

## Information and Computing Infrastructure of JINR

**Leader:** V.V. Korenkov

**Deputy:** T.A. Strizh

### Participating Countries and International organizations:

Armenia, Azerbaijan, Belarus, Bulgaria, CERN, China, Czech Republic, Egypt, France, Georgia, Germany, Italy, Kazakhstan, Moldova, Mongolia, Poland, Romania, Russia, Slovakia, South Africa, Sweden, Taiwan, Ukraine, USA.

### Issues addressed and main goals of research:

The purpose of the theme is to develop the network, information and computing infrastructure of JINR for the research and production activities of the Institute and its Member States on the basis of state-of-the-art information technologies in accordance with the Seven-Year Plan for the development of JINR. A particular direction within the theme is the development of the JINR LIT Multifunctional Information and Computing Complex (MICC) presented as a Project.

### Expected main results in the current year:

- Provision of the stable and safe operation of the JINR local network infrastructure and external telecommunication channels (backbone network (2x100 Gbps); transport network of the NICA megaproject (4x100 Gbps); LIT mesh network (100 Gbps); backbone telecommunication channels (3x100 Gbps); Wi-Fi network at the JINR sites) to ensure reliable data exchange between the Institute's subdivisions, the JINR Member States and international organizations collaborating with JINR.

Provision of the full-scale and optimal operation of the guaranteed power supply and climate control systems of the MICC computing infrastructure. Implementation of the project on a new fire safety system of the MICC infrastructure.

Expansion of the performance and the storage system of the MICC basic grid component, i.e. the Tier1 center of the CMS experiment at JINR: processor capacities up to 240 kHS06, dCache storage systems on disks up to 11 PB.

Enlargement of the computing resources and data storage systems as part of the Tier2/CICC integral component: processor capacities up to 130 kHS06, disk storages up to 6 PB.

Transition to new system software: job batch processing system and job schedulers, i.e. HTCondor and Slurm.

Maintenance of the unified system of access to the CVMFS software.

Support and updates of grid middleware. Support of the operation of WLCG virtual organizations, the NICA experiments and local user groups on the MICC Tier1 and Tier2 resources. Provision of virtual organization services for the NICA experiments and local user groups.

Expansion of the capacity of the general distributed data storage and access system based on the EOS file system at the JINR MICC up to 30 PB. Support of user work with the EOS system at LIT and other JINR subdivisions.

Commissioning of the cloud service for scientific and engineering calculations (<http://saas.jinr.ru>) with a set of applications to study Josephson nanojunctions. Creation of a computing environment prototype for the neutrino experiments, i.e. a neutrino platform. Development of a cloud platform for data analysis and management within the international environmental monitoring and forecasting program. Development of a multifunctional platform and a mobile application for detecting plant diseases on the basis of the cloud infrastructure. Enlargement of the computing part of the MICC cloud component up to 2400 CPU cores and 12 TB of RAM. Increase of the total volume of the ceph-based cloud storage up to 2 PB and the write speed by adding an SSD cache pool. Expansion of the capacity of the JINR cloud due to the resources acquired by the experiments Baikal-GVD, JUNO, NOvA/DUNE and their maintenance. Development of

the distributed information and computing platform based on DIRAC, which integrates cloud resources of the JINR Member States' organizations.

Extension of the computing resources and the hierarchical data storage and processing system of the "Govorun" supercomputer in accordance with the Seven-Year Plan for the development of JINR.

Development of a "computing system on demand" technology for users of the "Govorun" supercomputer based on the mechanism of user application containerization, which will allow one, based on user-defined parameters, to allocate the required number of computing nodes and create a temporary data storage with the required volume and input/output speed under the management of the corresponding file system (NFS, Lustre, EOS, etc.). Development of a system for managing containers with user applications. Stage-by-stage introduction of the hierarchical storage system of the "Govorun" supercomputer into the MICC general data storage and processing system.

Creation of a prototype of the MICC unified resource management system optimizing the efficiency of using computing and storage resources.

Implementation of the system for monitoring the operability and performance of the resources integrated in DIRAC. Integration of new computing and storage resources.

Expansion of the functions of the MICC monitoring system by including the control of the external engineering infrastructure parameters in monitoring: diesel generators, cooling towers, external and internal elements of the cooling system and uninterruptible power supply systems. Development of systems for monitoring and accounting the resources of the "Govorun" supercomputer.

- Development and maintenance of the electronic document system EDS "Dubna", the project management system APT EVM for NICA, the systems ADB2, ISS, "Document Base", HR LHEP at the request of end users and in accordance with the developed concept of the cloud SaaS platform of the unified administrative and business information system. Maintenance of the JINR Information System for Scientific Certification (ISSC). Modernization of the scientific database of the JINR Personal Information System (PIN).

Continuation of work on the transition from 1C MEM to 1C ERP 2.4. Consultation and support for users of information systems based on 1C. Work on the current maintenance, system refinement and user support. Creation of mobile systems for theme management. Continuation of work on enhancing the performance and reliability of the system by optimizing the code used, analyzing long requests, arising locks in the database, as well as by increasing the performance of servers and reallocating the functional performed on them.

Development of the institutional repository of scientific publications based on the Invenio JOIN2 software platform: enrichment and improvement of metadata quality; development of user services; support of normative records.

Maintenance of the libraries of JINRLIB programs and CERNLIB mathematical programs (MATHLIB). Study of the possibility of integrating modern high-level languages (Python, C#) with Fortran for their use of libraries written in Fortran (CERNLIB, JINRLIB).

Development and maintenance of central information servers, portals and databases for information support and software of the LIT and JINR activity: improvement of the presentation and information update on the website of the JINR Dissertation Councils; maintenance and development of services of the "Visit Centre" portal; modernization and administration of the website of the PEPAN and PEPAN Letters journals; development, creation and support of websites of conferences, symposia at the request of the laboratories and other JINR subdivisions; organization of websites of JINR subdivisions and conferences in a hosting mode.

Development of the ecosystem based on the HybriLIT platform for the tasks of machine and deep learning, which allows one to develop neural network models, to conduct their training and provide inference on different computing architectures for the tasks of the NICA project. Development of an information system that provides storage and access to experimental data and their analysis on the basis of machine learning methods for the tasks of radiation biology.

Support of the HLIT-VDI service, which allows platform users to use application packages with an advanced graphics interface, such as Mathematica, Matlab, COMSOL Multiphysics, FLUKA, etc., in their research.

Implementation and support of the “My Account” service for users of the HybriLIT platform, which contains information on work in the system, the statistics on the use of the platform resources, etc.

- Organization and holding of special courses and tutorials on novel HPC technologies, technologies and tools for solving applied problems on the basis of machine and deep learning methods for the Institute’s staff, students and young scientists from the JINR Member States within practices organized by the UC, as well as within conferences and schools organized by JINR. Holding of special courses and tutorials in the JINR Member States in accordance with international cooperation programs. Organization of specialized courses on training IT specialists to solve problems related to data processing and analysis for megascience experiments, including the NICA project.

Holding of schools on artificial intelligence and quantum computing. Creation of a laboratory of intelligent robotics for the development of cognitive control systems on the basis of the NICA accelerator complex and in other JINR laboratories. Development of a laboratory workshop on robotics.

### List of projects:

Project	Leader	Priority (period of realisation)
1. MICC	V.V. Korenkov	1 (2017-2023)

### List of Activities

Activity or Experiment Laboratory or other Division of JINR	Leaders Main researchers
1. MICC Project	<b>V.V. Korenkov</b> <b>A.G. Dolbilov</b> <b>V.V. Mitsyn</b> <b>T.A. Strizh</b>
LIT	Gh. Adam, Eu.I. Aleksandrov, I.N. Aleksandrov, K.N. Angelov, A.S. Baginyan, A.I. Balandin, N.A. Balashov, A.V. Baranov, S.D. Belov, D.V. Belyakov, A.S. Bondyakov, Yu.A. Butenko, A.I. Churin, S.V. Chashchin, S.V. Gavrilov, A.P. Gavrish, V.V. Galaktionov, T.M. Goloskokova, A.O. Golunov, E.N. Grafova, Eu.A. Grafov, N.I. Gromova, A.E. Gushchin, I.S. Kadochnikov, A.S. Kamensky, V.A. Kapitonov, I.A. Kashunin, A.O. Kondratiev, G.A. Korobova, E.Yu. Kulpin, N.A. Kutovskiy, A.A. Lavrentiev, S.B. Marchenko, D.M. Marov, M.A. Matveev, Ye. Mazhitova, S.V. Mitsyn, A.V. Nechaevsky, D.A. Oleynik, G.A. Ososkov, I.S. Pelevanyuk, A.Sh. Petrosyan, M.S. Plyashkevich, D.V. Podgainy, L.A. Popov, D.I. Pryakhina, Ya.I. Rozenberg, T.F. Sapozhnikova, R.N. Semenov, M.L. Shishmakov, I.A. Sokolov, O.I. Streltsova, V.V. Trofimov, N.N. Voitishin, A.S. Vorontsov, A.V. Uzhinskiy, A.Yu. Zakomoldin, P.V. Zrelov, M.I. Zuev
VBLHEP	Yu.K. Potrebenikov, Yu.P. Minaev, O.V. Rogachevsky, B.G. Shchinov, S.V. Shmatov, A.N. Moshkin, K.V. Gertsenberger
FLNP	G.A. Sukhomlinov
LRB	V.N. Chausov
FLNR	V.V. Sorokoumov, A.G. Polyakov
DLNP	Yu.P. Ivanov

BLTP

A.A. Sazonov, Yu.M. Shukrinov, I.R. Rahmonov, K.V. Kulikov

UC

I.N. Semeniushkin

**2. Information and software support of the research-and-production activity at JINR**

**P.V. Zrelov**  
**V.V. Korenkov**  
**I.A. Filozova**

LIT

N.A. Balashov, A.V. Baranov, D.V. Belyakov, N.A. Davyudova, S.V. Duchits, T.M. Goloskokova, D.S. Golub, N.V. Jerusalemova, L.A. Kalmykova, A.A. Karlov, D.V. Kekelidze, D.I. Koshlan, S.A. Kretova, S.V. Kunyaev, G.A. Kurmaeva, N.A. Kutovskiy, A.A. Kutovskaya, O.G. Melnikova, G.G. Musulmanbekov, S.A. Nechitailo, E.A. Paschenko, M.S. Plyashkevich, L.V. Popkova, A.V. Prikhodko, V.M. Pushkina, E.Yu. Razinkova, A.M. Raportirenko, A.P. Sapozhnikov, T.F. Sapozhnikova, S.V. Semashko, R.N. Semenov, A.V. Sheyko, G.V. Shestakova, D.B. Stankus, T.S. Syresina, N.N. Vorobieva, V.M. Yagafarova, A.G. Zaikina, T.N. Zaikina

SOICO

A.S. Sorin, V.F. Borisovskiy

VBLHEP

Yu.K. Potrebenikov, A.V. Philippov, K.V. Turusina

**3. Development of the system for training and retraining of IT specialists based on the JINR MICC and its educational components**

**V.V. Korenkov**  
**T.A. Strizh**  
**O.I. Streltsova**

LIT

N.A. Balashov, A.V. Baranov, S.D. Belov, V.V. Galaktionov, T.M. Goloskokova, N.I. Gromova, O.V. Ivantsova, I.S. Kadochnikov, D.V. Kekelidze, M.H. Kirakosyan, K.V. Koshelev, N.A. Kutovskiy, V.V. Mitsyn, S.V. Mitsyn, I.K. Nekrasova, A.V. Nechaevsky, D.A. Oleynik, A.Sh. Petrosyan, D.V. Podgainy, A.G. Reshetnikov, T.F. Sapozhnikova, R.N. Semenov, Sh.G. Torosyan, V.V. Trofimov, S.V. Ulyanov, A.V. Uzhinskiy, M.I. Zuev  
S.Z. Pakuliak

UC

**Collaboration**

**Country or International Organization**

**City**

**Institute or laboratory**

Armenia

Yerevan

IIAP NAS RA

Azerbaijan

Baku

ADA

Belarus

Minsk

IP ANAS

BSTU

INP BSU

JIPNR-Sosny NASB

UIIP NASB

Bulgaria

Sofia

INRNE BAS

SU

CERN

Geneva

CERN

China

Beijing

IHEP CAS

Czech Republic

Prague

IP CAS

Egypt

Giza

CU

France

Marseille

CPPM

Georgia

Tbilisi

GRENA

GTU

Germany

Darmstadt

TSU

GSI

	Frankfurt/Main	Univ.
	Hamburg	DESY
	Karlsruhe	KIT
	Zeuthen	DESY
Italy	Bologna	INFN
Kazakhstan	Almaty	INP
	Nur-Sultan	BA INP
		NU
Moldova	Chisinau	IAP
		IMCS
		RENAM
Mongolia	Ulaanbaatar	NUM
Poland	Krakow	CYFRONET
Romania	Bucharest	IFIN-HH
	Cluj-Napoca	INCDTIM
	Magurele	IFA
Russia	Chernogolovka	LITP RAS
		SCC IPCP RAS
	Dubna	Dubna State Univ.
		SCC "Dubna"
		SEZ "Dubna"
	Gatchina	NRC KI PNPI
	Moscow	FRC IM RAS
		IITP RAS
		ISP RAS
		ITEP
		KIAM RAS
		MPEI
		MSK-IX
		MSU
		NRC KI
		PRUE
		RCC MSU
		RSCC
		SINP MSU
	Moscow, Troitsk	INR RAS
	Nizhny Novgorod	UNN
	Novosibirsk	BINP SB RAS
	Pereslavl-Zalesskiy	PSI RAS
	Protvino	IHEP
	Puschino	IMPB RAS
	Samara	SU
	St. Petersburg	FIP
		ITMO Univ.
		SPbSPU
		SPbSU
	Vladikavkaz	NOSU
Slovakia	Kosice	IEP SAS
	Presov	PU
South Africa	Cape Town	UCT
Sweden	Lund	LU
Taiwan	Taipei	ASGCCA
Ukraine	Kharkov	NSC KIPT
	Kiev	BITP NASU

USA

Arlington, TX  
Batavia, IL  
Upton, NY

UTA  
Fermilab  
BNL