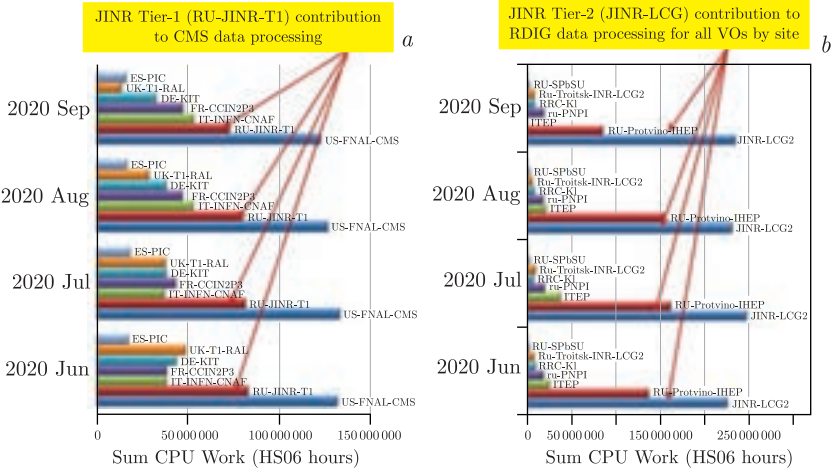


## **INFORMATION TECHNOLOGY AND COMPUTER PHYSICS**

The JINR grid infrastructure is represented by the Tier-1 center for the CMS experiment at the LHC and the Tier-2 center, which enables the processing of data from such experiments as BM@N, MPD, ALICE, ATLAS, CMS, LHCb, BES, BIOMED, COMPASS, NO $\nu$ A, STAR, ILC, etc.

In terms of performance, Tier-1 is ranked second among other Tier-1 centers for the CMS experiment to provide data exchange with all world sites operating for the CMS experiment. Since the beginning of the year, 13.23 PB of data have been transferred to Tier-1 from more than 180 grid sites, and over 19 PB of data have been downloaded. Moreover, simulation jobs for the MPD experiment at NICA are performed at JINR Tier-1.

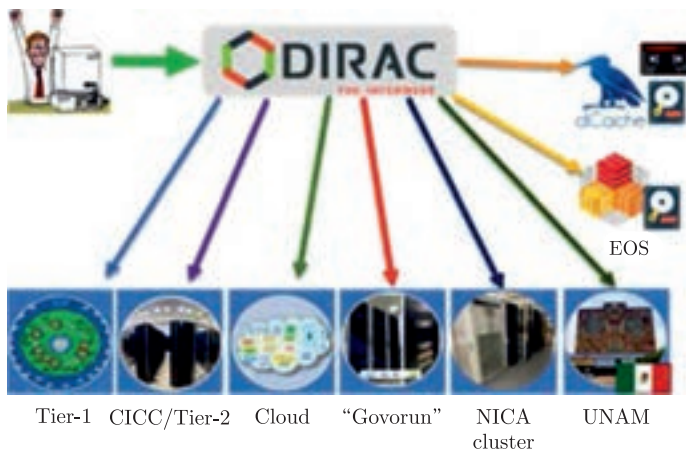
The JINR grid sites are the most productive in the Russian consortium RDIG (Russian Data Intensive Grid). More than 55% of the sum CPU time at RDIG was used for computing at our Tier-1 and Tier-2.



Distribution by the normalized CPU load time in HS06 hours within 2020 for Tier-1 sites for the CMS experiment (*a*) and Tier-2 sites being part of the RDIG consortium (*b*)

- *Korenkov V.V.* Trends and Prospects for the Development of Distributed Computing and Big Data Analytics to Support Megascience Projects // Nucl. Phys. 2020. V. 83, No. 6. P. 534–538.

Using the DIRAC (Distributed Infrastructure with Remote Agent Control) Interware, the computing resources of Tier-1/Tier-2, the “Govorun” supercomputer, the computing cloud of JINR and its Member States, the NICA cluster, the cluster of the National Autonomous University of Mexico (UNAM) and storage resources, namely, dCache, EOS and the Lustre ultrafast data storage system, were combined. Using this distributed infrastructure, the program of Monte Carlo data simulation for experiments of the NICA megascience project is performed.



Scheme of the integration of geographically distributed heterogeneous resources based on the DIRAC Interware

- *Pelevanyuk I. et al.* Integration of Distributed Heterogeneous Computing Resources for the MPD Experiment with DIRAC Interware // Phys. Part. Nucl. (in press).

Within JINR international cooperation, a kinematically complete experimental measurement of the characteristics of Compton scattering at free atoms, using the highly efficient method of COLD Target Recoil Ion Momentum Spectroscopy (COLTRIMS), was conducted, and a scientific paper by this international research group was published in *Nature Physics*. A theoretical description of the phenomenon is based on the calculations carried out at the "Govorun" supercomputer.

- *Kircher M. et al.* Kinematically Complete Experimental Study of Compton Scattering at Helium Atoms near the Threshold // Nature Phys. 2020. V. 16. P. 756–760.

On the basis of the HybriLIT platform, the active development of software and services for the joint project of the JINR Laboratory of Information Technologies and the JINR Laboratory of Radiation Biology on the creation of an information system (IS) for analyzing behavioral and pathomorphological changes in the central nervous system (CNS) in the study of the effects of ionizing radiation and other factors on biological objects is in progress. The IS under development is based on machine and deep learning methods and neural network approaches. To date, the client and server parts of the web service <https://bio.jinr.ru/> are implemented; a unified

storage of all data from experiments is elaborated; the first results of improved tracking of the experimental animal in the arena of the test setup are obtained; to test the training options for an artificial neural network, two ways of data marking are developed.

- *Kolesnikova I. et al.* Information System for Radiobiological Research // CEUR Workshop Proc. 2020. V. 2743. P. 1–10.
- *Bulatov A., Stadnik A., Streltsova O.* Computer Vision Algorithms for Studying the Influence of Various Factors on Biological Objects // CEUR Workshop Proc. 2020. V. 2743. P. 36–44.

A workable prototype of the Geometry Database for the BM@N experiment of the NICA project was developed. The main goal of the database is to provide a central storage of the BM@N geometries, convenient tools for managing its geometry modules, various software assembling versions of the BM@N setup from geometry modules and additional files. The developed information system includes a database, an intuitive and compact Graphical User Interface (GUI), and Application Programming Interface (API) tools as a set of ROOT macros. The experience of the Geometry Database design for the CBM experiment was applied to this development, and GUI improvements were made on the basis of BM@N users' requirements. The Geometry Database prototype was put into operation.

- *Akishina E. et al.* Development of the Geometry Database for the BM@N Experiment of the NICA Project // Eur. Phys. J. Web Conf. 2020. V. 226. P. 03003–03007.