LABORATORY OF INFORMATION TECHNOLOGIES

The main directions of the activity of the Laboratory of Information Technologies (LIT) are aimed at the provision of the experimental and theoretical studies conducted at JINR with modern telecommunication, network, information support and new mathematical and computing methods.

The LIT activity is focused on two directions, namely «Information, Computer, and Network Support of the JINR's Activity» and «Mathematical Support of Experimental and Theoretical Studies Conducted by JINR». These directions are developing in frames of the general JINR topic «Networks, Computing, and Computational Physics». The Laboratory staff involves high-skilled scientists and engineering personnel, including 25 doctors of science and 63 candidates of science. LIT participates in research work done within 20 topics of the Topical plan for JINR research and international cooperation.

LIT received a BMBF grant for «Development of the Grid-Infrastructure and Tools to Provide Joint Investigations Performed with Participation of JINR and German Research Centers», CERN–JINR Cooperation Agreement on several topics: PC-based distributed computing NICE, development of LabVIEW applications, and participation of JINR in the LCG. The project «Development of Grid Segment for the LHC Experiments» was supported in frames of the JINR–South Africa cooperation agreement in 2006–2008.

Some work was progressing within participation in common projects: NATO project EAP.NIG 982956 «DREAMS-ASIA» (Development of gRid EnAbling technology in Medicine&Science for Central ASIA), CERN–INTAS projects, Worldwide LHC Computing Grid (WLCG), and Enabling Grids for E-sciencE (EGEEIII) project co-funded by the European Commission (under contract number INFSO-RI-222667) through the Seventh Framework Programme. Seven grants were afforded by the Russian Foundation for Basic Research and two Contracts with Russian Federal Agency of Science and Innovations (FASI). The work under SKIF–GRID project — a programme of the Belarusian–Russian Union State — was continued. In cooperation with SINP MSU, RSC «Kurchatov Institute» and PNPI, LIT participates in the Grid National Nanotechnology Network (GridNNN) project performed under the federal target programme of development of the infrastructure of the nanoindustry in the Russian Federation in 2008–2010.

NETWORKING, COMPUTING, INFORMATION SUPPORT

In 2008, the Laboratory provided the reliable operation and development of the JINR networking and informational infrastructure. The key components of this infrastructure comprise JINR telecommunication data links, local area network (LAN), JINR Central Information Computing Complex (CICC) and base software responsible for integration of the Institute's information and computing resources in a unified information environment accessible to all users and with using Grid-technologies.

JINR Telecommunication Data Links. In 2008, an agreement was concluded between JINR and Russian Satellite Communications Company (RSCC) on the rent of optical fiber cable for the provision of optical communication links between Moscow and Dubna. The project is realized in cooperation by JINR, RSCC, NORTEL, JET Infosystems, RosNIIROS, the Computer Networks Interaction Center «MCK-IX». A high throughput channel Dubna–Moscow is under construction in frames of this project on the basis of state-of-the-art

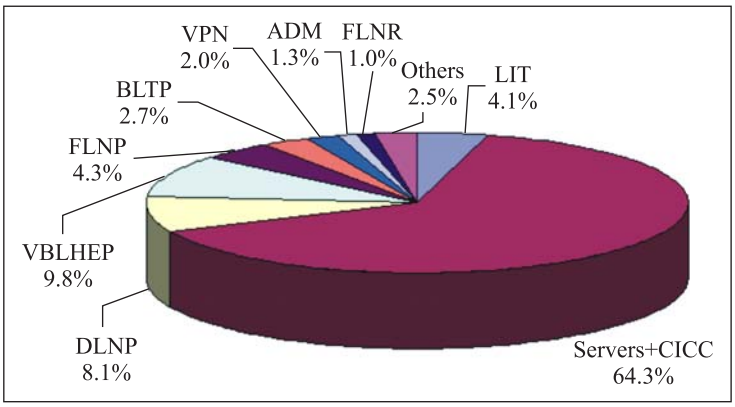

Fig. 1. Distribution of the incoming traffic over JINR subdivisions

technologies DWDM and 10 Gb Ethernet. The channel is planned to be launched in 2009 with a capacity of 20 Gbps. The mentioned technologies allow one to create up to 72 channels of 10 Gbps each, and to raise the total throughput up to 720 Gbps.

The Russian national scientific network is designed as an integrated information environment. Its connecting basis is the RBNet network. Important roles in the development of the national scientific infrastructure are also held by the networks RUNNet, RASNet, RUHEP and by several departmental and regional networks. The process of transition of the trunk lines of these networks to the DWDM technology was started. This will allow a substantial increase of the throughput of the channels (from 10 Gbps up to several hundreds Gbps) and reaching a new level of service.

The development of the segment of the international channels for science and education joining Russia with Europe, with a throughput target of 10 Gbps in 2009, and subsequent growth in 2010–2016 is based on the connectivity with GEANT network. The JINR-participating countries develop regional and national research and educational networks, many of which are being connected to the European network GEANT. As a result of this joint activity, the integration of the Grid-infrastructures of JINR and its Member States will be realized through the high-speed European network GEANT. This is the overall adopted approach to the integration of the regional networks for science and education in Europe.

In 2008, a module was added to the system of the external traffic monitoring that allows one to divide the traffic into categories, for example, a traffic with scientific networks, a traffic with Dubna networks, a multimedia translation traffic, etc.

Figure 1 shows the distribution of the incoming traffic over JINR subdivisions. The Servers and CICC traffic include the common Grid-traffic of JINR.

JINR LAN. The provision of the fail-safe work of the JINR LAN is the primary goal of the network service at LIT. At present the JINR LAN includes 6370 computers and nodes (5880 in 2007). In 2008, the JINR LAN included 3562 users, more than 1500 users of mail.jinr.ru service and 1300 users of remote access VPN. Over 120 network nodes are in round-the-clock monitoring (gateways, servers, basic switchboards, etc.). 15 servers are supported and over 40 user inquiries are served per shift. Introduction of new spam protection systems allowed one to fix about one million spam-messages a day for central mail-servers. In 2008, the registration mechanism of access to external libraries was integrated into the JINR user register — the IPDB base. In total, during October 2008, more than 800 users of external electronic libraries were registered. On the average, 20 new users are registered per month.

Central Information and Computer Complex. During the last two years, the development of the computing power of the Central Information and Computer Complex in LIT JINR was done by the acquisitions of multicore processor modules from leading computer providers. Three rackmount modules (two from T-Platforms and one from Hewlett–Packard) each consisting of 40 dual-core 2.66 GHz Intel Xeon 5150 processors, were acquired in 2007. During 2008, an additional amount of four blades was acquired from SuperMicro: three blades involve 20 quad-core 2.66 GHz Intel Xeon E5430 processors each, while the fourth one involves 20 quad-core 3.0 GHz Intel Xeon X5450 processors. Inside each module, the RAM is 2 Gb/core. The information transfer is secured by one Gigabit Ethernet (GbE) in each machine, while every module is connected to the main Backbone Ethernet switch via a four-port GbE trunk, so the aggregated in-between modules rate was upgraded up to 4 Gbps. The fourth blade can work as a dedicated parallel cluster under InfiniBand interconnect as well.

Thus, the present-day CICC JINR cluster has a heterogeneous 560-core structure. Performance assessment using High Performance LINPACK benchmark points to an overall 2.982 TFlops, while the sum of its three homogeneous parts yields 3.3374 TFlops under Gigabit Ethernet interconnect [1].

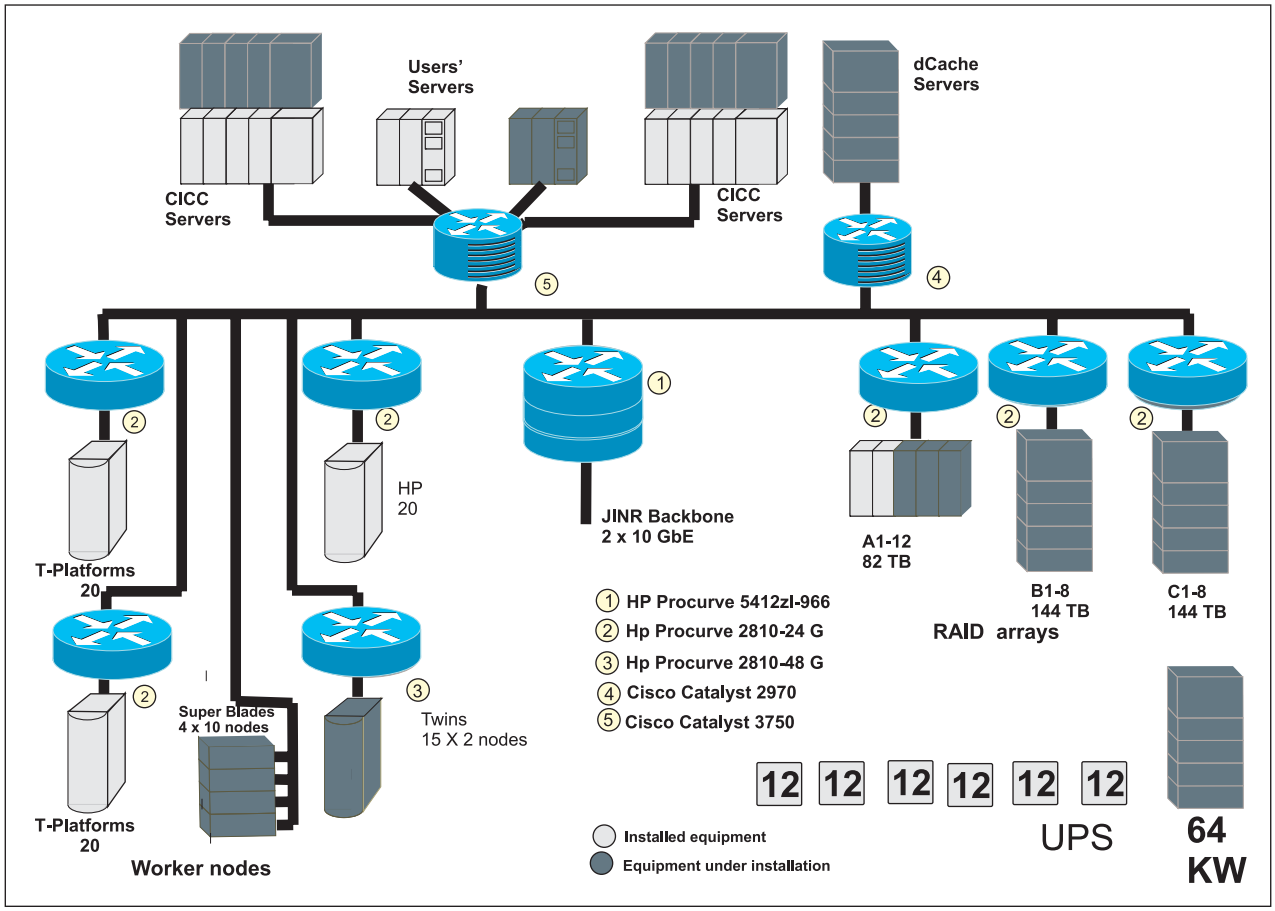

Fig. 2. New structure of the CICC

In the summer of 2008, the CICC conventional performance was equal to 1400 kSI2K (SI2K units are usually used for computing performance evaluation in accordance with the Spec Integer 2000 special test and 1 kSI2K approximately corresponds to computing power of one core of Intel Xeon 2.8 GHz processor) and the disk storage capacity — 100 TB (82 TB — for user catalogs, software and large data volumes storage). The new equipment was purchased at the end of 2008 under the FASI Contract «Working out the computing system for development of the Grid-complex RuTier2/RDIG for carrying out by the Russian institutes the distributed data analysis for the LHC experiments as a part of global Grid-system WLCG/EGEE» and significant increase of the CICC performance up to 2000 kSI2K and the mass storage capacity up to 400 TB will be expected after the equipment installation. Figure 2 shows a new structure of the CICC.

The CICC resources are used by participants of the experiments E391a, KLOD, COMPASS, CDF, D0, DIRAC, CMS, ALICE, ATLAS, H1, OPERA, HERMES, CBM, PANDA, etc., for simulation of physical processes and experimental data analysis. All the CICC computing and data storage resources can be used both locally and globally (for distributed computations in the WLCG/EGEE grid-infrastructure and in the Russian Data Intensive Grid (RDIG) consortium) for all the projects the JINR physicists participate in. The system software has been tuned in an optimal way, providing maximal use of computing resources and the most universal and secure access to the data storage. The Torque batch system and the Maui scheduler are used for computing resources allocation and accounting.

Basically, access to data is provided by the dCache system and partially via NFS. The access to the general-purpose software and user home catalogs is provided by the Andrew File System (AFS). The Kerberos5 system is used for registration and authentication of local users.

Table 1 shows a batch jobs distribution over JINR Groups excluding WLCG groups in 2008.

The distribution of Grid Virtual Organizations (VO) jobs at JINR CICC in 2008 is tabulated below (Table 2).

Grid-Technologies and WLCG Project. During the last years JINR takes an active part in two large-scale worldwide grid projects: Worldwide LHC Computing Grid (WLCG) project (http://lcg.web.cern.ch/LCG/) and Enabling Grids for E-sciencE (EGEE) project (http://www.eu-egee.org/).

Table 1

Laboratory/Groups	DLNP	VBLHEP	Panda	LIT	FLNR	BLTP	FLNP	foton2	na48	Total
Number of jobs	32435	13925	12913	3554	1865	1275	774	161	55	66957
CPU time (kSi2K·h)	476237	35092	6112	66598797	13815	2867176	1064907	9755	20	71071911
Wallclock (kSi2K·h)	485187	54066	84740	202087	3723	236726	136368	9997	22	1212916

Table 2

Grid VO	atlas	cms	alice	biomed	lhcb	ops	hone	fusion	dteam	lrgst	Total
Number of jobs	342159	327330	161437	48372	36433	28952	23747	10525	7893	200	987 048 (in 2007 — 220 793)
CPU time (kSi2K·h)	1151012	1246384	1400131	799909	547456	1464	447568	376339	23	1	5 970 287 (in 2007 — 1 834 466)

Participation in WLCG/EGEE includes: WLCG-infrastructure support and development at JINR in accordance with the requirements of the experiments for the LHC running phase; participation in WLCG middleware testing/evaluation; grid monitoring tools development; JINR WLCG portal support and development, MCDB development; user training and induction to grid; support of JINR member states in the WLCG activities.

In 2008, the CICC was switched over from the LCG middleware environment to the gLite new generation middleware (the current version is gLite-3_1_0) and the Scientific Linux 3 operational system has been updated to Scientific Linux 4. Users can access the LCG/EGEE resources via User Interface (UI) service installed at the interactive computers of the JINR CICC. At present all basic and special grid services and VOboxes special services for ALICE, CMS and PANDA are provided at JINR. The software required for VOs is currently installing at the JINR LCG/EGEE site including dCache xrootd door, AliROOT, ROOT, GEANT packages for ALICE; ATLAS packages; CMSSW packages for CMS, DaVinchi and Gauss packages for LHCb.

In 2008, for the user support to stimulate their active usage of WLCG resources the special courses, lectures, and trainings (http://www.egee-rdig.ru/rdig/user.php) were organized.

In 2008, the Laboratory staff continued participation: in Service, Data, Software and Analysis Challenges and MC Production for ALICE, CMS and ATLAS in coordination with LHC experiments and Tier1 centers at Karlsruhe (FZK), CERN (CERNPROD) and Amsterdam (SARA); in CMS Phedex test data transfers (Phedex server for JINR and Russian institutes was supported at the CMS VObox at JINR); in ALICE software support required for ALICE production Data and Service Challenges and distributed analysis not only at the JINR–WLCG site but also at 12 ALICE sites in Russia; in WLCG middleware testing/evaluation; support and development of monitoring and accounting system (http://rocmon.jinr.ru:8080) for the WLCG-infrastructure at JINR and other sites of the Russian Tier2 cluster; in File Transfer Service monitoring and testing (https://twiki.cern.ch/twiki/bin/view/LCG/TransferOperations) [2], new web-interface to the monitoring system has been developed and implemented in the LHC Dashboard; participation in CMS Dashboard development, including monitoring of the CMS Monte-Carlo production system and Condor-G job monitoring, etc.

The reconstruction of the GridLab at LIT JINR (in frames of the «Dubna-Grid» project) and creation of fully functional educational lecture-room were done in 2008.

The analysis and selection of the middleware for the internal information bus of the remote real-time monitoring system (RRTMS) was done. The remote real-time monitoring system conception was implemented. A functional real-time remote monitoring system prototype was implemented for ATLAS. It uses mirror of the online published data from Point1 in the CERN public network. The development and support of ATLAS TDAQ components: Event Dump, Resource Manager, WMI, was continued.

Results of our activities in WLCG/EGEE computing are summarized in Table 3, where data

Table 3

FZK-LCG2	7356145
GRIF	5866168
N2P3-CC-T2	5410861
IN2P3-CC	5033304
NIKHEF-ELPROD	4985490
TRIUMF-LCG2	4491970
NDGF-T1	3763150
RWTH-Aachen	3634905
RAL-LCG2	3436688
JINR-LCG2	3340491

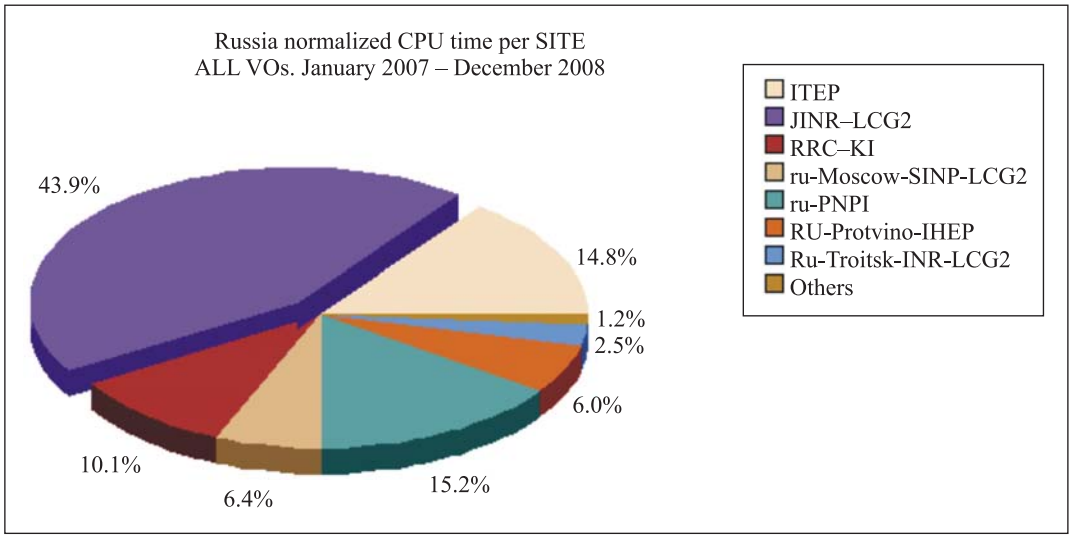

Fig. 3. Distribution of normalized CPU time per RDIG sites (from http://www3.egee.cesga.es/gridsite/accounting/CESGA/tier2_view.html)

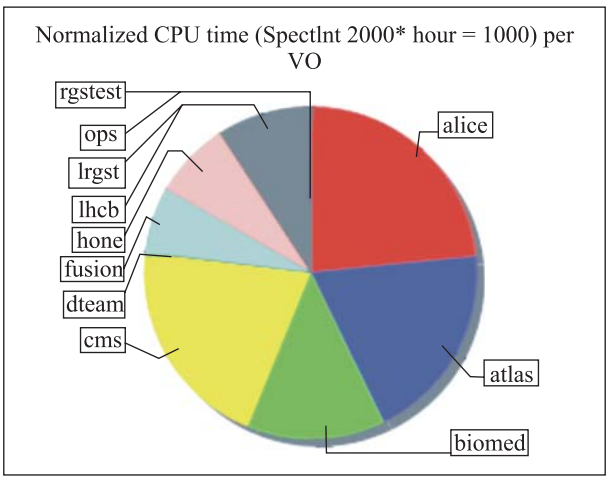

Fig. 4. Distribution of normalized CPU time per VO at JINR site (January–December 2008)

on top EGEE/LCG sites for LHC VOs (ALICE, ATLAS, CMS and LHCb) by normalized CPU time obtained from the EGEE accounting portal http://www3.egee.cesga.es/gridsite/accounting/CESGA/egee_view.html for period June–December 2008 (after JINR CICC modernization in June 2008) are presented.

The activities on the LHC computing support will become especially important on the LHC start, which is expected in the year 2009. The Russian distributed grid computing infrastructure adopted for the LHC experiments has been successfully built as the RuTier2 (Russian Tier2) distributed cluster. In accordance with the RDIG computing model for the LHC, a distributed RuTier2 cluster operates with the resources located at different institutes and shares them between all the LHC experiments. The JINR CICC is a segment of the RDIG infrastructure used for the LHC computing and for different Grid Virtual Organizations for simulation of physical processes and experimental data analysis. These resources have been reliably and successfully used during 2007–2008, and their contribution to RDIG was about 44% (see Figs. 3 and 4).

Information and Software Support. The consecutive development of JINRLIB, a program library for solving a wide range of physical and mathematical problems originated in JINR researcher's scientific activity, is in progress. JINRLIB program packages created by JINR specialists and corresponding to a wide range of scientific tasks in JINR are renewed and replenished with new programs regularly. Object libraries of mathematical programs are prepared in OS Scientific Linux 4 with x86_64 CPU architecture for GNU Fortran 77 compiler, GNU Fortran 95 compiler and Intel Fortran compiler. The maintenance and supplement of the previous object libraries for OS Scientific Linux 3 and Windows 9X/NT/2000/XP is also continued.

The maintenance of the program libraries developed by other research centers and organizations (CPCLIB, CERNLIB) as well as the provision of the information and technical help to users continues. The full information on the JINR program libraries is available at the specialized WWW-site http://www.jinr.ru/programs/ and in LIT News Bulletin (http://lit.jinr.ru/Inf_Bul_4/bullet.pdf).

The traditional provision of information, algorithmic and software support of the JINR research-and-production activity included a large spectrum of activities both at LIT and JINR levels. In 2008, work was in progress on the regular actualization of the program environment and contents of the central information sites of LIT and JINR (http://wwwinfo.jinr.ru, http://lit.jinr.ru, etc.), on creation and support of databases required for functioning these sites. In cooperation with JINR STD ASM, LIT provided support and

modernization of administrative databases, updating and support of software for the central accounting department, translation of programs into version 8.0 1C.

In a hosting mode work was progressing on the development, creation and support of information websites of various conferences, workshops, symposia organized by JINR laboratories. Work on the information system developed in LIT JINR for the internal paperless document circulation (http://lit.jinr.ru/DoctorDoc/) has been in progress.

MATHEMATICAL SUPPORT OF EXPERIMENTAL AND THEORETICAL STUDIES

The main part of this activity is related to the development of the mathematical description and algorithmic reformulation of the physical models such as to receive significant numerical solutions; development of methods and algorithms able to extract physically insightful information from experimental data; simulation of physical processes within experimental installations; algorithm implementations into effective and reliable hardware adapted program environment. More than 150 scientific publications and conference proceedings were published in 2008. More than 90 reports were presented at international conferences.

Essential improvements have been done in the Fritiof (FTF) model, and they are now implemented in the latest version 9.2 of the Geant4. Two new Physics lists, FTFP and FTF_BIC, utilizing the model, have been proposed for the Geant4 package. The UrQMD model version 1.3 has been tested for pion–nucleus interactions. The bugs were fixed in the UrQMD model versions 1.3 and 2.3. The improved version 1.3 is used for the NICA project. The well-known AMPT model installed at specialized HEPWEB server (http://hepweb.jinr.ru) has been tested for RHIC energies.

An updated version of Fitter — a C++ program aimed to fit a chosen theoretical multiparameter function through a set of data points — was installed. Some standard mathematical models and minimization module are added for wider applicability. The important feature of Fitter's design is its expandability: both new models and new minimizing algorithms can easily be added to the existing ones. A long write-up description of the new version of Fitter was published [3]. Also, a new version of the Gluplot — the data plotting package, was included in JINR Program Library. The Gluplot handles both curves (2D) and surfaces (3D) [4].

Algorithms for charged particle track reconstruction and their identification by the Transition Radiation Detector (TRD) have been developed at LIT for CBM experiment. The algorithm is based on a track-following method with the Kalman filter application. An artificial neural network, that uses as input samples the particles energy losses in the TRD layers, is applied for electron/pion identification. First results on the optimization of the TRD geometry taking into account the efficiencies of track reconstruction, electron identification and pion suppression, are presented in [5].

The work performed by researchers of LIT and GSI, Darmstadt, Germany, describes a 3D finite elements mesh generator based on the «Mapping» approach. A user-friendly interface for defining the input geometry has been developed. A set of tools to describe the curvature of standard and nonstandard current windings curvature with various cross sections is designed. The proposed generator can be used as a preprocessor for solving a wide range of problems based on the finite elements method [6].

The work within the activities on ϕ-meson cross section and F_2^D proton structure function calculations on H1 experimental data with FPS (Forward Proton Spectrometer) are in progress. Elastic ϕ-meson photo-production obtained on 2005–2007 experimental data is presented in Fig. 5 [7].

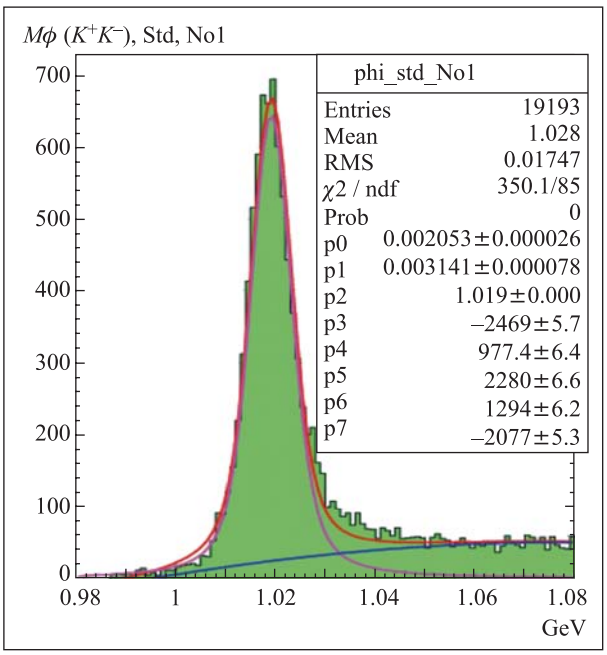

Fig. 5. Elastic ϕ-meson photo-production in H1 experiment (DESY) on 2005–2007 data

An excellent Dubna Cathode Strip Chamber spatial resolution (46 microns) has been obtained from CMS muon cosmic data with 3.8 T magnetic field in the actual version of CMSSW (several improvements with additional cross-talk corrections) [8].

A new scheme for the introduction of form factors for the $SU(4)$ chiral meson Lagrangian approach to the

J/ψ breakup cross sections by pion and ρ-meson impact was suggested. The model calculation for Gaussian vertex functions within the meson form factor scheme was performed and compared with those of the usual global form factor model. The new meson form factor model was calibrated with results for the pion impact processes from a relativistic quark model and present predictions for the ρ-meson induced processes. A fit formula for the resulting energy-dependent cross sections has been provided for practical use in future model calculations [9].

A software complex KANTBP 2.0 has been designed for computing the wave functions of a discrete and continuous spectrum of multi-dimensional quantum systems by the Kantorovich method (KM). The Kantorovich method is applied to calculate the wave functions of a discrete and continuous spectrum of a hydrogen atom in a magnetic field and the cross sections of photoionization of the linearly polarized light along the axis z from an initial state of the discrete spectrum into a final state of the continuous spectrum. A method of effective computation of potential curves and matrix elements for coupled radial equations describing the behaviour of a hydrogen-like atom in a homogeneous magnetic field has been developed and realized in the Fortran 77 programming language. The efficiency of the method is essentially based on the developed and realized in the MAPLE system algorithms of computation in an analytical form of asymptotics of basic functions, matrix elements and radial solutions. A numerical research on the photoionization model and speeds laser-induced recombination of a hydrogen atom in a homogeneous magnetic field of a suitable magnetic optical trap has been conducted. The effects of resonant passage and full reflection of the unlike charged particles in the homogeneous magnetic field have been predicted for the first time [10].

An anisotropic Bianchi type-I string cosmological model in the presence of a magnetic field is investigated. Some exact solutions are produced using a few tractable assumptions usually accepted in the literature. The analytical solutions are supplemented with a numerical and qualitative analysis. In frames of the present model the evolution of the Universe and other physical aspects are discussed [11].

A self-consistent system of interacting spinor and scalar fields within the scope of a Bianchi type-I gravitational field in presence of a viscous fluid and Λ-term was studied. A corresponding system of equation has been derived and thoroughly studied qualitatively. The system is studied from the viewpoint of blow-up. It has been shown that in absence of viscosity the blow-up does not occur. It should be emphasized that the phenomena similar to that in question can be observed in other discipline of physics and present enormous interest from the viewpoint of catastrophe, demography, etc. [12].

Calculations of microscopic optical potentials (OP's) (their real and imaginary parts) are performed to analyze the $^6\mathrm{He} + p$ elastic scattering data at a few tens of MeV/nucleon. The OP's and cross sections are calculated using three model densities of ^{6}He. Effects of the dependence of the NN forces on nuclear density are investigated. The role of the spin-orbital terms and the nonlinearity of the OP's and also the role of its renormalization are studied. The sensitivity of the cross sections to these effects is tested [13].

Interactions of relativistic heavy ions with energy above 30 GeV have been studied in thick Cu and Pb targets (> 2 cm) based on computer simulation using the Dubna Cascade Model (DCM) (and other available computer codes — MCNPX). Calculated data are compared with available experimental data acquired at JINR (Dubna), LBL (Berkeley), Sacley (France), etc. Open unresolved problems are pointed out, e.g., neutron production by 44 GeV ^{12}C ions with thick Cu and Pb targets. It is shown that the neutron production of 44 GeV ^{12}C within thick Cu and Pb targets is beyond the estimated extrapolated yield determined in experiments with 12 GeV ^{12}C which is promising when applied to enhanced transmutation capacity of subcritical assemblies [14].

On the basis of the solution of a nonlinear diffusion equation with initial and boundary conditions, a transport coefficient of moisture in a sample of a porous material is found by minimization of a functional, which expresses diversion of the computed profile of moisture concentration in well-defined time moments from their experimental values for the defined moisture transport coefficient by the Newton method. In this case, the transport coefficient as opposed to the previous works is found as a sum of the degree and exponential functions of the moisture concentration. The exponential term provides a good coincidence of the mentioned profiles for big times nearby the boundary of the sample, where evaporation of the moisture to the atmosphere takes place [15].

The research related to producing nanostuctures in materials exposed to high-energy heavy ions was performed in collaboration with FLNR. The numerical results obtained in frames of a thermal spike model for an anisotropic material on an example of highly-oriented pyrolytic graphite are represented. The experimental data are compared to the calculated ones, new experiments and theoretical approaches are suggested [16].

A method of entanglement production is suggested, based on the resonant generation of topological modes in systems with Bose–Einstein condensates trapped in optical or magnetic lattices. The method allows one to regulate the strength of entanglement production as well as to govern its time variation. This method can serve as a practical tool for quantum information processing and quantum computing [17].

A new method for numerical solution of nonlinear boundary value problems for systems of ODE's given

on the embedded intervals has been proposed. The algorithm is based on the continuous analog of the Newton method. A numerical solution to corresponding linear boundary-value problems at each iteration is performed with a spline-collocation scheme. As a particular example, a problem is considered about possible distributions of the magnetic flux in a system of two magnetically coupled long Josephson junctions with different layers lengths. The influence of the length's ratio on the main physical properties of basic bound states is studied numerically. The existence of bifurcations by changing the lengths of the layers for some class of solutions is proved [18].

The problem of optimal biosensor development was analyzed. The electrostatic properties of a number of enzymes and nucleic acids have been calculated. The results obtained reveal a number of patterns in interaction of enzymes with charged nanostructures, which can be directly utilized in biosensor development, provided that new software aimed at systematization and generalization of data on immobilized proteins should be developed, such as an appropriate database and an expert system. Such a software will be able to become a first step towards implementation of computational nanotechnology, aimed at the development of biosensors with predetermined properties [19].

One of the important tasks of quantum engineering is the designing of various quantum structures possessing desirable spectral properties. Basic elements of the modern micro- and nano-electronics are structures of low dimension which are generated from quantum wells, dots, wires. From a theoretical viewpoint, the problem of determining the potentials of quantum wells which would support the desirable spectrum, arises. A positive solution to this problem would make the quantum engineering more effective and flexible, thus providing conditions for the development of new quantum objects. The generalized Schrödinger equation with effective mass dependent on a spatial variable has been used lately to simulate the electronic properties of nano-objects [20].

The exact mean field Green function solution of the effective two-dimensional two-band Hubbard model of the high-T_c superconducting phase transition in cuprates unveils three important features of this model. (i) While the conjecture of the spin-charge separation in cuprates, repeatedly stressed by P. W. Anderson, is at variance with the existence of the Fermi surface in these compounds, the main findings of the present investigation point towards its actual occurrence and to an alternative explanation. (ii) The two-band Hubbard model recovers the superconducting state as a result of the minimization of the kinetic energy of the system, in agreement with ARPES data. (iii) The anomalous charge–charge pairing may be consistently reformulated in terms of localized Cooper pairs both for the hole-doped and the electron-doped cuprates [21].

Computer Algebra and Applications. An algorithm was developed for decomposition of multivariate algebraic polynomial equations into triangular subsystems with disjoint solution space. The algorithm is a part of the general algorithmic approach to completion of nonlinear partial differential systems to involution [22].

The $SU(n)$ Yang–Mills light-cone mechanics is studied in detail [23]. In the framework of the Dirac constraint formalism for degenerate Hamiltonian the complete set of constraints was computed and classified for the cases of $SU(2)$ and $SU(3)$ symmetry groups. All underlying computations were done by means of the Gröbner bases technique in the polynomial ideals theory.

Discrete dynamical systems and mesoscopic lattice models are studied in [24] from the standpoint of their symmetry groups. Universal specific features of the dynamical system behavior associated with nontrivial symmetries of these systems are specified. A program in C for the group analysis of such systems was also developed. In particular, the program constructs and investigates phase portraits of discrete dynamical systems modulo symmetry group and seeks dynamical systems possessing special features, such as, for example, reversibility. Typical examples of discrete systems with high symmetry are (hydro)carbon nanostructures (Fig. 6).

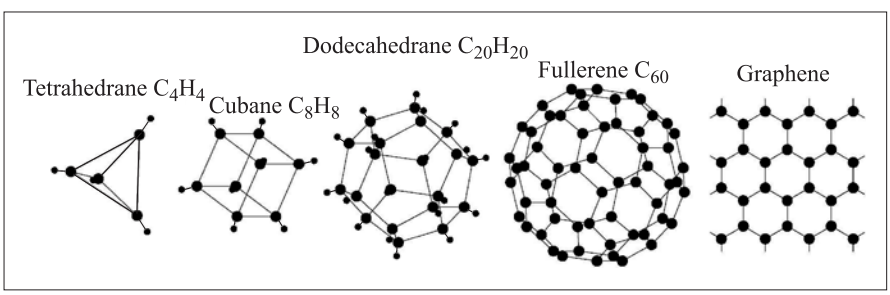

Fig. 6. Typical examples of discrete systems with high symmetry — (hydro)carbon nanostructures

Nontrivial connections between symmetries and dynamics of discrete systems have been revealed. In particular, it is shown that formation of moving soliton-like structures is typical of discrete dynamical systems with nontrivial symmetry group. These structures are analogs of «spaceships» in cellular automata and «generalized coherent states» in quantum physics.

A method to describe dynamics of a composite system interacting with a strong laser field is suggested [25]. The suggested method takes into account the relativistic and quantum effects caused by a high intensity of the laser field.

INTERNATIONAL COOPERATION

In cooperation with German centres in 2008 FTS test file transfers between FZK and JINR to certificate the link between T1–FZK and T2–JINR were performed. In October 2008, the link between T1–FZK and T2–JINR was successfully tested in frames of CMS Phedex data transfer system and certified in CMS. The maximal transfer rates were more than 37 MBs.

The common activities with DESY (Hamburg) were continued in the 2008 year on H1 MC production grid monitoring. HONE VO queue was configured and enabled at JINR WLCG-site and was in an active use for H1 Monte-Carlo production. From December 2007 to November 2008, more than 23 000 HONE VO jobs have been completed at the JINR WLCG-site (it is 4% of a total number of HONE VO jobs during this period).

In collaboration with FLNP and co-authors from the Martin Luther University (Halle, Germany) and PSI (Villigen, Switzerland), a numerical analysis of the small-angle neutron scattering data has been performed to investigate the structure and properties of the ceramide 6 based four-component membrane of unilamellar vesicles at temperatures of 32 and 60° C. At a small-angle scattering region, one observes a deviation of numerical results and experimental data that indicates a strong short-range interaction of vesicles between each other leading to generating cluster structures that confirms the chain-flip transition phenomenon [26].

New methods of mathematical simulation of Josephson structures have been suggested at LIT in collaboration with the universities of Sofia and Plovdiv, Bulgaria. A new effective numerical algorithm for solving a nonlinear system of ODE's describing the static distributions of the magnetic flux in N-stacked Josephson junctions (JJ) was worked out. The algorithm is based on the continuous analog of the Newton method. The linear boundary-value problems arising at each iteration are solved numerically with a finite element method. A corresponding matrix Sturm–Liouville problem for studying their global stability is proposed. To solve the problem, a sub-space iteration method is used. As an example, the existence, stability, lack of stability and some physical characteristics of two kinds of magnetic flux distributions in 3-layered JJs are analyzed [27].

CONFERENCES AND WORKSHOPS

On January 28 – February 2, 2008 the 15th interdisciplinary conference «Mathematics. Computer. Education» (MCE) was held. The specificity of the conferences is that they have a scientific-educational and interdisciplinary character. They provide a way for professional scientific dialogue at sectional sessions and allow scientific youth to communicate with experienced researchers and lecturers and to discuss their results.

A traditional 12th Workshop on Computer Algebra was held at the Laboratory of Information Technologies (JINR) on May 14–16, 2008. The main goal of the workshops is to provide a forum for researchers on computer algebra methods, algorithms and software and for those who use this tool in theoretical, mathematical and experimental physics. A number of new promising results were presented on increase of computing efficiency of algorithms for solving systems of algebraic, differential and difference equations; modelling of quantum computations and research of entanglement of multiparticle quantum systems important for problems of quantum computer science; solution to the boundary-value problems arising in nuclear physics and engineering sciences.

The international conference «Distributed Calculations and Grid Technologies in Science and Education» was held on June 30 – July 4. This conference is the only event in Russia dedicated to the issues of development and application of Grid technologies and other related aspects of information technologies and was organized under the support of the Russian Foundation for Basic Research. The programme included not only the issues on the establishments and operation of Grid-infrastructures, but also theoretical and practical aspects of application of distributed calculation media, distributed data processing, etc. Sponsors of the conference — representatives of the companies T-platform, Niagara, EtegroTech., and IBM — informed the participants about their produce and activities. This year the conference gathered 228 participants from 20 countries, as well as from CERN and JINR. Russia was

represented by participants from 49 universities and research centres. There were the following sections at the conference: «Grid Applications», «WLCG — Worldwide LHC Computing Grid», «Grid Service and Architecture», «Personnel Training in Advanced IT Trends». LIT staff members organized a special lecture session on Grid technologies for beginning users. The traditional plenary reports at the conference dwelt on modern status and prospects of foreign Grid centres development. This type of events is a powerful tool for consolidation, experience sharing and attraction of new participants. Each time, it becomes more and more useful and important for Grid development and its applications both in Russia and in JINR Member States.

On October 7–10, LIT hosted the All-Russian scientific conference «Digital Libraries: Perspective Methods and Technologies, Electronic Collections» (RCDL'2008) that celebrated its anniversary in a decennial series of annual Russian conferences. The RCDL Conferences have always been open to Russian as well as to foreign leading specialists in the specified area that allowed them to exchange experience, ideas and results for setting up contacts for close cooperation in the future. The reports presented summed up the achievements in the mentioned area focusing on the possibility to apply semantic representation of information and knowledge in distributed and hybrid DL and scientific collections, ontological modelling, and integration of heterogeneous resources. Traditionally special attention was paid to the work on the electronic collections created within the RFBR projects and other programs on digital libraries. In frames of the RCDL'2008 a specialized Russian seminar on the data retrieval methods estimation ROMIP'2008 was organized where the developers of algorithms and specialists-analysts of the well-known companies Yandex, Mail.ru, Galaxy Soft, KM.RU, HeadHanter, etc., presented their reports.

REFERENCES

1. *Adam Gh. et al.* // Proc. of the 3rd Intern. Conf. «Distributed Computing and Grid Technologies in Science and Education, GRID-2008», JINR, Dubna, 2008. P. 283–286.
2. *Korenkov V., Uzhinskiy A.* // Open Systems. 2008. V. 2. P. 52–56.
3. *Soloviev A. G. et al.* JINR Commun. E10-2008-2. Dubna, 2008.
4. *Soloviev A. G.* http://www.jinr.ru/programs/jinrlib/gluplot/indexe.html
5. *Ivanov V. V. et al.* JINR Commun. P10-2008-152. Dubna, 2008.
6. *Akishin P. G. et al.* JINR Commun. P11-2008-149. Dubna, 2008.
7. *Kapishin M., Nikitin D., Palichik V., Spaskov V.* // Diffractive Working Group Meeting, July 1, 2008. https://www-h1.desy.de/icgi-h1wiki/moin.cgiDiffractiveWorkingGroup/DiffractiveMeeting2008-07-01
8. *Palichik V.* // CMS Week, Dec. 8, 2008. http://indico.cern.ch/contributionDisplay.py?contribId=10&confId=46650.
9. *Blaschke D. B., Grigorian H., Kalinovsky Yu. L.* arXiv: 0808.1705. 2008; Phys. Rev. C (submitted).
10. *Chuluunbaatar O. et al.* // Comp. Phys. Commun. 2008. V. 179. P. 685–693;
    Chuluunbaatar O. // Vestnik RUPF: Ser. Math. Informatics. Phys. 2008. V. 2. P. 40–56;
    Chuluunbaatar O. et al. // Comp. Phys. Commun. 2008. V. 178. P. 301–330;
    Chuluunbaatar O. et al. // Phys. Rev. A. 2008. V. 77. P. 034702-1–034702-4;
    Chuluunbaatar O. et al. // Phys. At. Nucl. 2008. V. 71. P. 844–852.
11. *Saha B., Visinescu M.* // Astrophys. and Space Science. 2008. V. 315. P. 99–104.
12. *Saha B., Rikhvitsky V.* // J. Math. Phys. 2008. V. 49. P. 112502.
13. *Lukyanov K. V. et al.* // Bul. of the RAS: Phys. 2008. V. 72. P. 854–858.
14. *Brandt R. et al.* // Part. Nucl. 2008. V. 39, No. 2. P. 259–285;
    Brandt R. et al. // Rad. Meas. 2008. V. 43. P. 132–138.
15. *Amirkhanov I. V. et al.* // Part. Nucl., Lett. 2008. V. 5, No. 3(145). P. 479–484;
    Amirkhanov I. V. et al. // Materials and Structures. 2008. V. 41. P. 335–344.
16. *Amirkhanov I. V. et al.* // Nuclear Physics and Nanotechnologies: Nuclear Physics Aspects of Formation, Study and Application of Nanostructures. Dubna, 2008. P. 339–349.
17. *Yukalov V. I., Yukalova E. P.* // J. Phys. Conf. Ser. 2008. V. 104. P. 012003-11;
    Yukalov V. I., Yukalova E. P. // Laser Phys. Lett. DOI: 10.1002/lapl.200810111.
18. *Melemov H., Boyadjiev T.* JINR Preprint E11-2008-143. Dubna, 2008; Lect. Notes in Comp. Sci. (submitted).
19. *Ivanov V. V. et al.* // Nuclear Physics and Nanotechnologies: Nuclear Physics Aspects of Formation, Study and Application of Nanostructures. Dubna, 2008. P. 293–311.
20. *Suzko A. A., Schulze-Halberg A.* // Phys. Lett. A. 2008. V. 372. P. 5865–5871;
    Suzko A., Tralle I. // Acta Physica Polonica. B. 2008. V. 39, No. 3. P. 545–567.
21. *Adam Gh., Adam S.* // J. Optoelectronics and Adv. Materials. 2008. V. 10, No. 7. P. 1666–1670.
22. *Gerd V. P.* // Acta Appl. Math. 2008. V. 101. P. 39–51.
23. *Gerd V. P., Khvedelidze A. M., Palii Yu. G.* // Theor. Math. Phys. 2008. V. 155, No. 1. P. 557–566;
    Palii Yu. G., Khvedelidze A. M. // Programming and Comp. Software. 2008. V. 34, No. 2. P. 101–106.
24. *Kornyak V. V.* // Programming and Comp. Software. 2008. V. 34, No. 2. P. 84–94.
25. *Jameson P., Khvedelidze A.* // Phys. Rev. A. 2008. V. 77. P. 053403.
26. *Zemlyanaya E. V. et al.* // J. of Surface Investigation. X-ray, Synchrotron and Neutron Techniques. 2008. V. 2, No. 6. P. 884–889.
27. *Hristov I., Dimova S., Boyadjiev T.* JINR Preprint E11-2008-160. Dubna, 2008; Lect. Notes in Comp. Sci. (submitted).