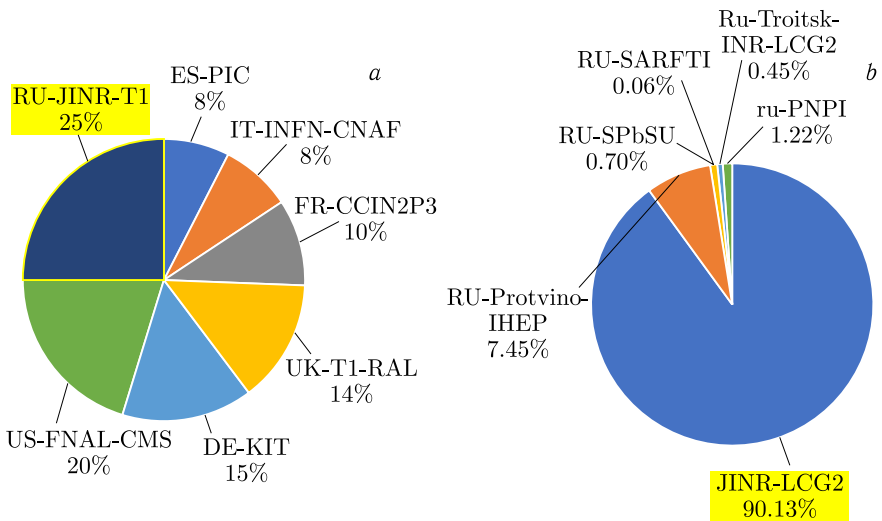
INFORMATION TECHNOLOGY AND COMPUTER PHYSICS

In 2024, the successful operation and development of the JINR Multifunctional Information and Computing Complex continued. The creation of an Accelerator Complex at JINR within the NICA megascience project and experimental facilities on it entailed the extension of the functions of the JINR grid sites with the introduction of their resources in the system for modeling, processing and storing data from the BM@N, MPD and SPD experiments. The tape data storage capacity was increased from 50 to 90 PB. The JINR Tier-1 site is ranked first among Tier-1 world centres for the LHC CMS experiment in terms of the CPU time for data processed. The JINR Tier-2 output is the highest in the Russian grid segment (RDIG).



Distribution by the normalized CPU load time in HS23 hours within 2024 for Tier-1 sites for the CMS experiment (*a*) and Tier-2 sites comprising the RDIG consortium (*b*)

- *Baginyan A., Balandin A., Dolbilov A., Golunov A., Gromova N., Kashunin I., Korenkov V., Mitsyn V., Pelevanyuk I., Shmatov S., Strizh T., Trofimov V., Vorontsov A., Voytishin N.* JINR Grid Infrastructure: Status and Plans // Phys. Part. Nucl. 2024. V. 55, No. 3. P. 355–359; https://doi.org/10.1134/S1063779624030079.

To perform computing related to data mass production and processing within the experiments of the NICA megascience project, a distributed environment based on the DIRAC Interware platform, integrating the JINR computing infrastructure, was created. Thirty-six data mass production campaigns and 10 modeled data analysis campaigns within the MPD experiment were carried out on the resources of this environment. The total amount of the generated data is 1.6 PB. The BM@N collaboration also employs the created infrastructure for processing experimental data coming from the detector. To date, over 30 campaigns to process data of various volumes have been completed, the total number of processed events is close to 650 million.

- *Gertsenberger K. V., Pelevanyuk I. S.* BM@N Run 8 Data Processing on a Distributed Infrastructure with DIRAC // Phys. Part. Nucl. Lett. 2024. V. 21. P. 778–781; https://doi.org/10.1134/S1547477124701334.
- *Pelevanyuk I. S.* MLIT Resources and Services for the MPD Experiment // XIV Collab. Meeting of the MPD Experiment at NICA, Dubna, Russia, 14–16 Oct. 2024; https://indico.jinr.ru/event/4806/contributions/27989/.

A prototype of a data processing and analysis system was deployed for the SPD experiment. In 2024, Monte Carlo simulation tasks were processed on the platform: 200 million events with a volume of 100 TB were generated. Together with DLNP colleagues, a testbed for developing and debugging the components of the data acquisition system of the SPD facility was created and put into operation.

- *SPD Collab.* Technical Design Report of the Spin Physics Detector at NICA. arXiv:2404.08317.
- *Petrosyan A., Oleynik D., Zhemchugov A., Kiryanov A.* SPD Offline Computing System // Phys. Part. Nucl. 2024. V. 55, No. 3. P. 450–452.

Within the Mathematical Engineering book series, Springer Nature Switzerland published a monograph “New Developments of Newton-Type Iterations for Solving Nonlinear Problems”. The monograph contains main results developed at MLIT JINR and the National University of Mongolia. The book explores higher-order iterations for nonlinear equations and their systems, and their applications in linear algebra and some nonlinear problems of theoretical physics.

- *Zhanlav T., Chuluunbaatar O.* New Developments of Newton-Type Iterations for Solving Nonlinear Problems. Cham: Springer, 2024. XIV. 281 p. Electronic book (Mathematical Engineering); https://doi.org/10.1007/978-3-031-63361-4.

A quantum computing polygon was deployed on the resources of the ML/DL/HPC ecosystem of the HybriLIT heterogeneous platform, providing computations using libraries that support parallel computing on both central processors and graphics accelerators. The heterogeneous structure of the platform allows for quick changes in the characteristics of the polygon, adjusting it to the requirements of user tasks, adding servers with necessary computing components, in terms of central processors and graphics accelerators.

- *Belyakov D., Bogolubskaya A., Zuev M., Palii Yu., Podgainy D., Streltsova O., Yanovich D.* Quantum Computing Polygon on the HybriLIT Heterogeneous Platform // Proc. of the XIV All-Russian Conf. with International Participation "Information and Telecommunication Technologies and Mathematical Modeling of High-Tech Systems". M.: RUDN, 2024. P. 303–309.
- *Anikina A., Belyakov D., Bezhanyan D., Kirakosyan M., Kokorev A., Lyubimova M., Matveev M., Podgainy D., Rakhmonova A., Shadmehri S., Streltsova O., Torosyan Sh., Valya M., Zuev M.* Capabilities of the Software and Information Environment of the HybriLIT Heterogeneous Computing Platform for JINR Tasks // Proc. of the XXVII Intern. Sci. Conf. "Distributed Computer and Communication Networks: Control, Computation, Communications", Moscow, Russia, 2024. P. 244–249.