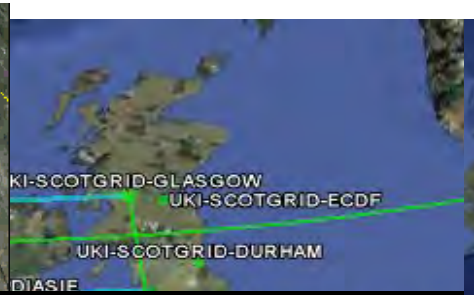
- Receive data from Tier-0
- Reprocessing of received data
- Long-term data storage (tapes)
- Distribution of data to other Tier-1 and Tier-2 centers

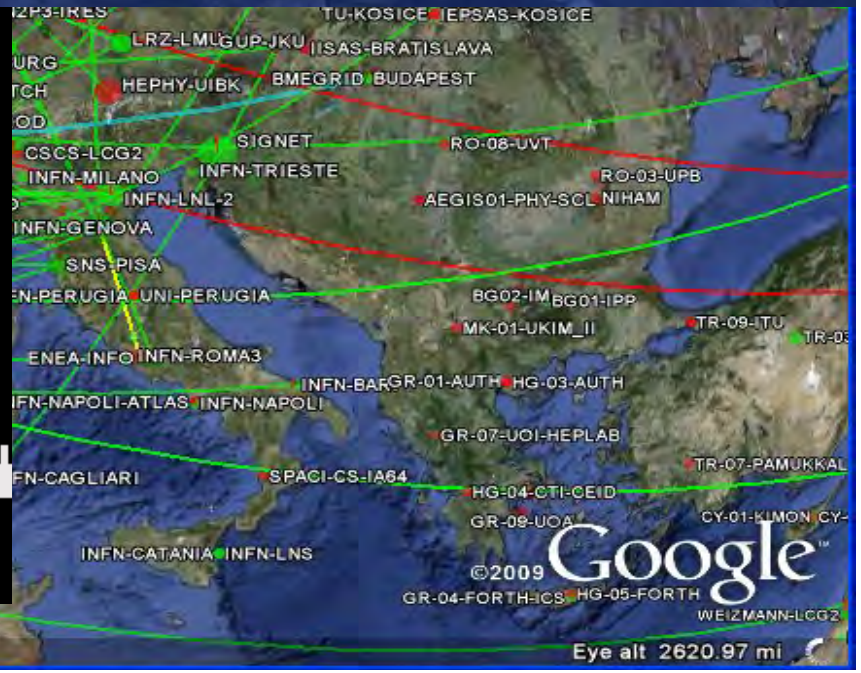
Tier-2 (>200 центров):

- Simulation
- User analysis

The Worldwide LHC Computing Grid (WLCG)



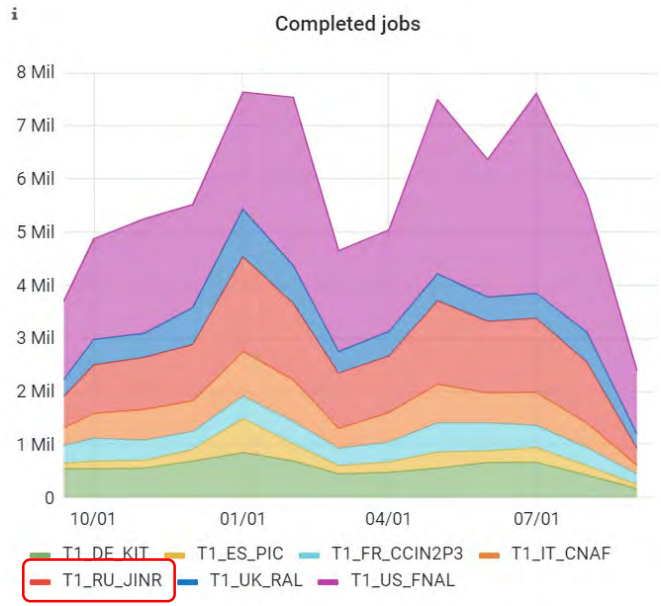


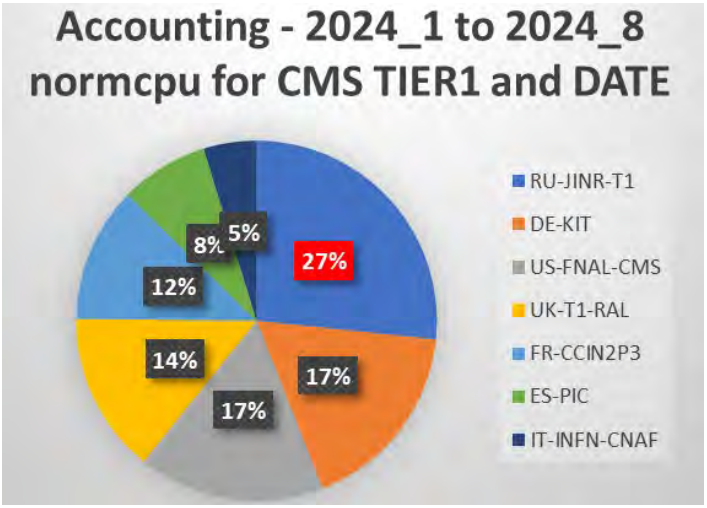


JINR is a part of Worldwide LHC Computing Grid

JINR Tier1 for CMS @LHC and NICA Experiments

Last year



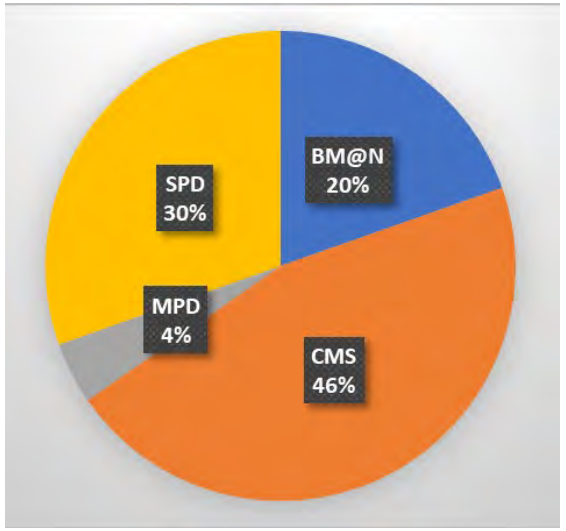


Since the beginning of 2015, a full-scale WLCG Tier1 site for the CMS experiment has been operating at MLIT JINR.

The importance of developing, modernizing and expanding the computing performance and data storage systems of this center is dictated by the research program of the CMS experiment, in which JINR physicists take an active part within the RDMS CMS collaboration.

JINR Tier1 is regularly ranked on top among world Tier1 sites that process data from the CMS experiment at the LHC.

50% of all jobs executed at Tier1 JINR are NICA jobs

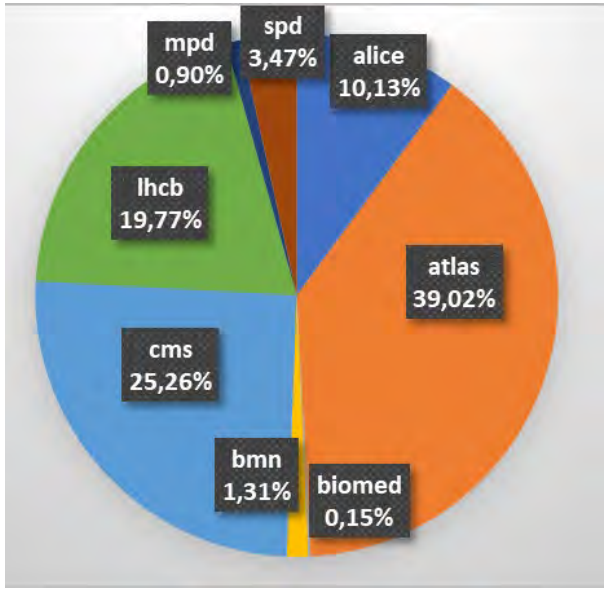


Since 2021, the JINR Tier1 center has demonstrated stable operation not only for CMS (LHC), but also for the NICA experiments.

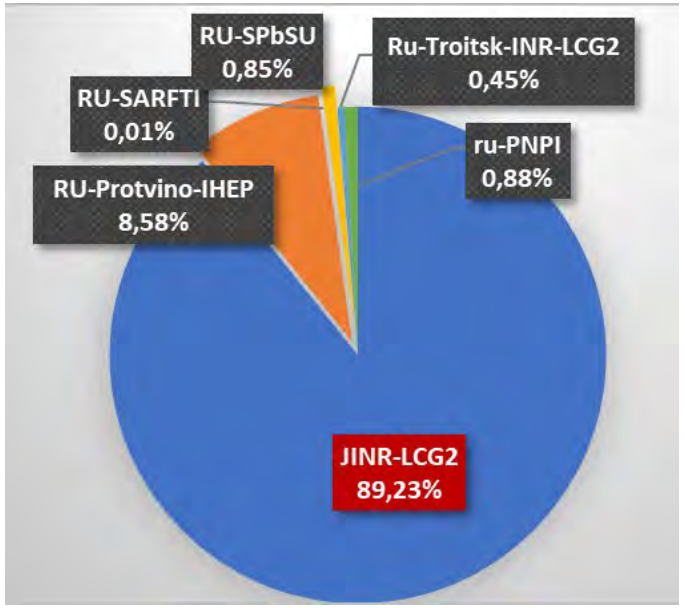
20096 CPU cores; 360 kHS06
15 PB dCache based disk storage;
100 PB Tape storage
100% reliability and availability

JINR Tier2 in WLCG & RDIG

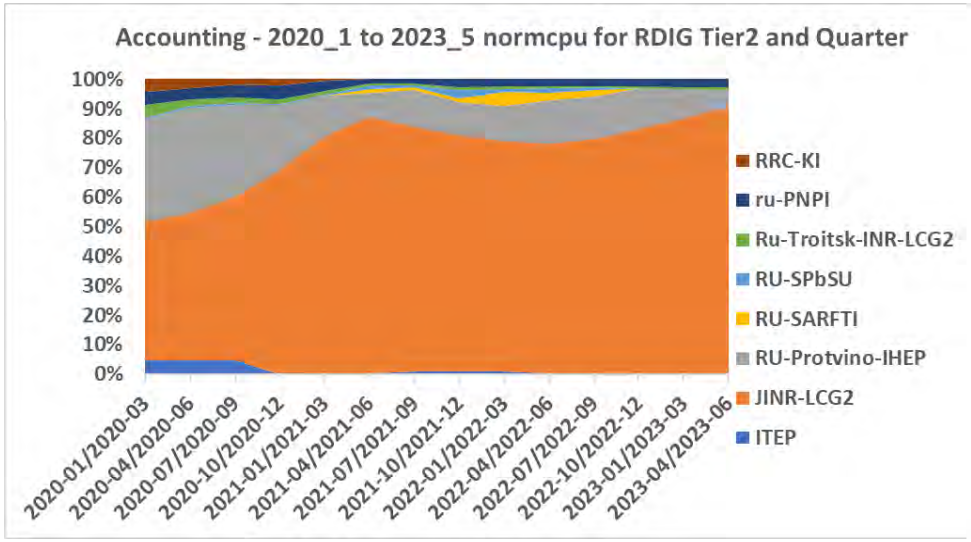
Use of the JINR Tier2 site by virtual organizations within grid projects



Tier2 at JINR provides computing power and data storage and access systems for the majority of JINR users and user groups, as well as for users of virtual organizations (VOs) of the grid environment (LHC, NICA, etc.).

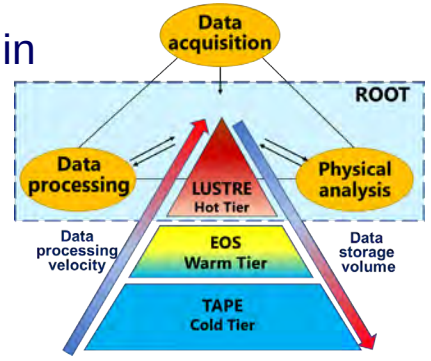


JINR Tier2 is the most productive in the Russian Data Intensive Grid (RDIG) Federation. Almost 80% of the total CPU time in the RDIG is provided by JINR Tier2 site.

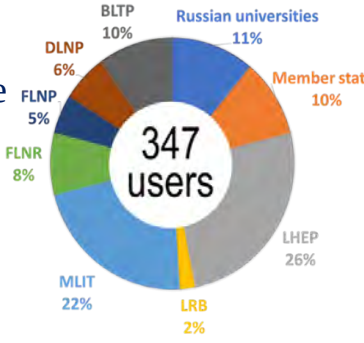


“Govorun” Supercomputer

- Hyper-converged software-defined system
- Hierarchical data processing and storage system
- Scalable solution Storage-on-demand
- Total peak performance: 1.7 PFlops DP and 26 Pflops for AI tasks
- GPU component based on NVIDIA Tesla V100&A100
- CPU component based on RSC “Tornado” liquid cooling solutions
- The most energy-efficient center in Russia (PUE = 1.06)
- Storage performance >300 GB/s



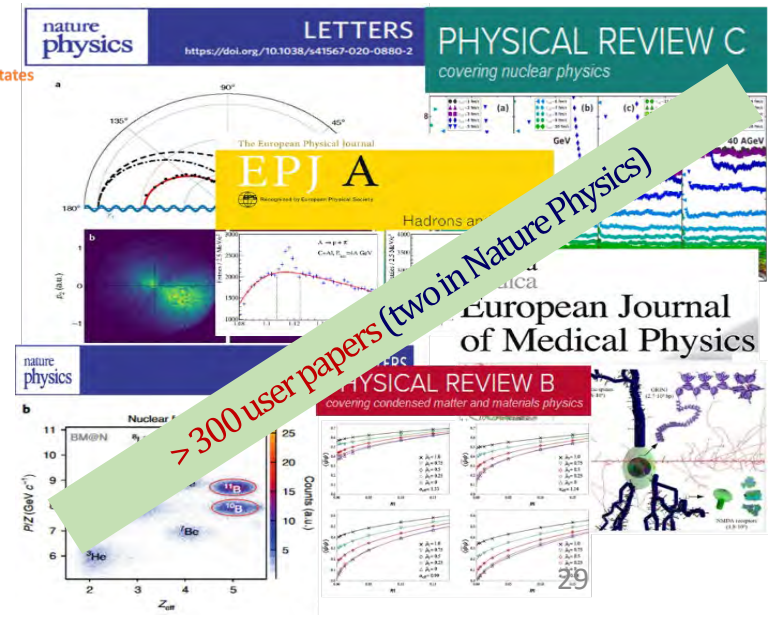
Total number of users : 347
including from the Member States (Armenia, Belarus, Vietnam, Egypt, South Africa)



Key projects that use the resources of the SC “Govorun”:

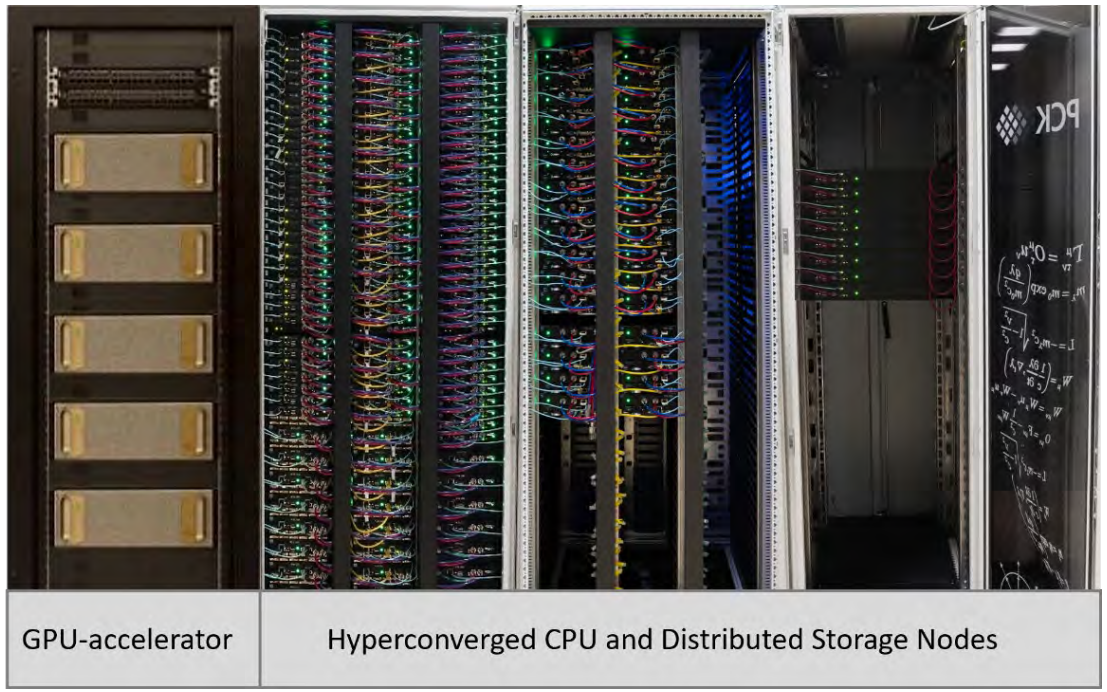
- NICA megaproject,
- calculations of lattice quantum chromodynamics,
- computations of the properties of atoms of superheavy elements,
- studies in the field of radiation biology,
- calculations of the radiation safety of JINR’s facilities.

Russian DC Awards 2020 in “The Best IT Solution for Data Centers”



SC "Govorun" is included into a single supercomputer infrastructure based on the National Research Computer Network of Russia (NIKS).

"Govorun" supercomputer modernization in 2022 - 2023



GPU-accelerator | Hyperconverged CPU and Distributed Storage Nodes

\+

5 servers with 8 NVidia A100 GPUs in each

\+

Computation field:
+32 hyperconverged compute nodes

\+

Hierarchical Storage:
+8 distributed storage nodes

+ 40 NVIDIA A100 GPU accelerators
Performance: + 600 Tflops DP

+32 hyperconverged compute nodes
+2 432 new computational cores
Performance: +239 Tflops DP
"New cores"/"old cores" performance increase by more than 1.5 times

+8 distributed storage nodes
Lustre, EOS increase: +8 PB
DAOS increase: +1.6 PB
+0.4 PB for MPD mass production storages integrated into the DIRAC File Catalog
+1 PB for the MPD EOS storage

"Govorun" SC total peak performance: 1.7 PFlops DP
Total capacity of Hierarchical Storage: 10 PB
Data IO rate: 300 Gb/s

"Govorun" supercomputer. Liquid cooling.

A dry cooling tower is installed. The task of a dry cooling tower is to provide cooling of the heat carrier used in the technological process. This is achieved due to the fact that the liquid supplied to the heat exchange device reduces its temperature under the influence of the air flow taken by the ventilation unit from the environment.

From the cooling tower, the ethylene glycol enters a collector and then a heat exchanger unit that absorbs thermal energy from the water, which is directly circulated through the supercomputer's computing nodes.

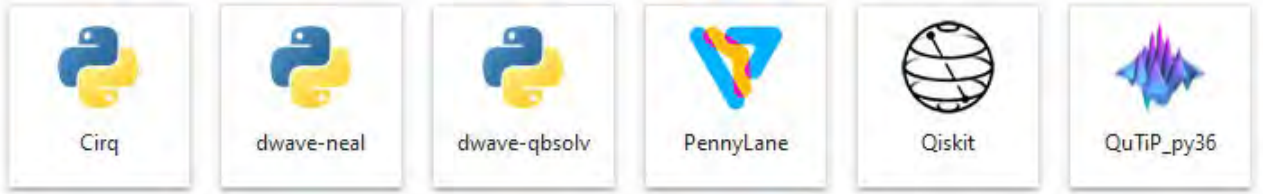
PUE ~ 1,06

Hot water to avoid the dew point

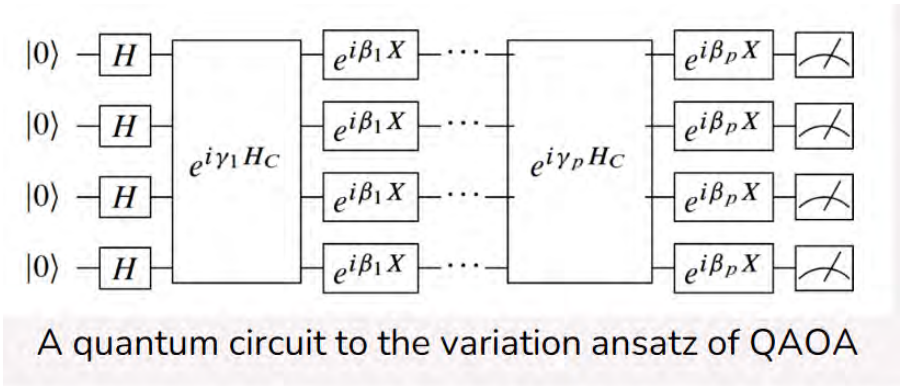
Water cooled to a temperature of **45 degrees** enters the supercomputer. After passing through the entire circuit in the supercomputer, the water is heated up to **50 degrees** returns to the heat exchanger, where it cools down, transferring thermal energy to the hydraulic circuit of the dry cooling tower. The cooling system has a smooth performance adjustment, which allows increasing or decreasing the capacity of the cooling system in accordance with the actual load. This allows for a significant reduction in electricity consumption at partial load.

Quantum Computing Polygon

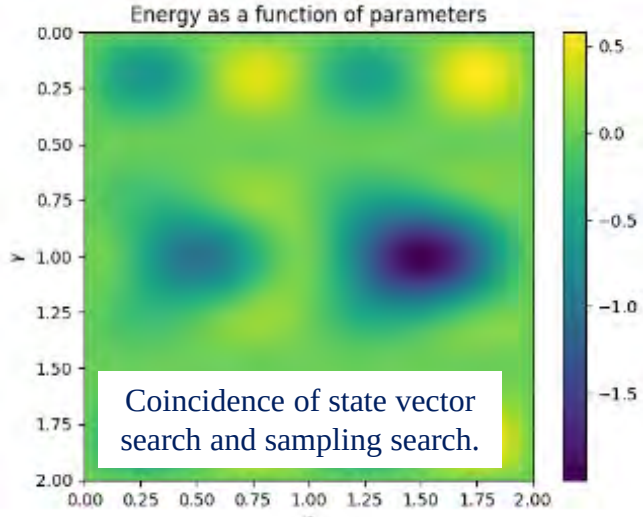
deployed on the ML/DL/HPC ecosystem of the HybriLIT platform.



As an example, we present a search for the ground state and its energy in the Ising model with a longitudinal magnetic field using the quantum approximation optimization algorithm (QAOA).



A quantum circuit to the variation ansatz of QAOA



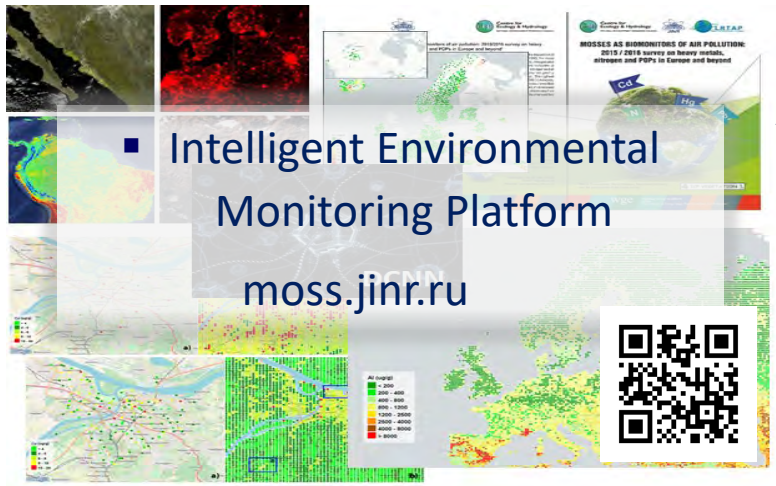
OpenMP for CPU computations and cuStateVec for GPU computations

Ising Model 3x3x3 lattice 27 qub	AMD EPYC 7763, 128 th.	Intel Xeon Platinum 8368Q, 128 threads	NVIDIA A100, cuStateVec
Comp. time	3 h 20 min	3 h 10 min	**14 min 35 sec**

Yu. Palii, A. Bogolubskaya, and D. Yanovich: Quantum Approximation Optimization Algorithm for the Ising Model in an External Magnetic Field // PEPAN, V. 55, N. 3. Pp. 600-602, 2024.

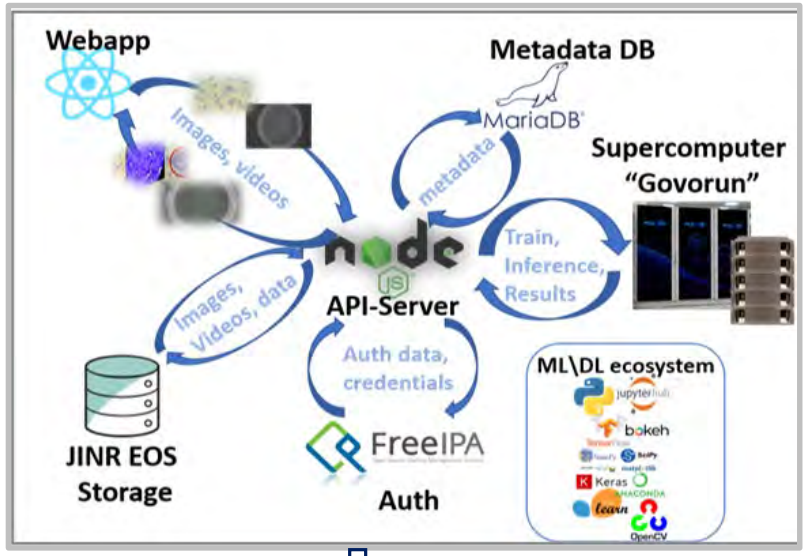
Radiobiology and Life Science

Application of accumulated experience to various classes of problems!



- Intelligent Environmental Monitoring Platform

moss.jinr.ru

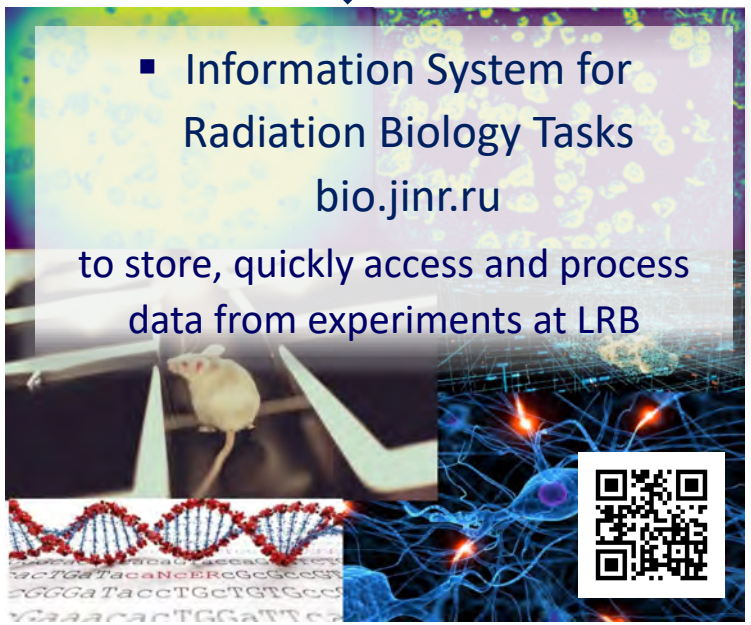


The ML/DL/HPC ecosystem

- top of ML/DL technologies
- modern IT solutions for data storage, processing and visualization
- statistical analysis

- Development of the intelligent platform for determining the state of agricultural and decorative plants

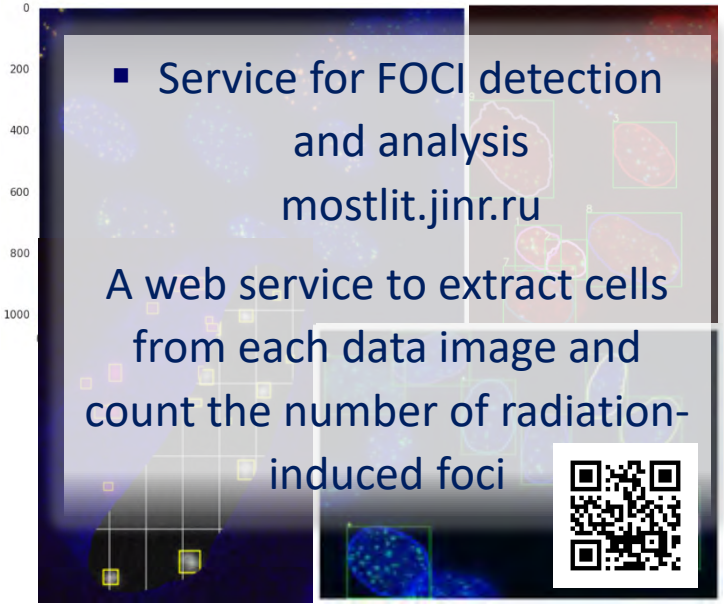
doctorp.ru



- Information System for Radiation Biology Tasks

bio.jinr.ru

to store, quickly access and process data from experiments at LRB



- Service for FOCI detection and analysis

mostlit.jinr.ru

A web service to extract cells from each data image and count the number of radiation-induced foci

Cloud Infrastructure

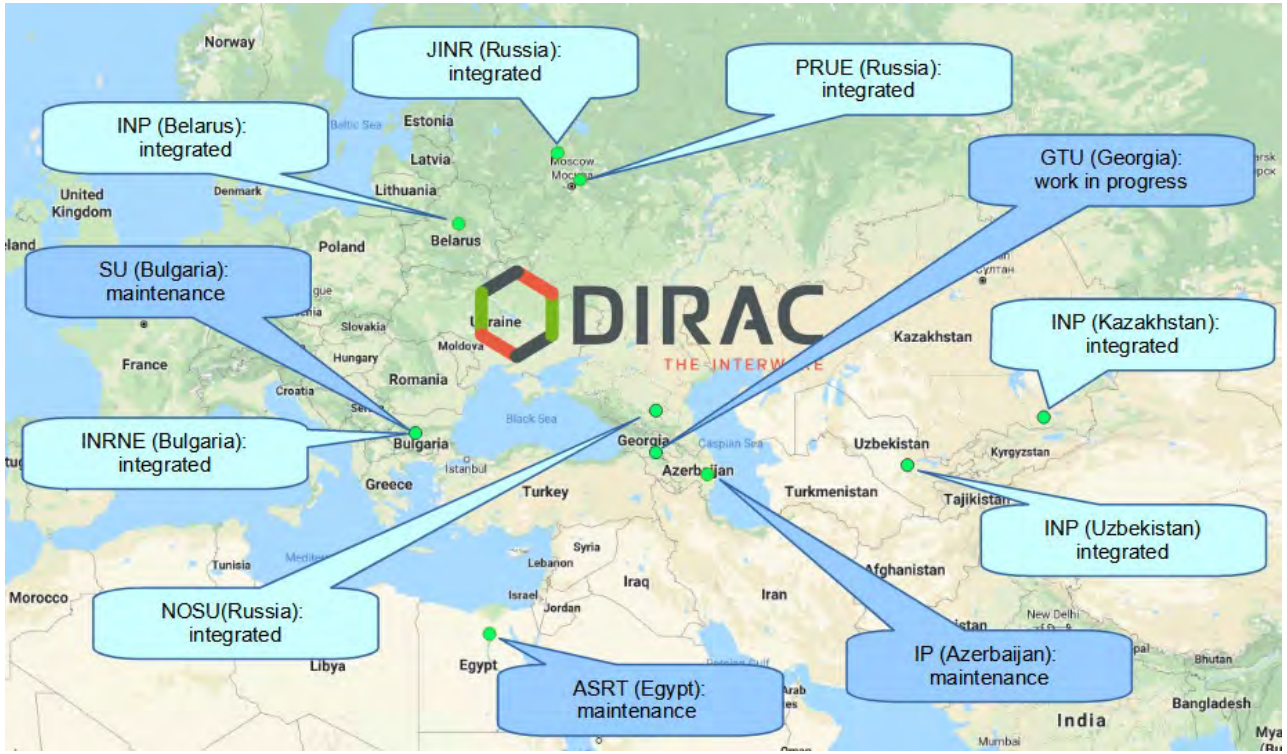
- Cloud Platform– OpenNebula,
- Visualization – KVM

- Storage (Local disks, Ceph)
- Resources: ~ 5,152 CPU core; 5 PB ceph-storage

➢ Computational resources for neutrino experiments

Neutrino experiments (JUNO, Baikal-GVD, NOvA) are the major users of the cloud infrastructure.

- ➢ VMs for JINR users
- ➢ Testbeds for research and development in IT
- ➢ COMPASS production system services
- ➢ Data Management System of the European Air Pollution Programme (UNECE ICP Vegetation)
- ➢ A system for diagnosing diseases of agricultural crops using modern machine learning methods
- ➢ Service for data visualization, Gitlab and some others



DIRAC-based distributed information and computing environment (DICE) that integrates the JINR Member State organizations' clouds

Support for the JINR Neutrino Program

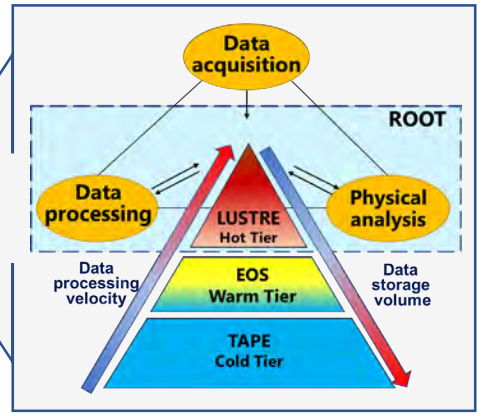
MLIT contribution: engineering infrastructure (electricity, UPS, cooling, network, racks, manpower)

DLNP contribution: computing and storage resources (CPUs/GPUs&disks)

Computational resources for the **JINR neutrino program** using the cloud infrastructure of the MICC. The **NOvA, Baikal-GVD and JUNO** experiments are the **major consumers** of the cloud infrastructure.

Distributed Multi-layer Data Storage System

- Limited data and short-term storage – to store the OS itself, temporary user files
- AFS distributed global system – to store user home directories and software
- dCache is traditional for the MICC grid sites – to store large amounts of data (mainly LHC experiments) for the middle-term period
- EOS is extended to all MICC resources – to store large amounts of data for the middle-term period. At present, EOS is used for storage by BM@N, MPD, SPD, BaikalGVD, etc.
- Tape robotic systems – to store large amounts of data for the long-term period for CMS, BM@N, MPD, SPD, JUNO – in progress.

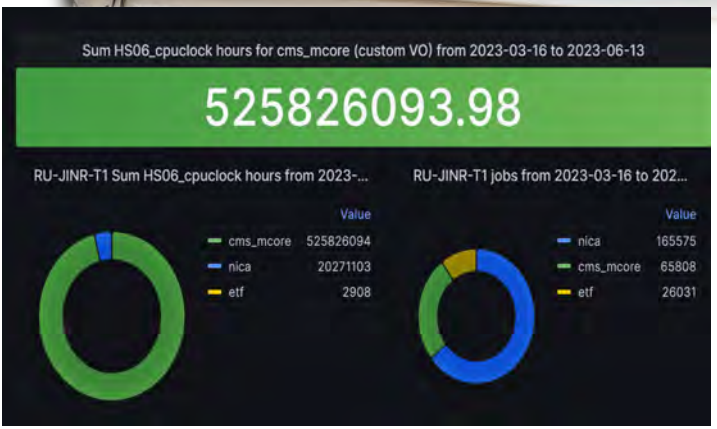


A special hierarchical data processing and storage system with a software-defined architecture was developed and implemented on the "Govorun" supercomputer.

According to the speed of accessing data, there are the following layers:

- hot data (LUSTRE),
- warm data (EOS)
- cold data(TAPE)

MICC Monitoring @Accounting



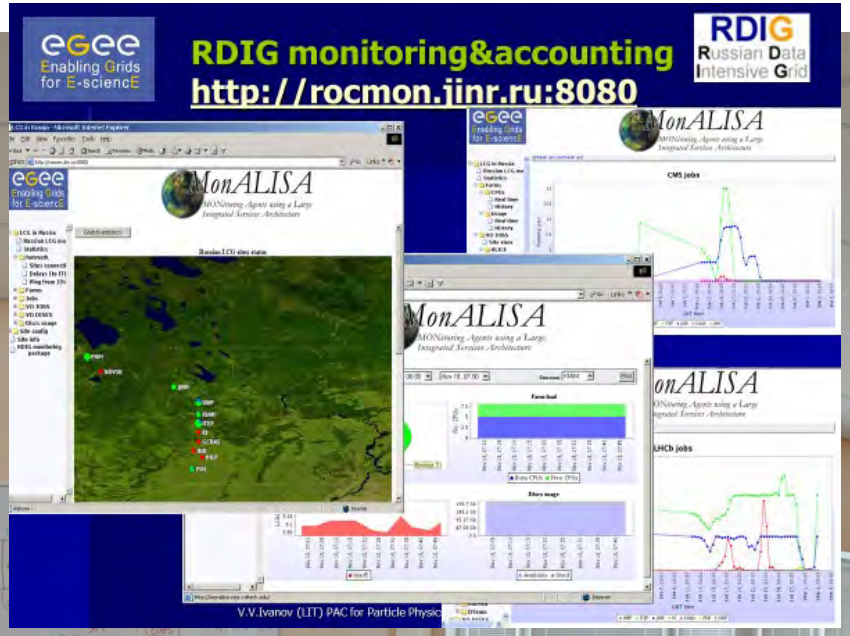
- ❖ 3 monitoring servers
- ❖ About 1800 nodes
- ❖ About 16000 service checks

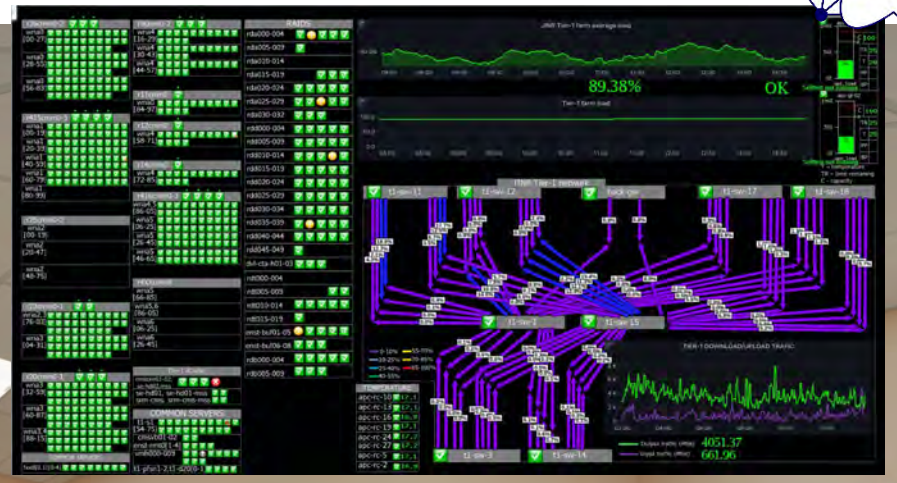
The successful functioning of the computing complex is ensured by the system that monitors all MICC components. We must

- ➢ expand the monitoring system by integrating local monitoring systems for power supply systems into it (diesel generators, power distribution units, transformers and uninterruptible power supplies);
- ➢ organize the monitoring of the cooling system (cooling towers, pumps, hot and cold water circuits, heat exchangers, chillers);
- ➢ create an engineering infrastructure control center (special information panels for visualizing all statuses of the MICC engineering infrastructure in a single access point);
- ➢ account each user job on each MICC component.

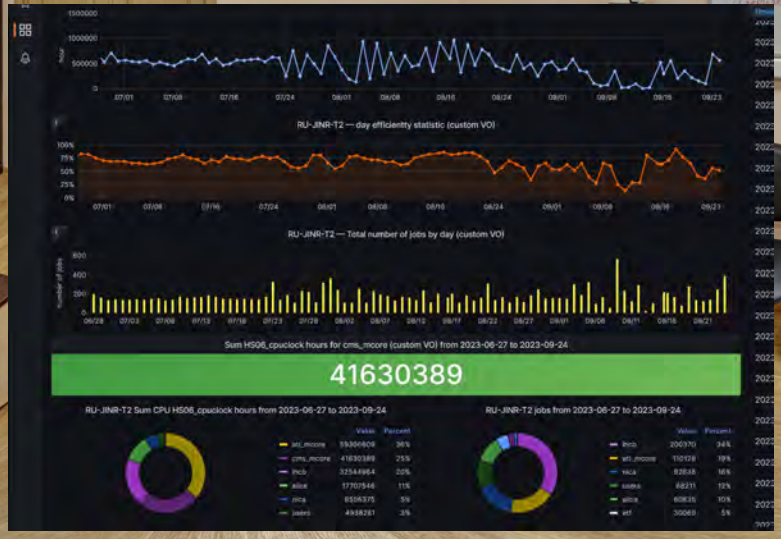
It is required to develop intelligent systems that will enable to detect anomalies in time series on the basis of training samples, which will result in the need to create a special analytical system within the monitoring system to automate the process.

Monitoring


eGee
Enabling Grids for E-sciencE
RDIG monitoring&accounting
http://rocmon.jinr.ru:8080
RDIG
Russian Data Intensive Grid
MonALISA
V.V.Ivanov (LIT) PAC for Particle Physic

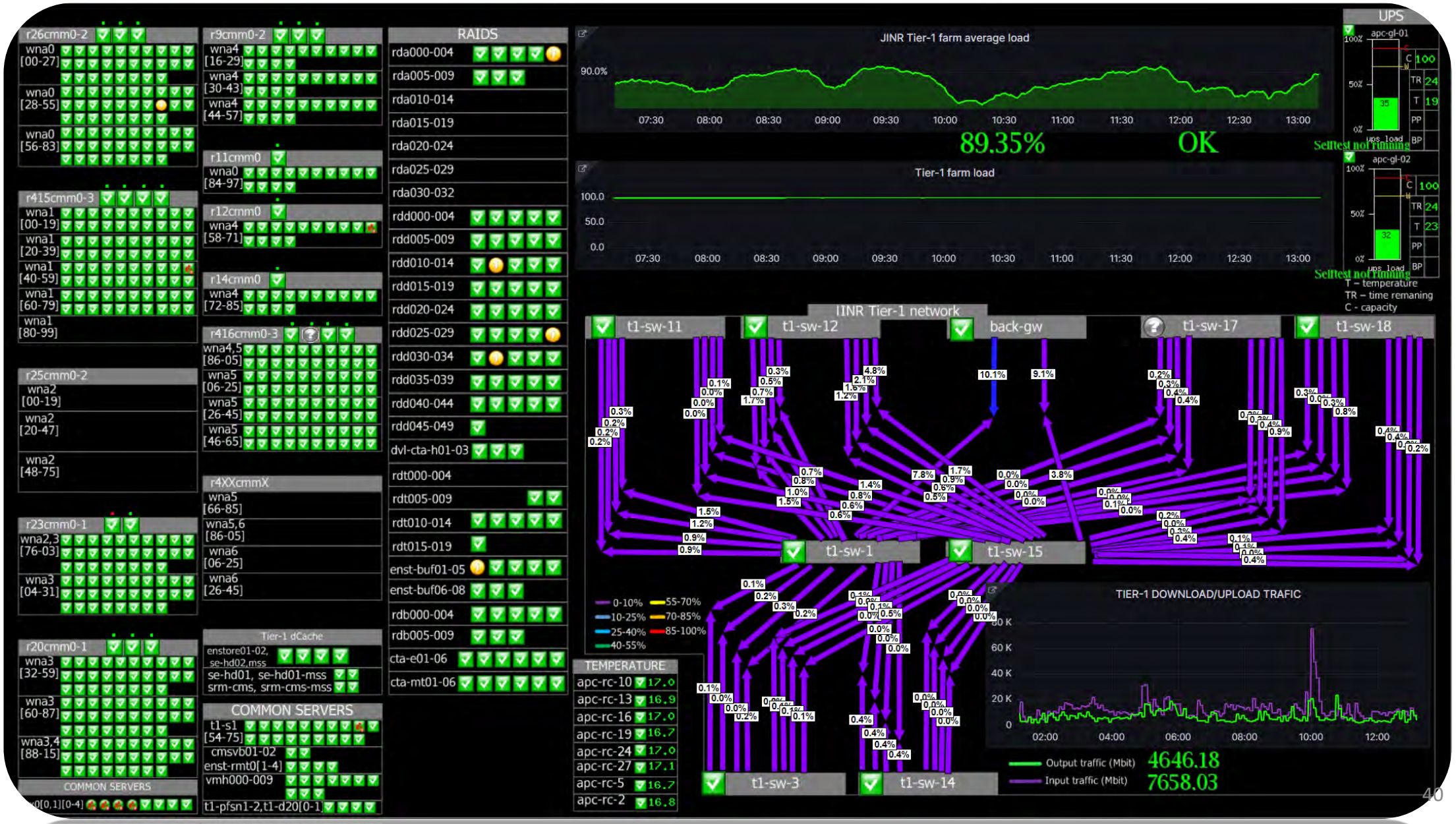

89.38%
OK
4051.37
661.96


50.6 PB
2.65 PB
11.7 PB
20000
1.99 PB
1.69 PB
1.94 PB
10364
7.51 PB
15680
22.4 PB
4320
5152
60.6 TB
3.84 PB
1.44 PB

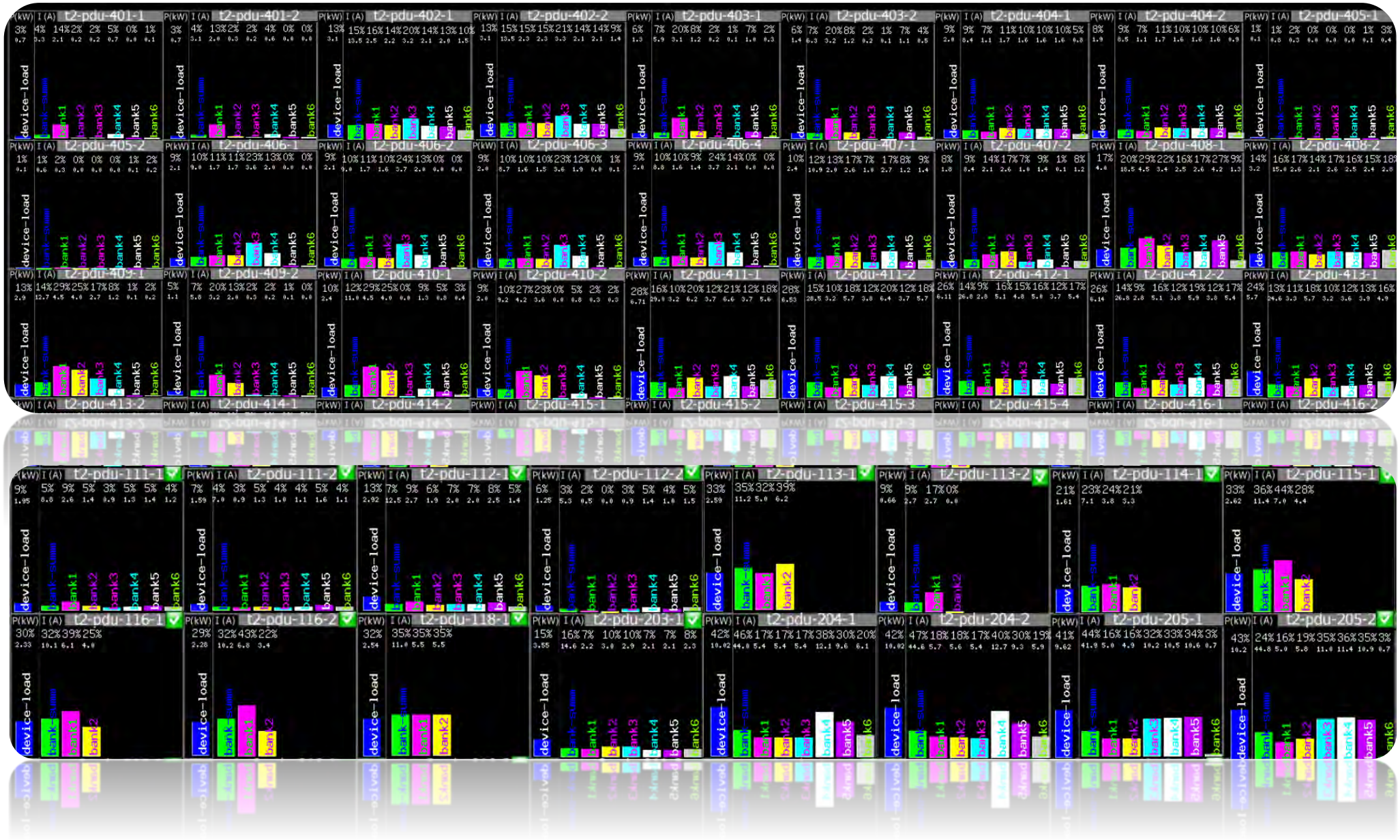

RU-JINR-T2 — day efficientty statistic (custom VO)
RU-JINR-T2 — Total number of jobs by day (custom VO)
Sum HS06_cpuclock hours for cms_mcore (custom VO) from 2023-06-27 to 2023-09-24
41630389
RU-JINR-T2 Sum CPU HS06_cpuclock hours from 2023-06-27 to 2023-09-24
RU-JINR-T2 jobs from 2023-06-27 to 2023-09-24

Monitoring and accounting

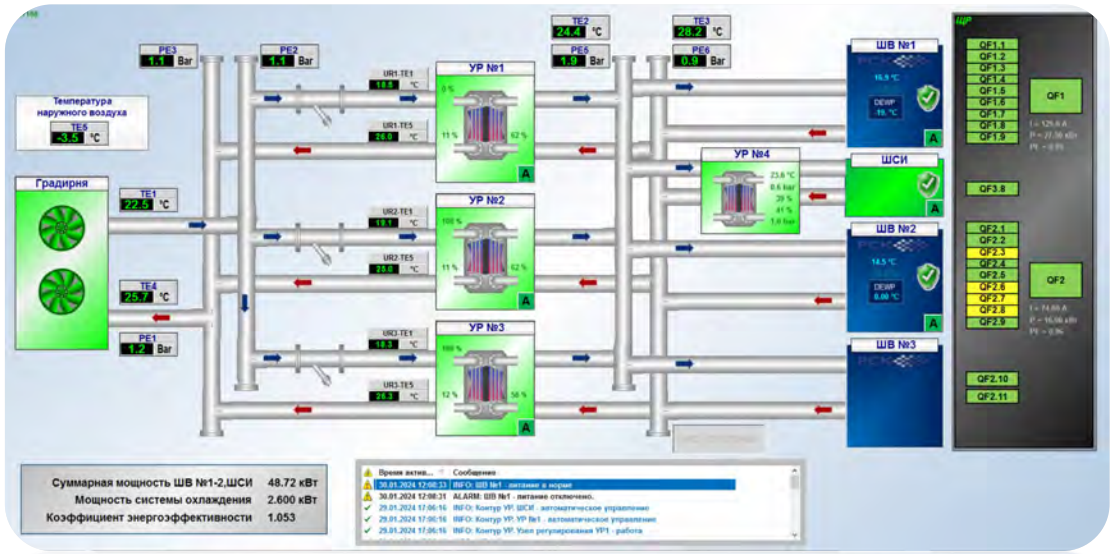
Monitoring Tier-1 current status

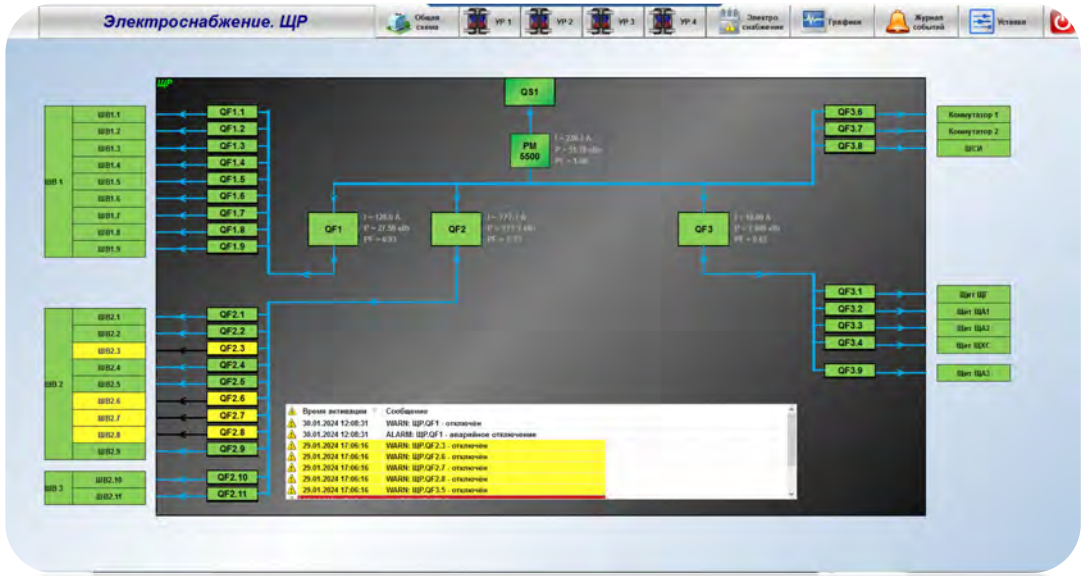


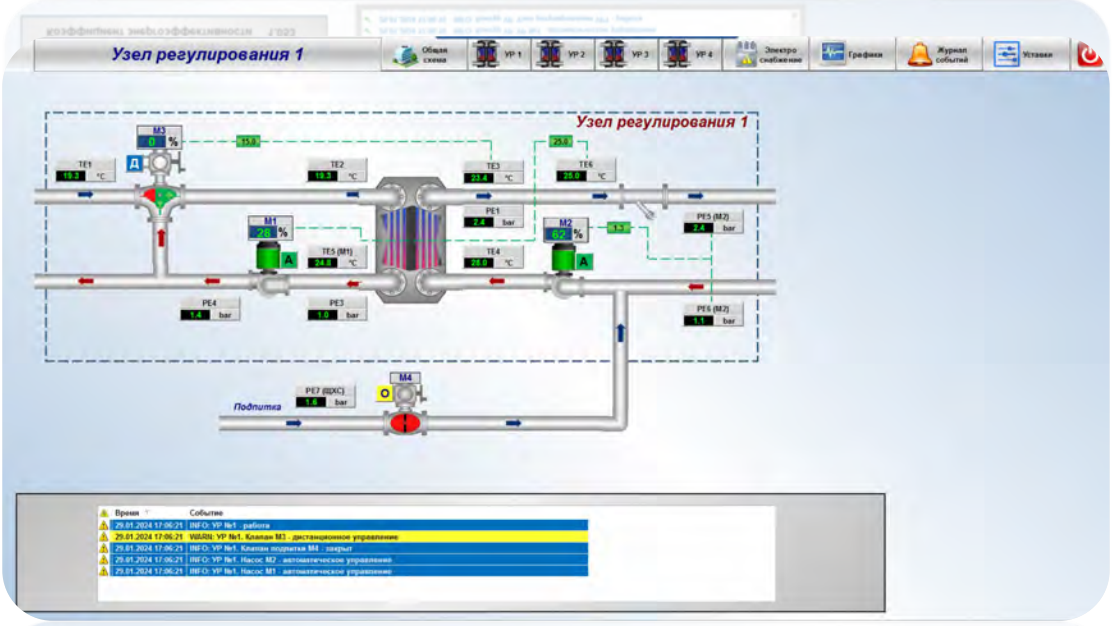
Monitoring power supply elements

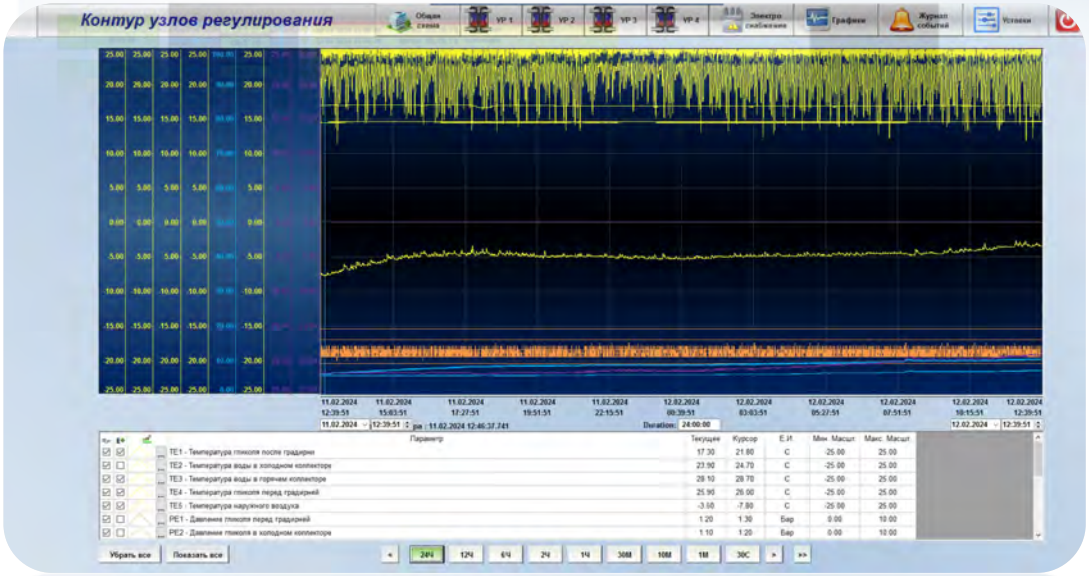


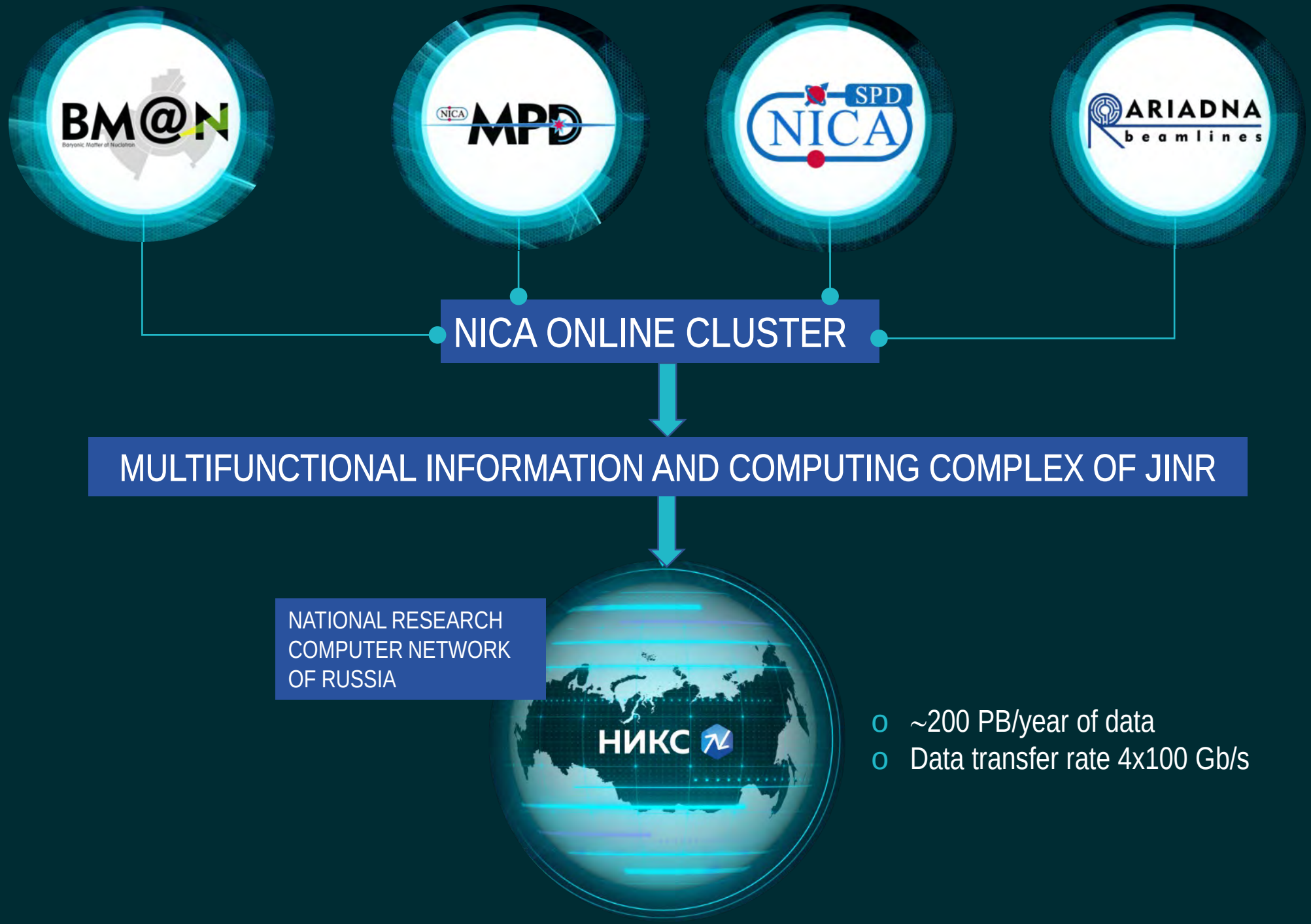
Monitoring of cooling system











- ~200 PB/year of data
- Data transfer rate 4x100 Gb/s

MULTIFUNCTIONAL INFORMATION AND COMPUTING COMPLEX OF JINR

CLOUD INFRASTRUCTURE

- 5,152 compute cores
- 4 PB

GRID INFRASTRUCTURE

- 30,000 compute cores
- 20 PB

"GOVORUN" SUPERCOMPUTER

- 1.7 PFlops for double-precision computations
- 26 PFlops for AI tasks

DISTRIBUTED DATA STORAGE

- 130 PB

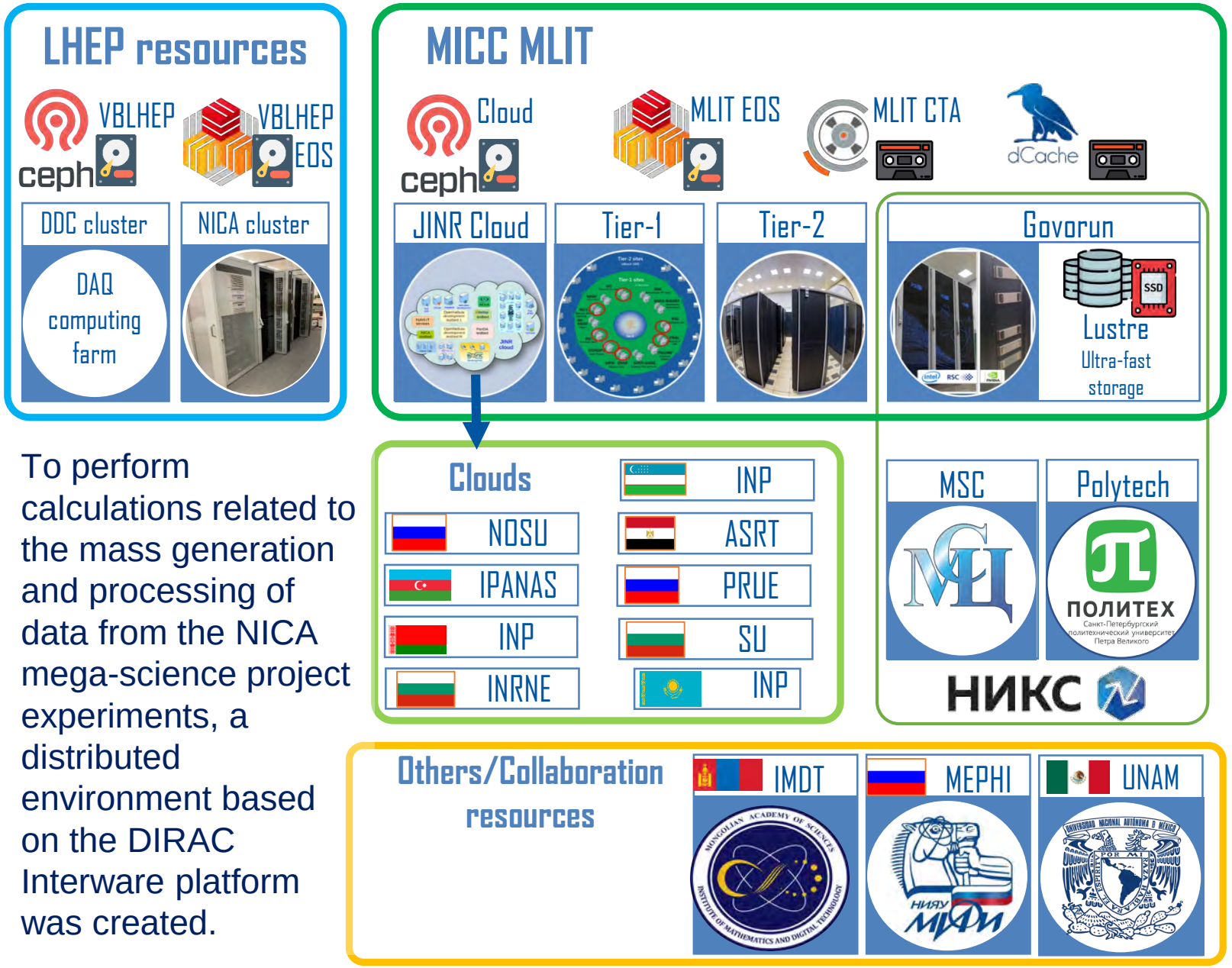
DISTRIBUTED INFORMATION AND COMPUTING SOFTWARE ENVIRONMENT – DIRAC PLATFORM

NICA/JINR CLUSTER

NICA – JINR: DEVELOPMENT OF A GLOBAL NETWORK OF PARTNERSHIP COMPUTING CENTERS

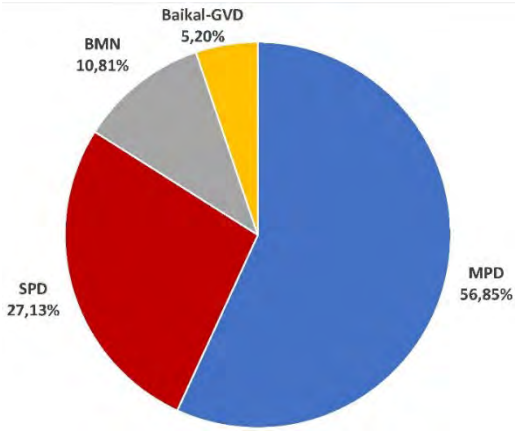
RUSSIA AZERBAIJAN BELARUS BULGARIA GEORGIA EGYPT UZBEKISTAN MEXICO

DIRAC-based distributed heterogeneous environment

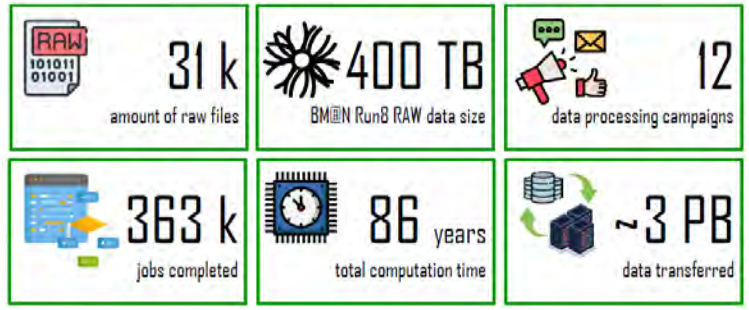


To perform calculations related to the mass generation and processing of data from the NICA mega-science project experiments, a distributed environment based on the DIRAC Interware platform was created.

DIRAC is employed to solve the tasks of collaborations of all three experiments at the NICA accelerator complex, as well as of the Baikal-GVD neutrino telescope.



In 2023, for the first time at JINR, the complete processing of raw data from the 8th run of the BM@N experiment was performed on the distributed heterogeneous computing infrastructure integrated using the DIRAC platform.



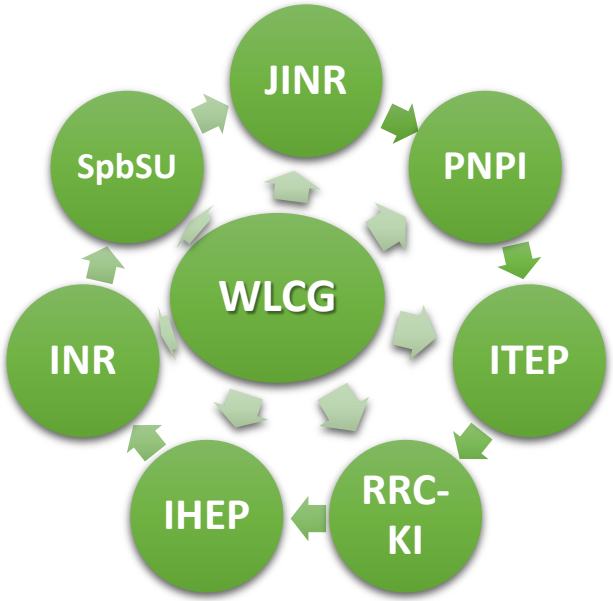
Summary statistics of using the DIRAC platform for BM@N Run 8 data processing

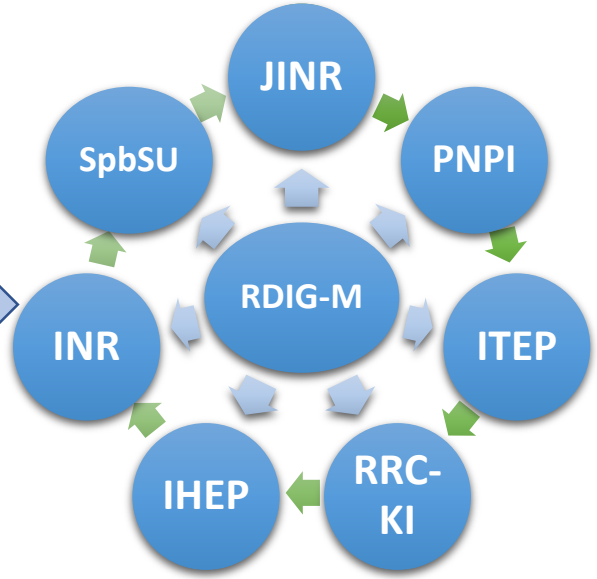
From RDIG to RDIG-M

The Russian consortium RDIG (Russian Data Intensive GRID) was set up in September 2003 as a national federation in the EGEE project.

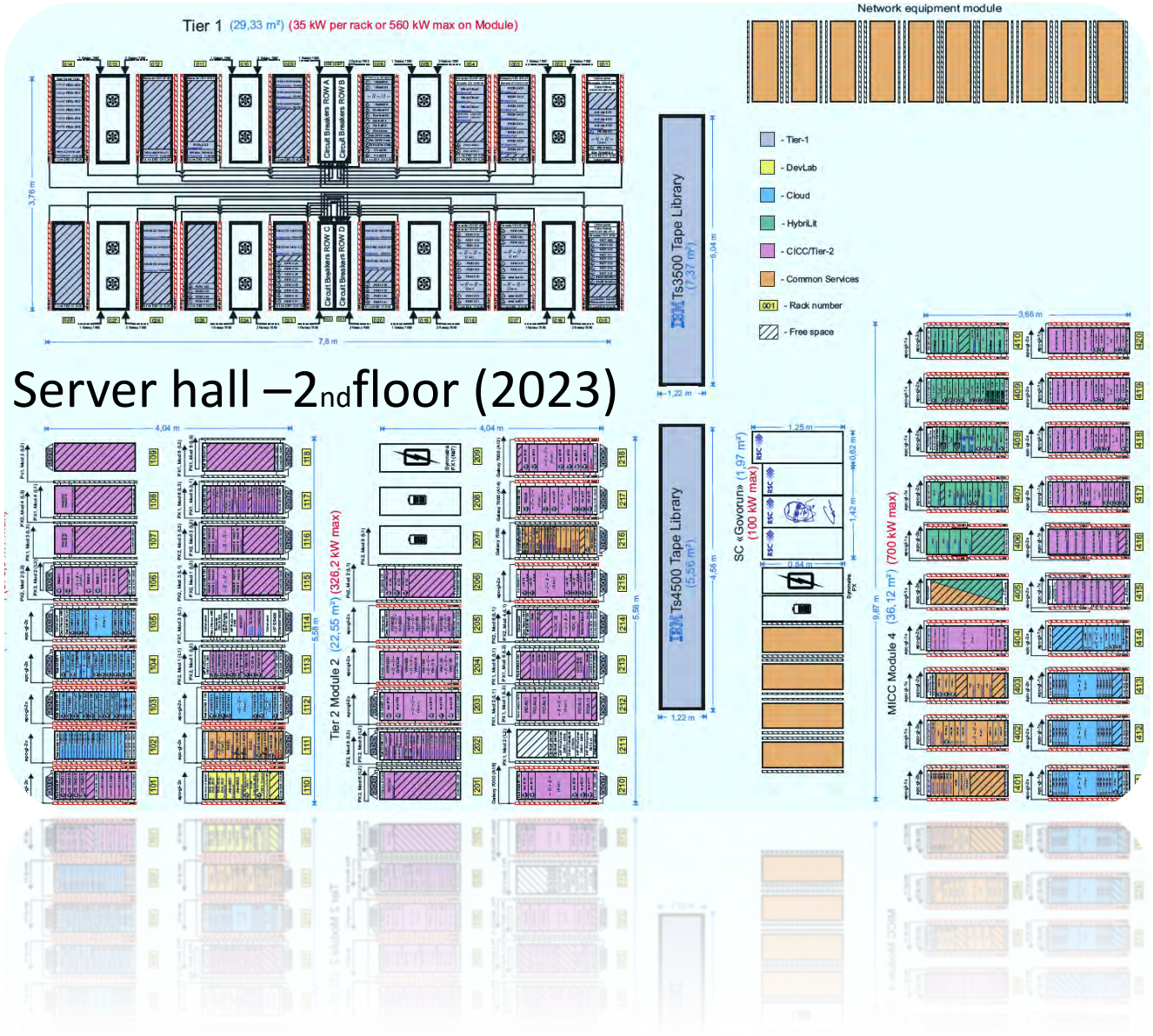
A protocol between CERN, Russia and JINR on participation in the LCG project was signed in 2003. MoU on participation in the WLCG project was signed in 2007.

The program of large-scale scientific projects is being implemented in Russia. To solve this large-scale task, it is necessary to develop a distributed computer infrastructure that unites key scientific and educational institutions participating in mega-science projects - RDIG-M. The consortium for IT support of megascience projects created in 2024 on the basis of JINR, NRC Kurchatov Institute, ISP RAS should become the core for IT support of the mega-science research infrastructure.





Current status of the 2nd floor server hall

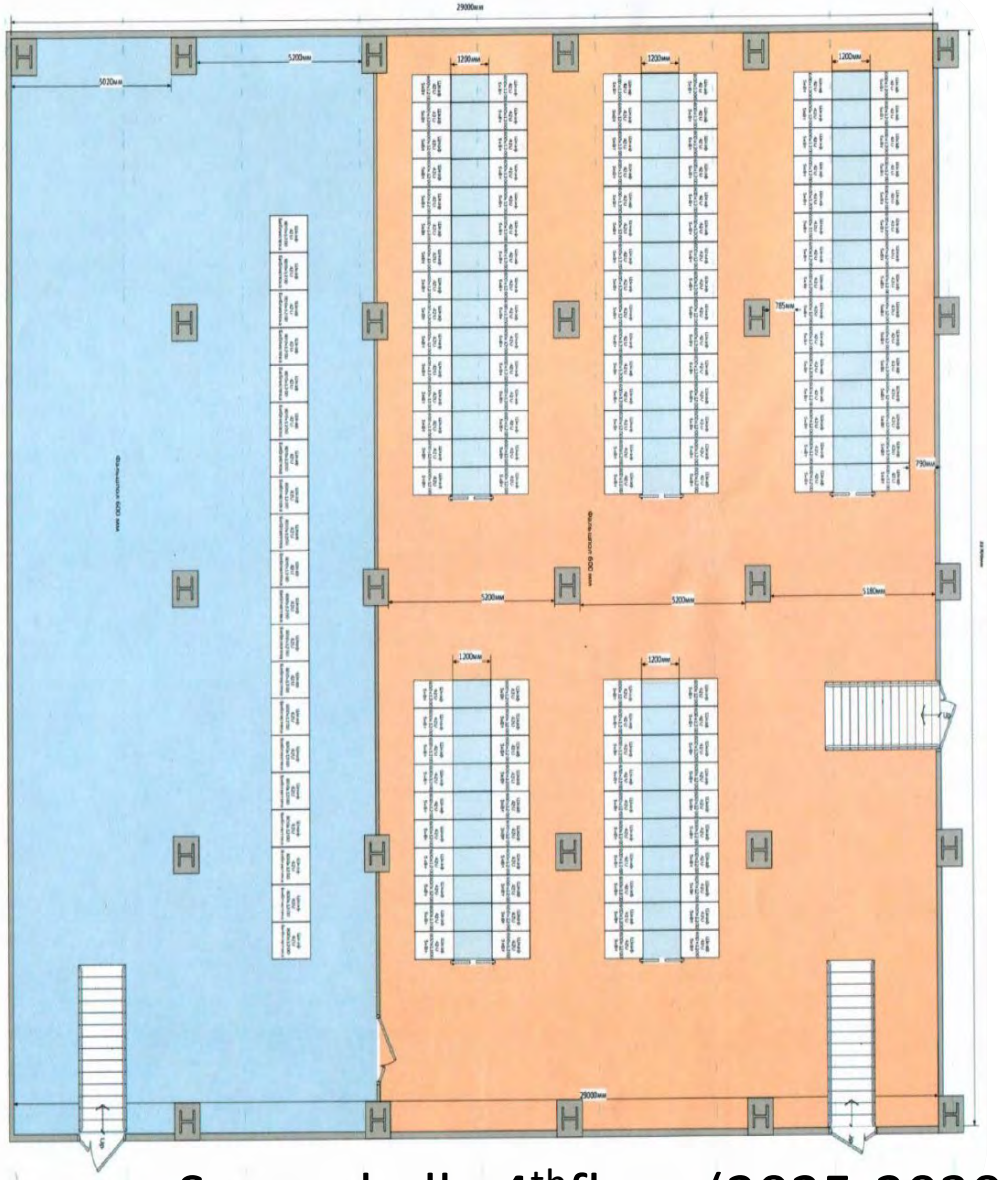


Server hall –2ndfloor (2023)

The computing capacities of the MICC are located in one computing hall with an area of 800 m^2 on the 2nd floor of the LIT building.
At present, it consists of eight separate modules with computing equipment with a total permissible capacity of 2 MW:

Besides computing and storage servers modules containe mission-critical servers of standard business computing type (administrative systems, financial accounting and databases, etc.) and network equipment.

Plans of the development of the 4th floor server hall



Server hall –4thfloor (2025-2030)

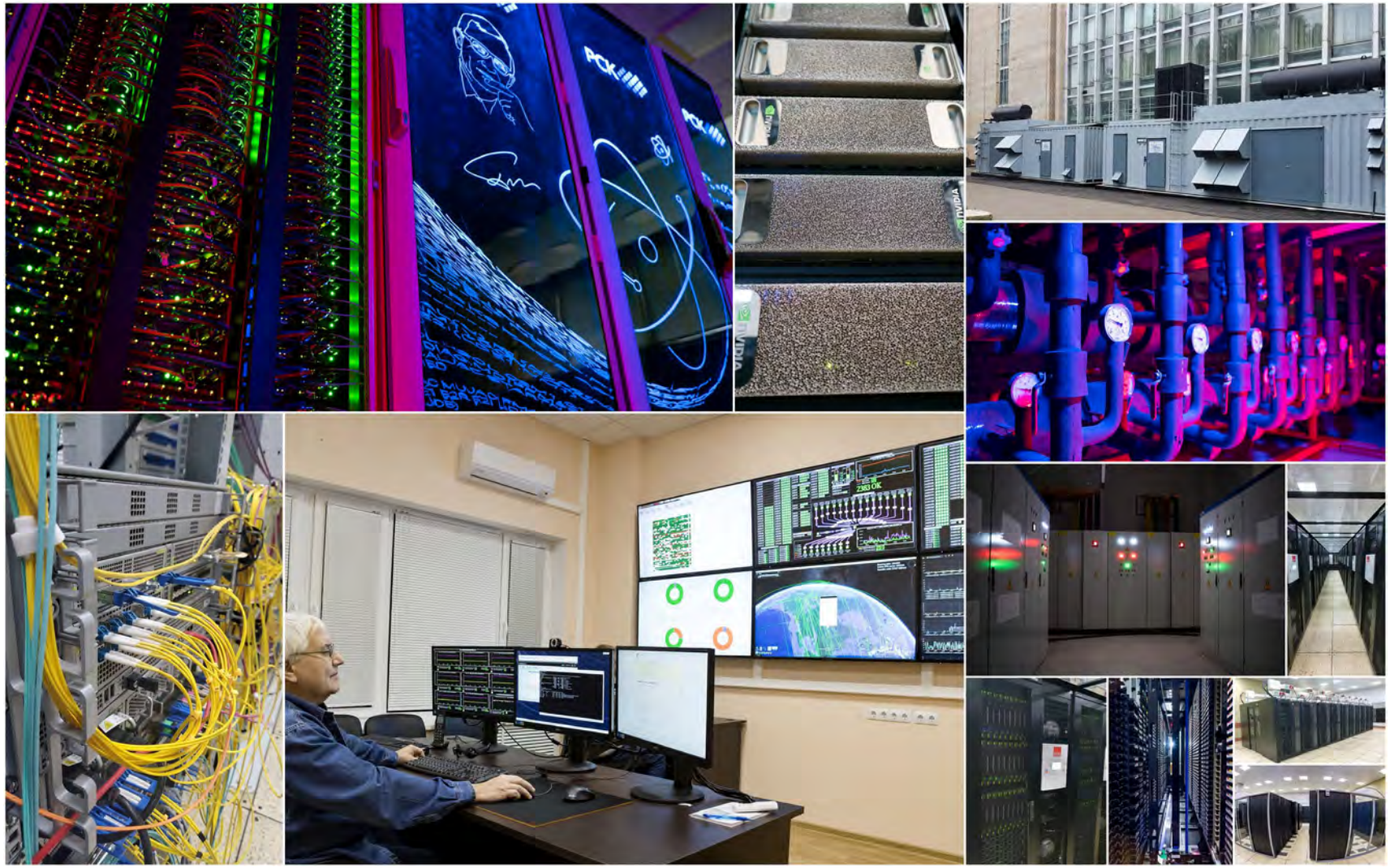
We are planning a new server room on the 4th floor - 600 kW

Main equipment:

- **robotic tape library zone**
- **130 server racks**

MICC

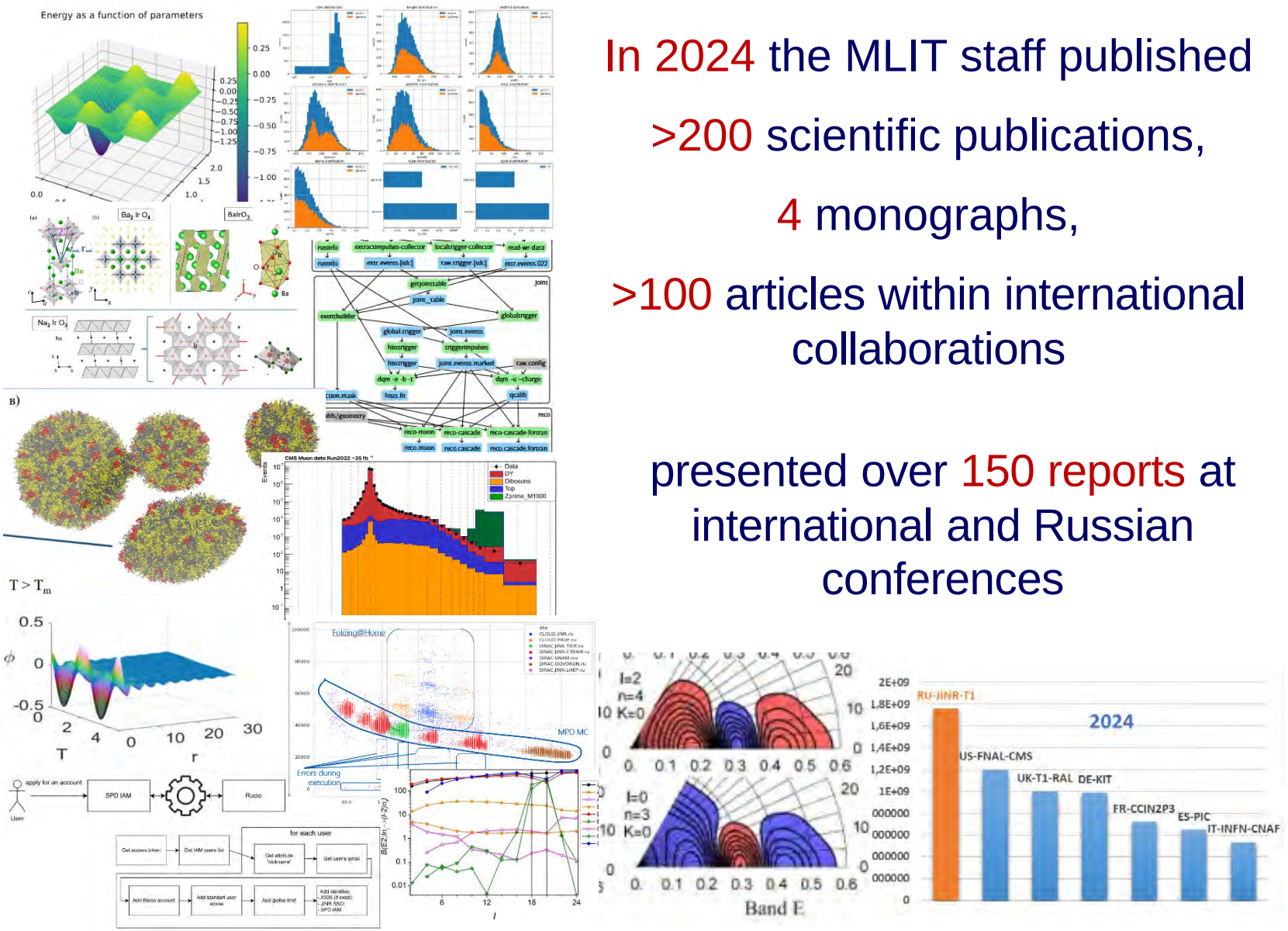
Thank you for your attention!



https://lit.jinr.ru

t.me/MLIT_news

Methods, Algorithms and Software



In 2024 the MLIT staff published

>200 scientific publications,

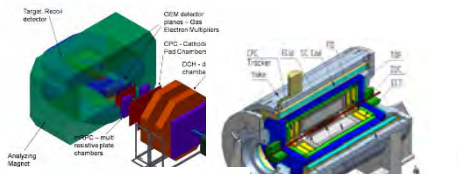
4 monographs,

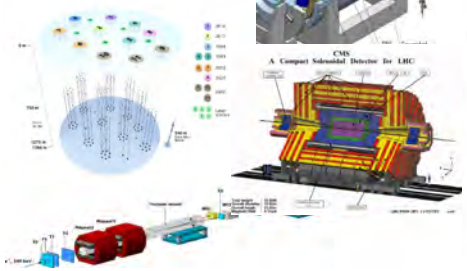
>100 articles within international collaborations

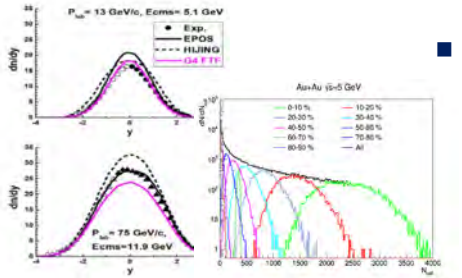
presented over 150 reports at international and Russian conferences

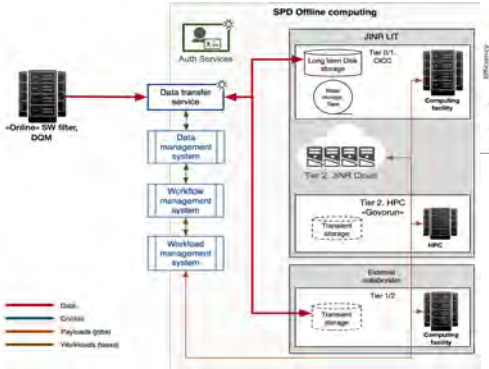
- Numerical modeling of complex physical systems
- Experimental data processing and analysis
- Big Data
- Machine and Deep learning
- AI and robotics
- Computer algebra
- Quantum computing

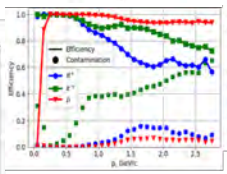
Mathematical Methods and Software for Experimental Data Processing and Analysis



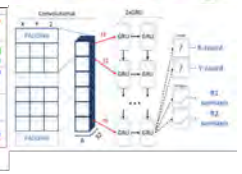




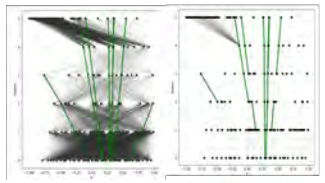




Gradient-boosted decision trees for PID in MPD

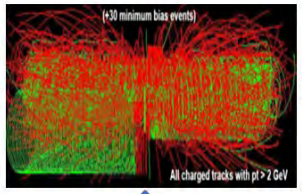


Deep GNNs for solving tracking problems in BM@N, BESIII, SPD

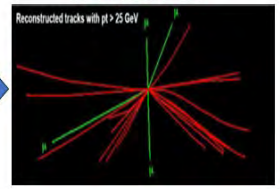


Graph Neural Networks for Tracking

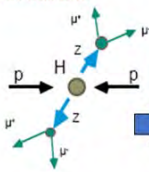
RAW Data



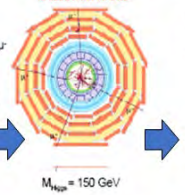
Event Selection

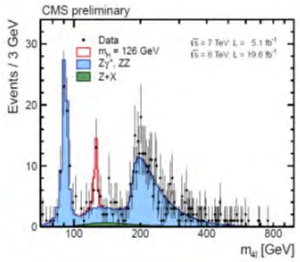


Theory/ Monte Carlo Simulation



Detector Response Simulation





- mathematical methods and software, including those based on ML/DL algorithms for modelling physical processes and experimental facilities, processing and analysing experimental data in the field of elementary particle physics, nuclear physics, neutrino physics, radiobiology, etc.

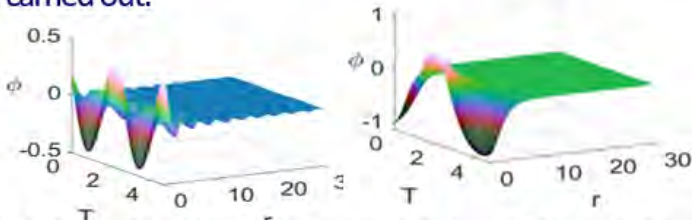
the creation of systems for the distributed processing and analysis of experimental data, as well as information and computing platforms to support research conducted at JINR and other research centres.

Simulation of Physics Processes and Facilities	Reconstruction and Data Analysis	Software Environment for Experiments
Physics event simulation	Particle trajectory reconstruction	Data processing and analysis models
GEANT-simulation of experimental setups	Particle identification	Data models
	Reconstruction of physics processes	Software platforms and systems
	Experimental data analysis	Development and maintenance of DBs
		Event visualization

Methods of Mathematical Modeling, Computational Physics, and High-Performance Computing for Complex System Studies at JINR

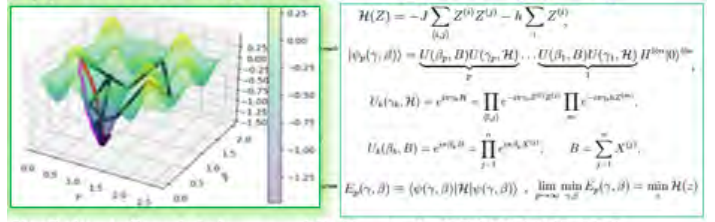
- **Simulating interactions of various types in nuclear-physical systems**, including calculations of cross sections for sub-barrier fusion/fission reactions of heavy nuclei within the channel coupling method.
- **Studying multifactorial processes in models of complex systems with external influences**, including the modeling of structural changes in materials under irradiation with charged particles and the superconducting processes study in Josephson structures.
- **Solving problems arising in the design and optimization of the operation of large experimental facilities**, including problems related to the simulation of magnetic fields.
- **Modeling physical phenomena based on the state equation of dense nuclear matter**, including complex astrophysical systems and heavy ion collision processes in the NICA energy range.

A numerical study of spherically symmetric standing waves in a ball, considered as an approximation of weakly radiating oscillons in the φ^4 theory, was carried out.



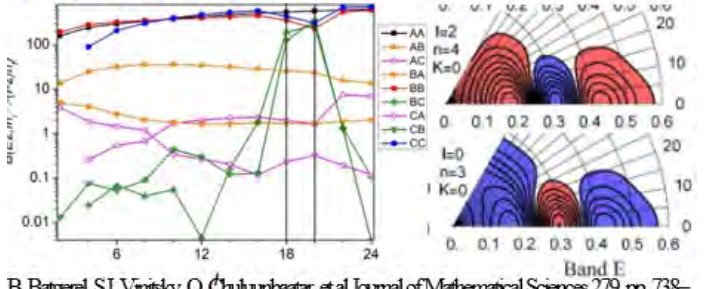
E.Zemlyanaya, A.Bogolubskaya, et al. Discrete and Continuous Models and Applied Computational Science, Vol.32, No.1, 106-111, 2024

computations of the problem of finding a state with the lowest energy in the Ising model with a longitudinal magnetic field using the quantum approximation optimization algorithm (QAOA).

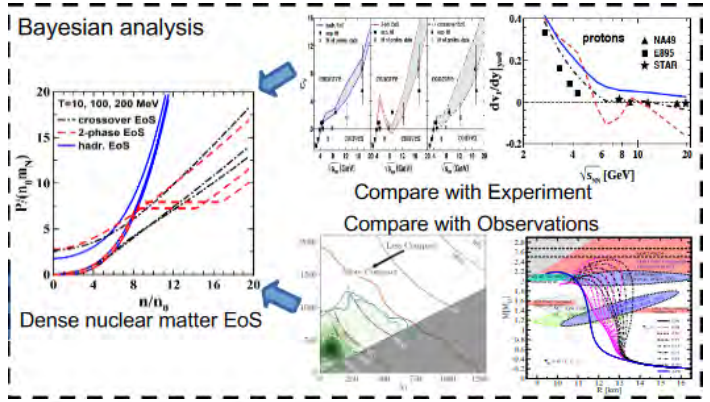


Yu. Palii, A. Bogolubskaya, and D. Yanovich: PEPAN, V. 55, N. 3. Pp. 600-602, 2024.

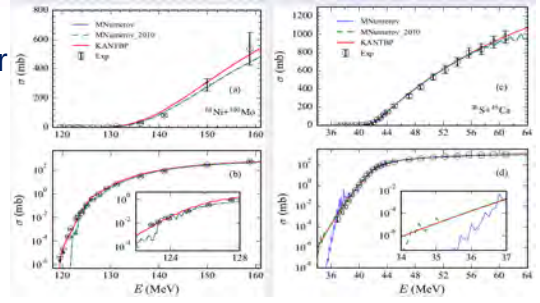
GCMFEM is a program for calculating quadrupole B(E2) transitions in the geometric collective model of the atomic nucleus. The B(E2) and leading components of eigenfunctions for the Gd-154 isotope were calculated.

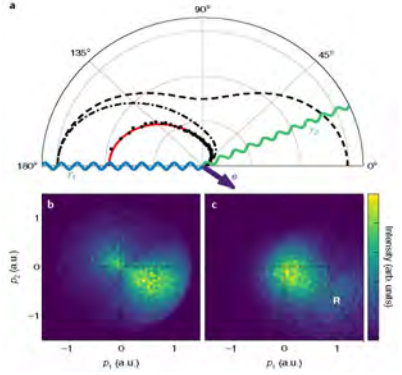


B. Batzorel, S.I. Vinitsky, O. Chuluunbaatar, et al. Journal of Mathematical Sciences 279, pp. 738–755 (2024).



Sub-barrier fusion and fission reactions of heavy nuclei



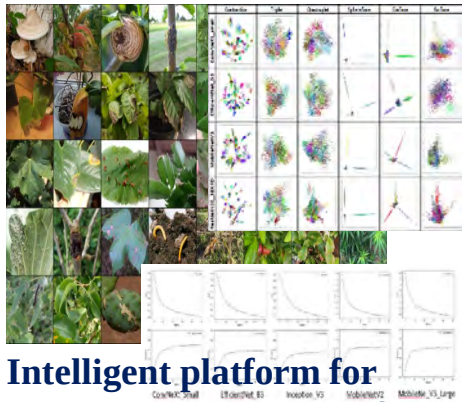


Scheme of ionization by Compton scattering at hv=2.1 keV

Kircher, M., Trinter, F., Grundmann, S. *et al. Nat. Phys.* **16**, 756–760 (2020). https://doi.org/10.1038/s41567-020-0880-2

Radiobiology and Life Science

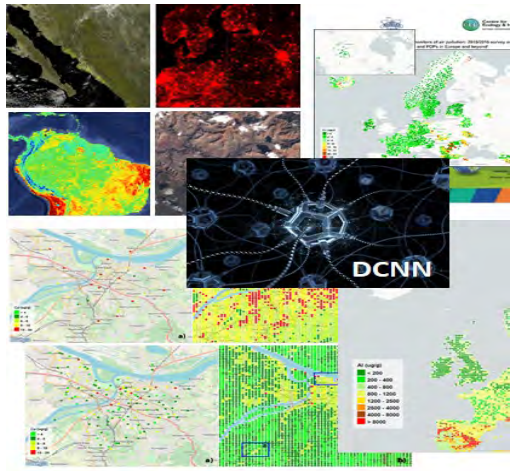
Application of AI technologies to solve various problems in the field of agriculture



Intelligent platform for determining the state of agricultural and decorative plants doctorp.ru

- image classification in conditions of a small training sample.
- software and hardware solutions for organizing automated control and accounting in greenhouse complexes.
- methods and means for organizing mobile object tracking complexes.

Applications of AI technologies and Earth remote sensing data to predict the state of the environment



The prediction of air pollution by heavy metals using biomonitoring data, satellite imagery and different technologies of machine and deep learning

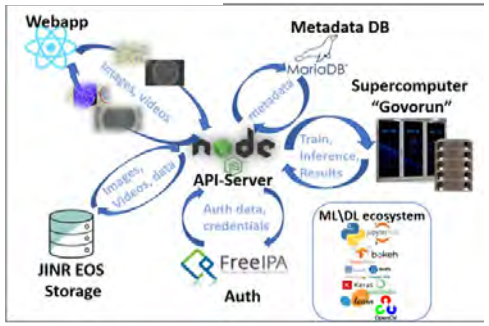
Intelligent Environmental Monitoring Platform
moss.jinr.ru

BIOHLIT project web services on the ML/DL/HPC ecosystem of the HybriLIT platform

(joint projects of MLIT and LRB)

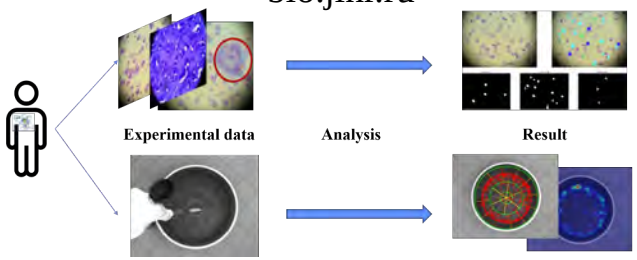
The ML/DL/HPC ecosystem

- top of ML/DL technologies
- modern IT solutions for data storage, processing and visualization
- statistical analysis



Information System for Radiation Biology Tasks

bio.jinr.ru

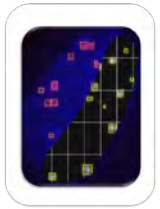


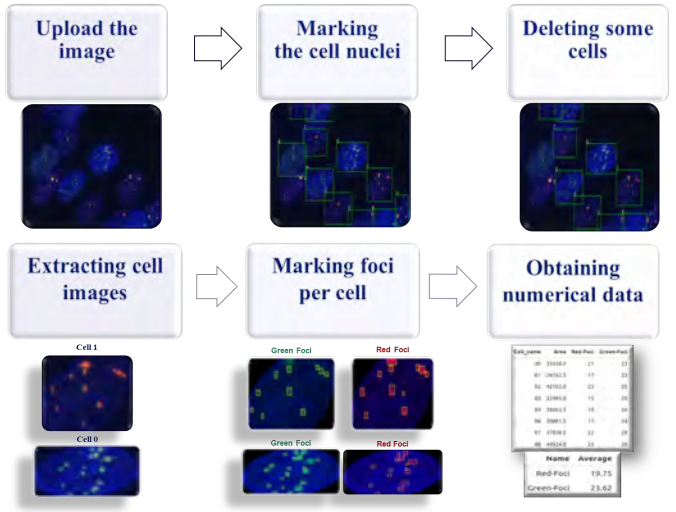
The IS allows one to store, quickly access and process data from experiments at LRB using a stack of neural network and classical algorithms of computer vision, providing a wide range of possibilities for automating routine tasks. It gives an increase in productivity, quality and speed of obtaining results.

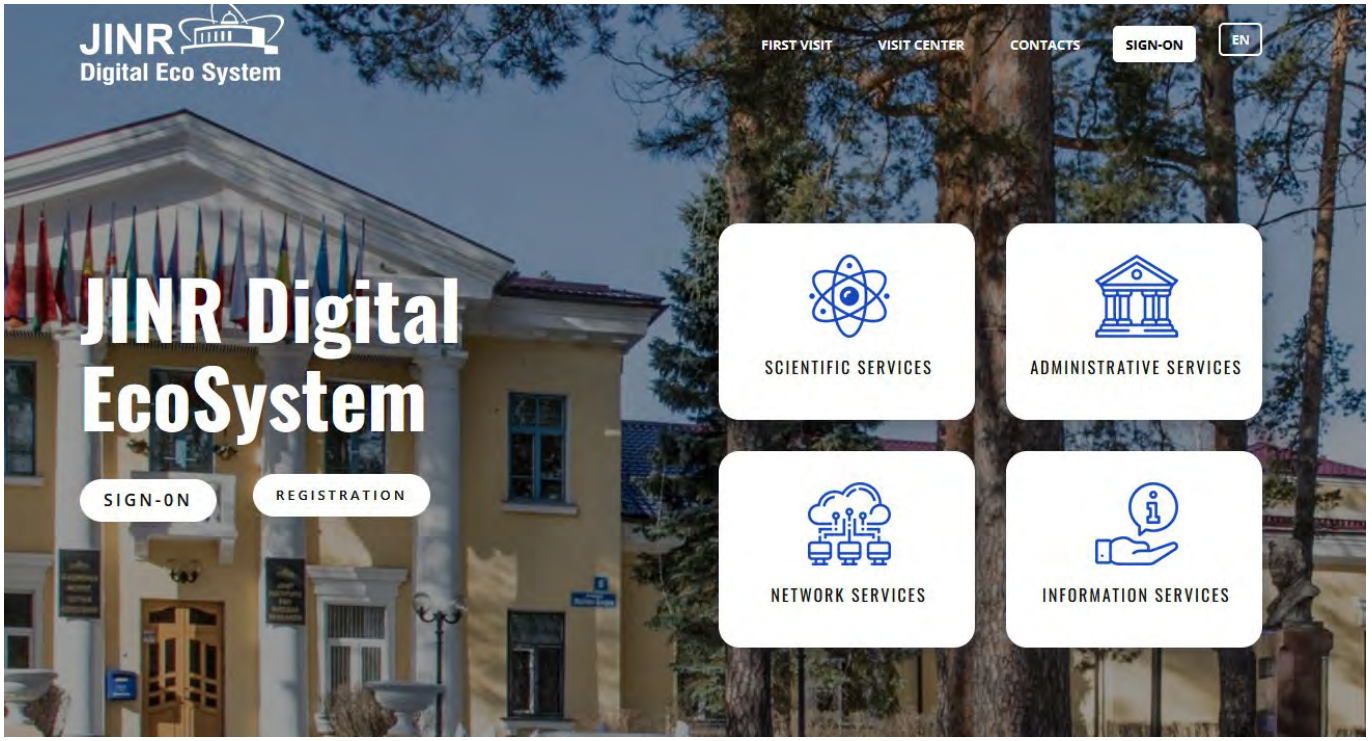
Web service for detection and analysis of radiation-induced foci (RIF)

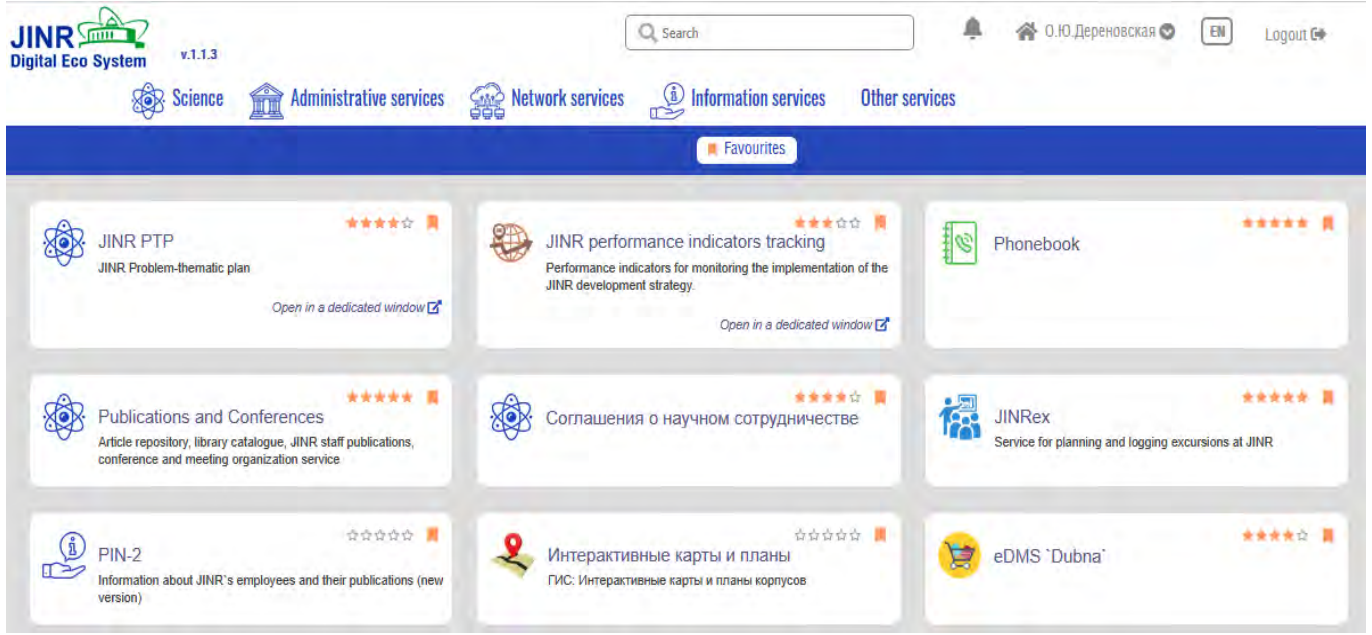
https://mostlit.jinr.ru

The web service functionality allows processing fluorescent images and providing analytical information:
cell area,
average number of RIFs per cell and per set of images.









JINR Digital Ecosystem

a single window into the JINR digital environment

- integration of existing and prospective services for **supporting scientific, administrative and social activities**, as well as maintenance of the Institute's engineering and IT infrastructure.
- Integrated Personal Account of a JINR Employee
- Notifications in the Personal Account
- Some resources are available to unregistered users
- Relevance. Information is updated promptly and regularly by service owners
- Convenient interface for service administrators
- Supports bilingualism: Russian and English
- Mobile version of the system

JINR School of Information Technology

for Russian speaking students

Involving young specialists in solving tasks that face JINR using high-performance and distributed computing, data analysis methods and algorithms, state-of-the-art information technologies

Stage 1

Autumn School

acquaintance with the directions of JINR scientific research

Stage 2

Spring School

presentation the results of joint work with the Institute's specialists

MATHEMATICAL MODELING AND COMPUTATIONAL PHYSICS 2024

MMCP

20–25 Oct 2024
Yerevan, Armenia

More than **150** participants

21 Plenary reports **110** Sessional reports

18 Countries: Armenia, Belarus, Bulgaria, Canada, the Czech Republic, Egypt, France, Georgia, Iran, Kazakhstan, Mongolia, New Zealand, Poland, Romania, Slovakia, Tajikistan, Uzbekistan and a large number of Russian research centers and universities.

Conference Topics:

- Mathematical methods and tools for modeling complex physical systems;
- Mathematical methods in life sciences;
- Modern methods for data processing and analysis in Mega-science projects;
- Machine learning and big data analytics;
- Methods of quantum computing and quantum information processing;
- Numerical and analytical calculations in modern mathematical physics;
- Methods and numerical algorithms in high-energy physics.

Joint Institute for Nuclear Research
Meshcheryakov Laboratory of Information Technologies

10 GRID2023

3-7 July 2023

10th International Conference
"Distributed Computing and Grid Technologies in Science and Education"

More than **275** participants
In person - 216
Remotely - 60

30 Plenary reports
135 Sessional reports

17 Countries: Azerbaijan, Armenia, Belarus, Bulgaria, the Czech Republic, Egypt, Germany, Georgia, Iran, Kazakhstan, Mexico, Moldova, Mongolia, Serbia, CERN and Uzbekistan. **Russia** was represented by participants **from 41 universities and research centers**.

Joint Institute for Nuclear Research
Meshcheryakov Laboratory
of Information Technologies

11th INTERNATIONAL CONFERENCE «DISTRIBUTED COMPUTING AND GRID TECHNOLOGIES IN SCIENCE AND EDUCATION»

GRID'2025

7 — 11 July, Dubna

CONFERENCE TOPICS

1. Distributed Computing Systems, Grid and Cloud Technologies, Storage Systems: architectures, operation, middleware and services
2. High Performance Computing
3. Application software in HTC and HPC
4. Computing for MegaScience Projects
5. Methods and Technologies for Experimental Data Processing

ORGANIZING COMMITTEE

*Korenkov V.V. - **Chairman***
*Strizh T.A. - **Vice-Chairman***
*Shmatov S.V. - **Vice-Chairman***
*Derenovskaya O.Yu. - **Scientific Secretary***

Belyakova N.E.
Kalagin I.I.
Katraseva T.I.
Khmelev A.V.
Makhalkin A.N.
Mazhitova Ye.
Moisenz K.P.
Podgainy D.V.
Priakhina D.I.
Rumyantseva O.Yu.
Sokolov I.A.
Stankus D.B.
Streltsova O.I.
Vorontsov A.S.
Voytishin N.N.
Zaikina A.G.
Zaikina T.N.
Zrelov P.V.
Zuev M.I.

Phone: (7 496 21) 64019, 64826
E-mail: grid2025@jinr.ru
URL: http://grid2025.jinr.ru

ADVISORY COMMITTEE

Avetisyan A. I. *ISP RAS, Moscow*
Bogdanov A. V. *SPbSU, St Petersburg*
Chetverushkin B. N. *KIAM RAS, Moscow*
Dimitrov V. *SU, Bolgaria*
Ilyin V. A. *NRC "Kurchatov Institute", Moscow*
Fedorov M. V. *IITP RAS, Moscow*
Gina El-Feky *ASRT, Egypt*
Kaliaev I. A. *SSC RAS, Rostov-on-Don*
Kalachev A. A. *FIC KazanSC of RAS, Kazan*
Khvedelidze A. M. *JINR, Dubna / GTU, Georgia*
Kilin S. Ya. *NAS, Belarus*
Kiryanov A. K. *PNPI, Gatchina*
Korenkov V. V. *JINR, Dubna*
Krvukov A. P. *SINP MSU, Moscow*
Lakhno V. D. *IMPB RAS, Pushchino*
Odoevskaya E. V. *HSE, Moscow*
Oganov A. R. *SkolTech, Moscow*
Ogoev A. U. *NOSU, Vladikavkaz*
Posypkin M. A. *FRC CSC RAS, Moscow*
Proletarskiy A. V. *BMSTU, Moscow*
Sahakyan V. G. *IIAP NAS, Armenia*
Sakhiyev S. K. *INP, Kazakhstan*
Sargsyan S. S. *RAU, Armenia*
Shabanov B. M. *JSCC, Moscow*
Shchur L. N. *HSE, Moscow*
Sithole H. *NICIS, South Africa*
Soifer V. A. *SU, Samara*
Sokolov I. A. *CSC MSU, Moscow*
Sokolinsky L. B. *SUSU, Chelyabinsk*
Toporkov V. V. *NRU MPEI, Moscow*
Tran C. T. *VINATOM, Vietnam*
Trubnikov G. V. *JINR, Dubna*
Tsaregorodtsev A. Yu. *CPPM-IN2P3-CNRS, France*
Velikhov V. E. *NRG "Kurchatov Institute", Moscow*
Voevodin V. V. *SRCC MSU, Moscow*
Zhang X. *IHEP CAS, China*
Zolotarev V. I. *CC SPbU, St.Petersburg*
Zaborovsky V. S. *SPbSTU, St.Petersburg*