LABORATORY OF INFORMATION TECHNOLOGIES

In 2007, the Laboratory of Information Technologies concentrated its activities on fulfillment of the research in frames of two first priority topics: «Information, Computer, and Network Support of the JINR's Activity» and «Mathematical Support of Experimental and Theoretical Studies Conducted by JINR». These topics are developed in frames of the JINR direction «Networks, Computing, and Computational Physics». The main tasks of the Laboratory of Information Technologies (LIT) consist in the provision with modern telecommunication, network, computing and information resources, and mathematical support of the theoretical and experimental studies conducted by JINR, Member State institutes, and other scientific centers within JINR Research programmes. Special attention was paid to essential growth of the JINR networking and computing resources, in order to satisfy the needs of experiments on LHC and new experiments that are under preparation at other accelerator complexes.

The Laboratory staff participated in research work done within 13 topics at the project level and within 23 topics at the cooperation level of the Topical plan for JINR research and international cooperation. The results of the research performed within the topics were published in the well-known journals, conference proceedings and preprints.

A number of scientific projects involving members of LIT staff have been financed by grants afforded by INTAS and the Commission of the European Community (Enabling Grids for E-sciencE (EGEE)). Six grants were afforded by the Russian Foundation for Basic Research. The work in the field of Grid-technologies was performed within the CERN–JINR cooperation (project Worldwide LHC Computing Grid (WLCG)), BMBF, and South Africa grants.

Since the year 2007, the LIT team participates in SKIF–GRID project — a programme of the Belarusian–Russian Union State directed to the development and use of hard- and software of Grid-technologies and advanced supercomputer systems SKIF.

In 2007, the JINR Central Information and Computing Complex (JINR CICC) in the Laboratory of Information Technologies was essentially modernized. Upon putting into service a new cluster in June 2007, the CICC ranks the 12th in the rating of the most powerful computer systems in Russia and SIC. From July to December 2007, the JINR CICC contribution to the solution of tasks within the Russian Grid-infrastructure RDIG (Russian Data Intensive Grid), which integrates the JINR Grid-segment and 15 resource centres in Russian institutes, amounted to 44%. In November the CICC data storage was increased up to 100 TB.

NETWORKING, COMPUTING AND INFORMATION SUPPORT OF JINR ACTIVITIES

JINR Telecommunication Links. In 2007, JINR continued leasing 1 Gbps computer communication link within 2.5 Gbps channel of the Russian Satellite Communications Company (RSCC). A highway single-mode fiber optic cable that organizes the channel comes to the M-9 station in Shabolovka, Moscow, where MSK-IX exchange node (Moscow Internet Exchange) is located. The node MSK-IX provides access to various Russian and international networks: through the network for science and higher school RBNet — to the Internet, through the Radio-MSU — to the international networks for high-energy physics RUHEP, through the network of the Russian Academy of Science RASNet — to the European network for science and education GEANT (Fig. 1).

In 2007, LIT specialists solved a number of problems related to a 10 Gbps external data link that is expected to be created in the year 2008.

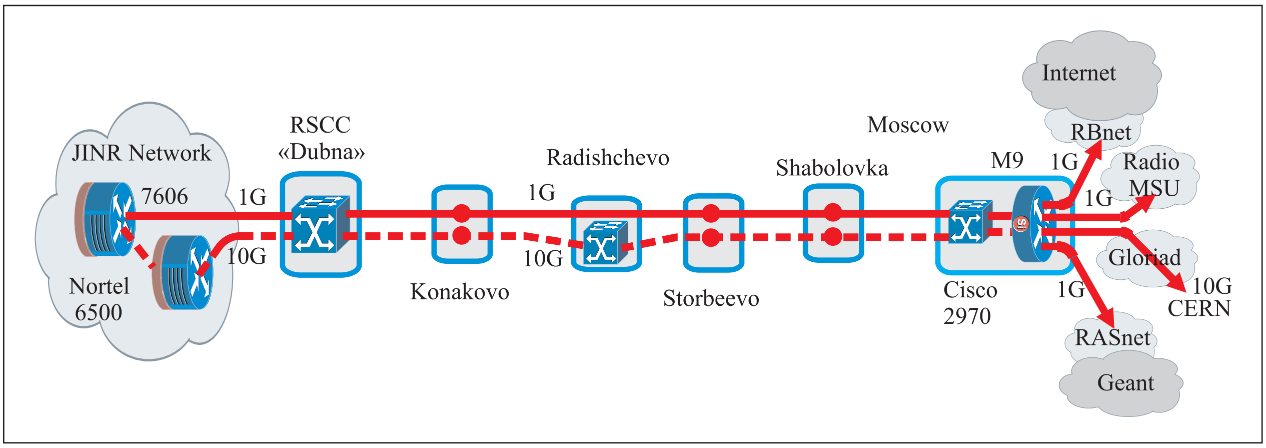

Fig. 1. Scheme of the JINR computer communication links: solid line — operating 1 Gbps channel, dashed line — planned 10 Gbps channel

Figure 2 shows distribution of the incoming and outgoing JINR traffic since 2003. The sharp increase of the traffic in 2007 is explained by activities within LHC experiments at the stage of preparing the computing centres for the LHC start-up.

In 2007, a direct telecommunication channel of a «point–point» type between CERN and CICC was established as a centre of Tier2 level in the hierarchical structure of the data processing system on the LHC project as well as a node of Internet exchange of city providers (JINR, Contact, Telecom-MPK).

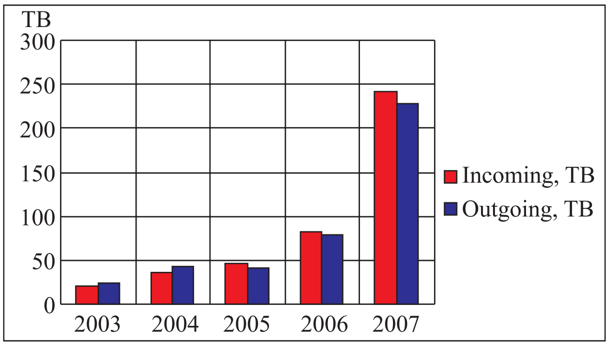

Fig. 2. Distribution of the JINR incoming and outgoing traffic by years 2003–2007

JINR Local Area Network. The LIT Network Operation Center provides uninterrupted work of the JINR LAN. At present the JINR LAN comprises 5880 computers and nodes (5681 in 2006). There are 3322 network users, 689 modem pool users, and 500 JINR staff members use VPN connections.

The NMIS (Network Management Information System) provides a constant automated observation of all the most important components of the JINR network infrastructure. It allows one to respond quickly to information on revealed failures. The information database IPDB provides interface with JINR users. The AFS (Andrew File System) module was put into a test mode operation within JINR user' IPDB. This permits one to unite four separate AFS domains located in LIT, DLNP and LPP to work as a united centralized domain.

Modernization of the JINR central telecommunication node started in 2006 was finally accomplished in 2007 (Fig. 3).

JINR Information and Computing Complex. The main achievement of 2007 is the performance increasing and modernization of the JINR CICC. At present the CICC performance equals 670 kSI2K, and disk storage capacity is 100 TB. Thus, in the last two years the CICC performance and disk storage capacity have been increased by 6.7 and 6 times, accordingly.

The former CICC structure represented a number of special-purpose clusters allowing two ways of each cluster usage: either local or global. Since June 2007, all the CICC resources and services are integrated into a unified information computer structure (Fig. 4).

The CICC logical and software structure was substantially restructured. The main changes concerned security and batch systems. All the CICC computing and data storage resources can now be used both locally and globally (for distributed computations in the WLCG/EGEE Grid-infrastructure) 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 protected access to the data storage. The Torque batch system and the Maui scheduler are used for computing resources allocation and accounting. Authorization and user data protection has been transferred from Kerberos 4 to Kerberos 5. Transition to the new protocols required an essential changing of tunes of the network and server equipment of JINR and CICC. A new configuration of the CICC computing resources has been performed. Instead of the resource separation into a farm for WLCG and a farm for local use, all computing resources became common. This has demanded significant changes in the WLCG standard software — gLite, because gLite standard foresees allocation of resources

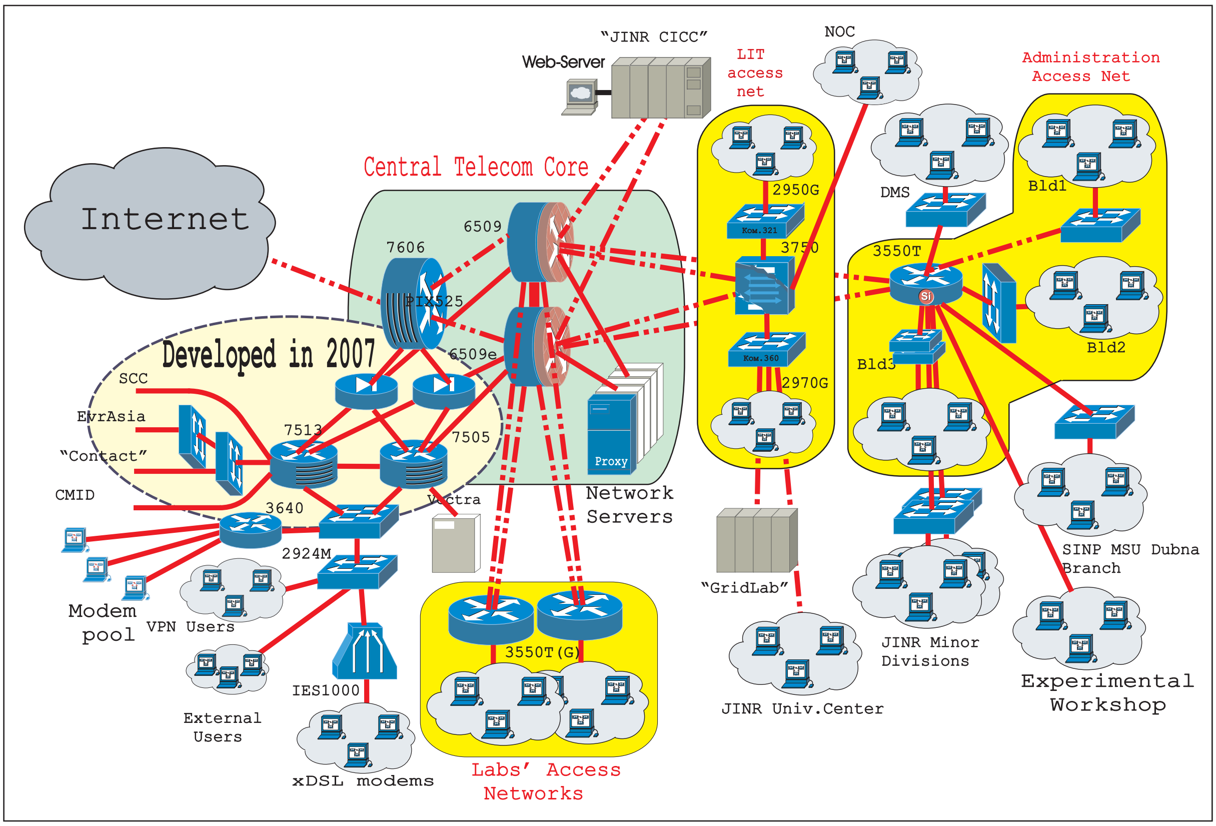

Fig. 3. JINR LAN scheme

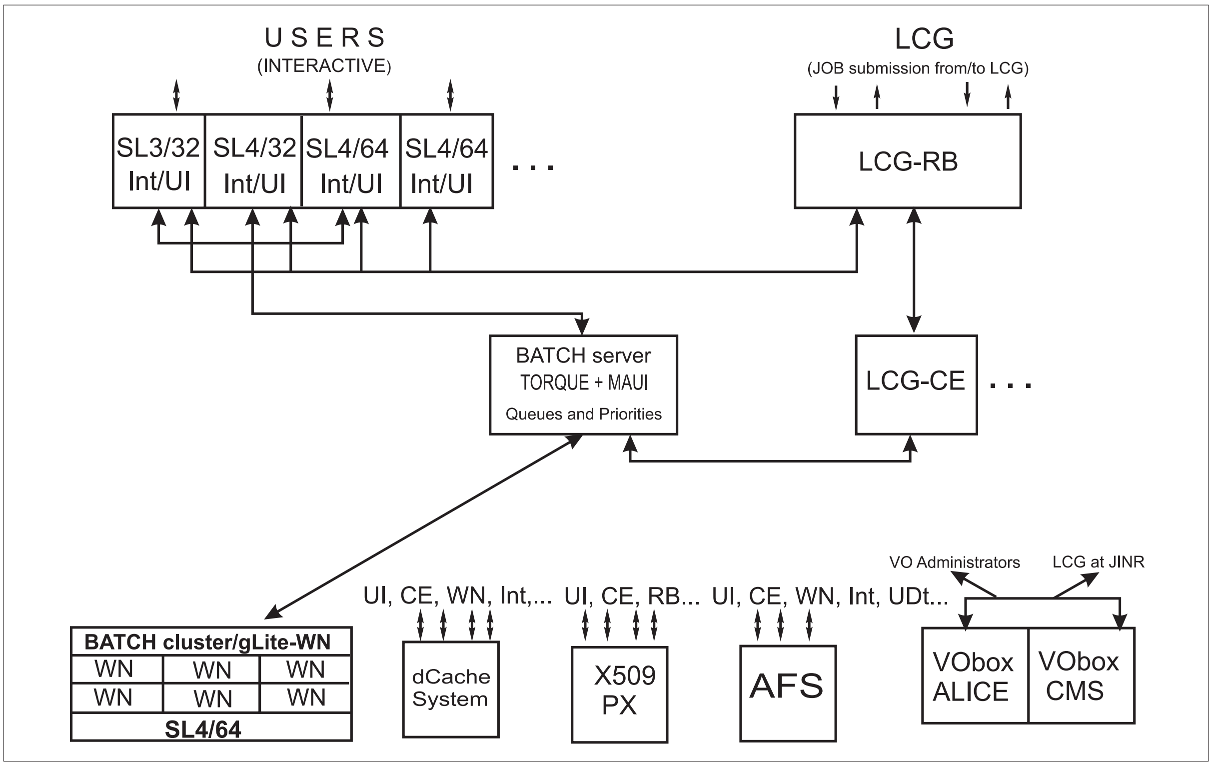

Fig. 4. CICC computing resources, access and maintenance scheme: SL3/32 Int/UI — Interactive nodes/User Interface at 32-bit architecture with Scientific Linux 3 (SL3), SL4/32 Int/UI – Interactive nodes/User Interface at 32-bit architecture with Scientific Linux 4 (SL4), SL4/64 Int/UI — Interactive nodes/User Interface at 64-bit architecture with SL4, LCG-RB — LCG Resource Broker, LCG-CE — LCG Computing Elements, WN — Worker Nodes, X509 PX — Proxy, VObox — special node where experiments (ALICE, CMS, etc.) or Virtual Organizations (VO) can run specific agents and services to provide a reliable mechanism to accomplish various tasks specific for VO, AFS — AFS servers, dCache — dCache servers

only under WLCG/EGEE needs. On the other hand, such an integration of the resources requires a special debugging of numerous parameters of the batch system.

Currently, there are following computing nodes at the CICC: 53 special-purpose servers (29 for main CCIC and JINR information infrastructure support and 24 for the JINR–LCG2 site support in RDIG, WLCG, and EGEE), 4 interactive nodes, 60 computers of 64-bit architecture (2 Xeon 5150 dual-core processors), 5 dual-core computers of 32-bit architecture.

The JINR users can run their tasks using 250 CPU both in a local and global mode (in WLCG/EGEE environment). The internal CICC network for the most part makes use Gigabit Ethernet. All the basic computing and data storage resources are connected to internal network routers at the rate of 1 Gbps. The internal CICC network is also connected to the JINR backbone network and the border router at the rate of 1 Gbps.

Special-purpose servers are used to support the work of users and JINR services: batch, WWW, MySQL and Oracle DBs, e-mail, DNS and others.

The AFS distributed file system with a highly secure data access is used at JINR for user home catalogs and general-purpose software. The total AFS space is about 1.45 TB (1.40 TB — at CICC servers). There are 8 AFS servers installed and supported at the CICC. Information stored at the CICC disk servers can be subdivided into 2 categories: user home catalogs and software products in different forms; «physical» information, i. e., data obtained from experiments and simulated data samples stored in the dCache system. The dCache system has finally replaced the Castor system. The dCache system was chosen instead the Castor, because dCache responds the best to the requirements to JINR as part of distributed RuTier2 center in the WLCG hierarchy. In December 2007, the volume of dCache data storage pools was increased up to 82 TB.

Table 1

Laboratory	LIT	FLNR	LPP	VBLHE	DLNP	BLTP	Total
Number of jobs	284	1062	3667	558	735	26	6332
Normalized CPU time (kSI2K · h)	51421.30	11823.26	10606.44	16755.44	5206.62	315.36	96128.42

Table 1 shows data over JINR Laboratories on jobs quantity and normalized CPU time spent for their completion in a batch mode at JINR CICC in June–December 2007.

The distribution of jobs of the Grid Virtual organizations which are part of the RDIG/WLCG structure at JINR CICC is tabulated as follows:

Table 2

Grid VO	Jobs quantity	CPU time (kSI2K · h)
alice	90441	1370820.40
atlas	15643	48980.43
biomed	25103	164102.07
cms	52249	51883.18
dteam	6988	101.91
fusion	9208	145053.80
hone	4402	46793.63
lhcb	10484	6604.50
ops	6275	126.56
Total	220793	1834466.49

The further development of the CICC as a node of the distributed Grid-infrastructure foresees increase in the complex performance and data storage capacity; development of the JINR Grid-segment with a full-function set of services.

Grid-Technologies and LCG Project. The activities on the LHC computing support becomes especially important before the LHC start, which is expected in the year 2008. A distributed Grid computing infrastructure adopted for the LHC experiments has been successfully built as a RuTier2 (Russian Tier2) distributed cluster.

The current JINR–LCG2 configuration comprises 251 computing nodes and 82 TB disk space. These resources are actively used in the Grid-infrastructure of experiments ALICE, ATLAS, CMS and LHCb. Table 3 gives a number of jobs fulfilled on the computing farm JINR–LCG2 by users of Virtual Organizations (VO) of ALICE, ATLAS, CMS, LHCb and other VO from June to December, 2007.

The users of ATLAS and CMS also can work at the CICC in a local mode, without using Grid for tasks debug, though applying the batch-system and corresponding specialized software installed in the AFS file system.

The Tier1 centres for RDIG are the following computer centres: FZK (Karlsruhe) — for ALICE, SARA (Amsterdam) — for ATLAS, Tier1s at CERN — for CMS (CERN–PROD) and LHCb. The quality of JINR communications with Tier1 nodes is under permanent observation. First test sessions of data transfer with FTS between JINR and Tier1 (FZK) took place in July–August 2007.

During 2007, JINR took part in all large-scale tests of the global computing infrastructure of CMS collaboration. The PhEDEx system was used for data transfer between CMS LCG sites. During the day the transfer rate reached 30 Mbps and 99% data were successfully transferred. At present, relevant CMSSW versions have been installed and checked-up with the help of a system of automatic job start (CMS Job Robot system) which has shown that 97% of 500 test jobs, started simultaneously at JINR–LCG2 site, were successfully completed. A complex testing of the JINR–LCG2 site during the year 2007 has resulted in its certification in the CMS collaboration as it fully corresponded to the collaboration's requirements.

A specialized server http://rocmon.jinr.ru:8080 was allocated to provide RDIG sites monitoring. The monitoring was performed according to the quantity of processors (total, operate, not operate, free, engaged), quantity of tasks (performed, in waiting), disk space (used, free), current network throughput and other numerous parameters.

Table 3

Month	alice	atlas	cms	lhcb	Other VO	Total
June	6643	2320	2303	6386	1773	19425
July	7411	4715	2930	924	9898	25878
August	18424	1198	4748	679	9858	34907
September	12172	1714	2683	1847	7258	25674
October	6177	1450	15843	185	10492	34167
November	18726	3029	12036	310	6471	40572
December	20888	1217	11686	153	6226	40170
In total	90441	15643	52249	10484	51976	220793

The further activities in the field of the Grid-technologies foresee: development of technologies of «gridification» of applications that allow adaptation of applied software packages to the Grid-environment; participation in international, national and regional projects on the development of Grid-technologies (WLCG, EGEE, OSG, NorduGrid, Dubna-Grid, etc.).

Information and Software Support. The modernization of CICC software and its installation on the 64-bit architecture required a full recompilation of programs from JINRLIB library. The object libraries of mathematical general-purpose programs have been 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 old object libraries for OS Scientific Linux 3 and Windows 9X/NT/2000/XP are also maintained and filled. The program libraries developed in other research centres (CPCLIB, CERNLIB) are also maintained.

JINRLIB program packages created by JINR specialists are renewed regularly. These programs serve a wide range of scientific tasks underway at JINR — from experimental data processing automation to low energy theoretical physics. Work is in progress on the project «Re-engineering Technology for Distributed Computing in a Local Area Network» [1]. A specialized WWW site provides an electronic access to the descriptions of the programs, compiled libraries and source texts.

In 2007, work on the regular actualization of the program environment and contents of the central information sites of LIT and JINR was in progress (http://www.jinr.ru, http://lit.jinr.ru, ftp://faxe.jinr.ru, http://faxe.jinr.ru). The electronic documents related to scientific and administrative activities of LIT (information on CICC operation, sectors, web pages devoted to publications of LIT staff members, etc.) and the Institute (upon presentation of the scientific-organization department — information about basic facilities, sessions of the JINR Scientific Council, agendas and reports to the Program Advisory Committees, etc.) were created and stored as well as access to them via the Internet. Work was progressing on the development, creation and support of information websites of various conferences, workshops, symposia organized by JINR laboratories (at their requests, on central information servers): a) QPC2007 (4th International workshop «Quantum Physics and Communications»), b) RCDL'2008 — «Electronic Libraries: Perspective Methods and Technologies, Electronic Collections», c) support of sites in a hosting mode (http://www.jinr.ru/esna2007; http://www.jinr.ru/sarantsev07; http://www.jinr.ru/pontecorvo07).

A prototype of the information system developed in LIT JINR for the internal paperless document circulation (http://lit.jinr.ru/DoctorDoc/) has been created.

In cooperation with JINR STD ASM was provided support and modernization of administrative databases.

MATHEMATICAL SUPPORT OF EXPERIMENTAL AND THEORETICAL STUDIES

The main objective of this direction is to provide mathematical, algorithmic and software support of experimental and theoretical studies underway at JINR. The results obtained in 2007 were reported in 130 publications in the leading scientific journals worldwide and in conference proceedings. More than 50 reports were presented at international conferences.

Software Complexes for Experimental Data Processing. This direction includes creation of large software complexes of general use and program complexes for specific experiments. The creation in LIT of a specialized physical server HEPWEB can serve as an example (http://hepweb.jinr.ru). The aim of the project is to provide physicists with informational and mathematical support of their investigations with use of WEB-access to LIT computing resources for Monte-Carlo simulations. Another aim is to test Monte-Carlo generators of physical processes for the LHC Computing Grid project. The web page is a user interface to simulation programs, it allows one to estimate the main properties of hadron–nucleus and nucleus–nucleus interactions (includes FRITIOF model, HIJING model, AMPT, CASCADE, UrQMD and tools for Glauber and Reggeon theories calculation). The server contains materials of comparing experimental data with calculations performed. The page can be useful for new experimental data analysis, or new experimental installations planning as well as for training young specialists.

A new Fitter version — a C++ program aimed to fit experimental data by a predetermined multi-parameter function and a package Gluplot for data visualization were introduced into the JINR Program Library [2].

In order to increase the efficiency of a local smoothing of surfaces, a bicubic model has been suggested where a biquadratic component is fixed by coordinates of reference points of the surface, a bicubic one remains free, and basic functions depend on parameters. Such an approach has allowed one to reduce more than twice the dimension of the matrix of normal equations, to increase essentially the speed and stability of computations. The algorithms constructed on the basis of the suggested model, are focused both on practical applications and on the development of more efficient global methods of approximation and smoothing of surfaces [3].

Mathematical Methods in Elementary Particle Physics and Relativistic Nuclear Physics. In frames of the CBM experiment (Compressed Byronic Matter, FAIR, GSI), the problem of electron/pion identification based on the measurements of energy losses in the TRD detector was studied. A possibility to solve such a problem by applying an artificial neural network [4] and with the help of nonparametric goodness-of-fit criterion ω_n^k [5] is investigated. It is shown that both approaches provide a good level of pion suppression and electron identification. It is shown that application of the ω_n^k criterion to the J/ψ reconstruction procedure provides a high-level suppression of a pion background and essentially improves a signal/background ratio.

Basing on a comparative study of methods for a circle fitting over measured points, a method, optimal from the accuracy viewpoint for estimating circle parameters, has been chosen. A robust algorithm has been developed. The program implementing this algorithm is used to estimate the parameters of the Cherenkov radiation rings obtained in the RICH (Ring Imaging Cherenkov) detector of the CBM experiment, and it is included in the CBM software framework [6].

In 2007, within the ATLAS experiment, in course of computational experiments with Monte-Carlo events for CTB04 setup, a new class of procedures based on Artificial Neural Networks (ANN) technique was developed for reconstruction of energy losses [7]. It has been shown that application of ANN procedures allows one to reach 40% reduction of the EDM reconstruction error compared to the conventional procedure (EDM $= C\sqrt{E_{LAr3}E_{HC1}}$) used in the ATLAS collaboration.

Studies were in progress within the SAD project. Monte-Carlo method is used to estimate production of secondary proton and neutron fluxes in different subcritical assemblies ($k_{\rm eff}$ in the range from 0.15 to 0.98) under irradiation with protons in the energy range from 660 MeV up to 2.0 GeV. Neutron and proton spectra emitted from the surface of these assemblies are calculated using the CASCADE and MCNP-X codes (Fig. 5). A scheme of the assembly under study is shown in Fig. 6 [8]. The assembly is built from the BN-350 MOX fuel elements, external lead reflector and concrete shield. The assembly is cooled with the flow of air. Estimated multiplication factor of the assembly is $k_{\rm eff} = 0.951$–0.974.

In frames of the collaboration with BLTP and Saratov State University [9], a software complex has been designed for computing the wave functions of a discrete and continuous spectrum of quantum systems by Kantorovich method. The efficiency and stability of the algorithm have been demonstrated with 2D exactly solvable quantum models. The software complex has been applied to computation of the wave functions of the discrete and continuous spectrum of a hydrogen atom in a magnetic field.

In cooperation with BLTP [10], research has been performed on the structure of the amplitude of $Z_1Z_2 \to l^+l^-Z_1Z_2$ process outside the Born approximation frames. A resummation of the perturbative series for the amplitude of the lepton pair production in the nucleus–nucleus collisions is performed on the basis of the Watson theorem and the hypothesis of the infrared stability. An explicit expression for this amplitude valid up to terms of the ninth order in fine structure constant is obtained.

Decay of regular static spherically symmetric solutions in the $SU(2)$ Yang–Mills-dilaton (YMd) system of equations has been studied self-consistently in a nonlinear regime. The considered regular YMd solutions are distinct local threshold configurations, separating blow-up and scattering solutions; the main unstable eigenmodes are only those responsible for the blow-up/scattering alternative. A question of applicability of the obtained results to the gravitation collapse problem for free-of-mass matter fields is discussed [11].

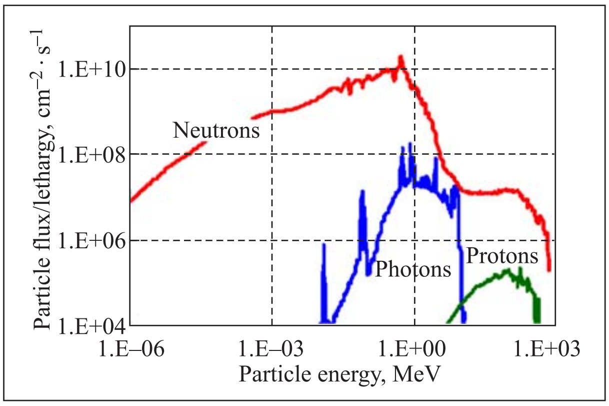

Fig. 5. Neutron, photon and proton fluxes emitted from the assembly under irradiation with 660 MeV protons

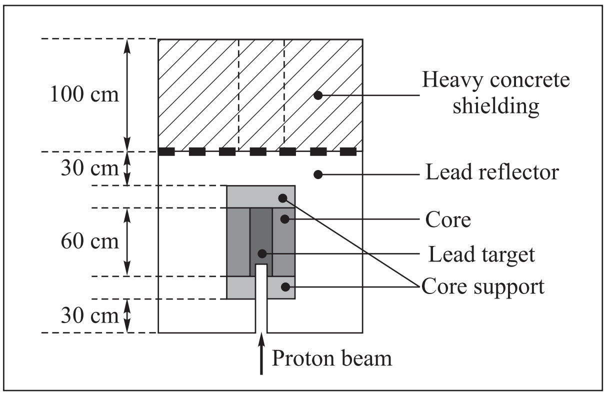

Fig. 6. General scheme of the assembly under investigation

Mathematical Methods in Nuclear Physics and Condensed Matter Physics. The Green function (GF) equation of motion technique for solving the effective two-band Hubbard model of high-T_c superconductivity in cuprates rests on the Hubbard operator (HO) algebra [12]. If to take into account the invariance to translations and spin reversal, the HO algebra results in invariance properties of several specific correlation functions. The use of these properties allows rigorous derivation and simplification of the expressions of the frequency matrix (FM) and of the generalized mean field approximation (GMFA) Green functions (GFs) of the model. For the normal singlet hopping and anomalous exchange pairing correlation functions which enter the FM and GMFA-GFs, the use of spectral representations allows the identification and elimination of exponentially small quantities. This procedure secures the reduction of the correlation order to GMFA-GF expressions.

Experimental data on the elastic scattering cross sections of the $^6\mathrm{He} + p$ reactions at energies $E = 25.2$, 41.6 and 71 MeV/n are analyzed in the framework of a microscopic optical potential. The real part of the optical potential was calculated with the help of a folding model. The imaginary part was calculated with Glauber–Sitenko microscopic theory of multiple scattering of the falling particle on nuclear nucleons. The influence of dependence of the nucleon–nucleon potential upon the density of the nuclear substance on the agreement of the calculations with experimental data as well as a role of spin-orbital interaction, nonlinearity of the microscopic optical potential and a role of its renumbering have been studied [13].

Some possibilities of a microscopic potential (including the bottom limit of its applicability on collision energy) have been studied to explain available experimental data on full cross sections of the reactions at the energy up to 100 MeV/n, and the models of distributing the density of the nuclear substance in nucleus ^{6}He known in the literature have been tested [14]. The existing experimental data on the total cross sections of the $^6\mathrm{He},^{6,7}\mathrm{Li} + ^{28}\mathrm{Si}$ reactions at energies $E = (5-50)$ A · MeV are demonstrated. The data on $^6\mathrm{He},^6\mathrm{Li}$ + ^{28}Si are analyzed in the framework of the microscopic optical potential with real and imaginary parts obtained with the help of the double-folding procedure and by using the current models of densities of the projectile nuclei. Comparisons are made of cross sections calculated within the microscopic double-folding Coulomb potential and when one applies the traditional Coulomb potential of the uniform charge distribution. The semi-microscopic potentials are constructed from the renormalized microscopic potentials and with an addition of their derivatives to take into account collective motion effects and to improve an agreement with experimental data.

Interactions between the dark solitons of the parametrically driven defocusing nonlinear Schroedinger equation with dissipation have been studied analytically and numerically. Two types of solitons were considered: the Bloch wall and the Neel wall [15].

Temperature effects have been studied in anisotropic material of highly-oriented pyrolitic graphite (HOPG) exposed to 253 MeV heavy ions ^{86}Kr and 710 MeV ^{209}Bi ions in frames of a nonlinear (i. e., with the account of temperature-dependent thermo-physical parameters) 3D thermal spike model [16]. Research of the temperature effects has been conducted in the model, when changing the coefficient of the electron–phonon interaction g. Basing on the performed calculations, one can explain qualitatively the experimental data about the presence of crater-type structures on the HOPG surface exposed to ^{209}Bi ions and their absence if irradiating by ^{86}Kr ions.

Computer Algebra and Quantum Computing. The methods on simulation of quantum computation [17] in the framework of circuit model were further developed in the form of a *Mathematica* package [18]. The package has a user-friendly interface to input an arbitrary quantum circuit. It contains the built-in database of one-, two- and three-qubit quantum gates that are widely used for implementation of quantum algorithms. Besides, the package exploits a linear algebra library of *Mathematica* to compute the unitary matrix determined by the input circuit. In addition, for a circuit constructed from the Toffoli and Hadamard gates and in accordance with the observation made in [17], for such a circuit its unitary matrix can be computed by counting the number of common solutions of the multivariate polynomial equations associated with the circuit, the package explicitly constructs this polynomial system [19]. After that it is possible to exploit the built-in Groebner basis module of *Mathematica* to count the number of solutions, and, thus, to find the circuit unitary matrix.

Improvement of methods, algorithms and programs for solving topical problems of physics by using Groebner bases is under study in [20] and [21]. New heuristically good selection strategies were discovered for non-multiplicative prolongations that is important to speed-up computation of Groebner bases by involutive methods, and computational efficiency of the new strategies was investigated. Due to their implementation into the specialized computer algebra system GINV this system became the fastest open source software in the world with respect to speed of computation of Groebner bases [20]. Some important algorithmization issues for the Dirac constraint formalism for degenerate dynamical systems with polynomial Lagrangians were studied [21]. As an important application, the full set of constrains was obtained and their classification in the first and second classes was done for the $SU(3)$ Yang–Mills light-cone mechanics.

Discrete dynamical systems and mesoscopic lattice models have been studied from the standpoint of their symmetry groups [22]. Universal specific features of behaviour of deterministic dynamic system associated with nontrivial symmetries of these systems were specified. Group nature of soliton-like moving structures analogous to the «spaceships» in cellular automata was revealed. Study of lattice models is also considerably simplified when their symmetry groups are taken into account. A program in C for group analysis of systems of both types has been developed. The program, in particular, constructs and investigates phase portraits of discrete dynamic systems modulo symmetry group and seeks dynamical systems possessing special features, such as, for example, reversibility. For mesoscopic lattice models, the program computes microcanonical distributions and looks for phase transitions.

An analytical numeric algorithm has been developed for computing coefficients of discrete two-dimensional elliptic equation on the given eigen-values and some symmetry conditions for basic eigen-functions [23].

INTERNATIONAL COOPERATION

Within participation of LIT specialists in projects WLCG, EGEE and ARDA in collaboration with Russian and foreign colleagues, the WLCG segment at JINR was developed and maintained as part of the global WLCG infrastructure. There were provided: participation in Service and Data Challenges for experiments CMS, ATLAS and ALICE; ALICE software support in 12 Russian WLCG sites; creation and development of the system of monitoring and accounting in the Russian WLCG/EGEE infrastructure; CMS Dashboard development [24]; FTS monitoring and testing (the FTS channels monitoring at CERN has been performed by JINR specialists since February 2007); MCDB development (simulated events database LCG): creation of a set of basic modules; web-interface development; provision of access to MCDB from CMSSW package (http://mcdb.cerb.ch) [25]. The testbed infrastructure for gLite 3.X environment has been designed on the basis of several local nodes at PNPI, INR, IHEP and JINR. 32 programs were developed and integrated into the automated system SAM (Service Ability Monitor) and are in regular use in EGEE for testing the functionality of VO administration (*voms-admin*) and 28 programs to check-up operation of user's command *voms-proxy-init* (proxy-certificate generation).

The JINR's participation in the projects WLCG and EGEE has resulted in a complete integration of the JINR's grid-site into the global WLCG/EGEE infrastructure, thus providing all the necessary hard-, software and organizational resources for participation of JINR specialists in experiments ALICE, ATLAS and CMS on LHC. Participation of the Institute in the WLCG project is based on the Memorandum of Understanding signed by Russia, JINR and CERN in September 2007.

In frames of Hulubei–Mescheryakov programme, a current status of the SIMFAP parallel computing cluster at IFIN-HH (Bucharest) has been investigated. The peak performance assessment and outputs of parallel computing case studies were done. They point to an effective and reliable operation of the open MPI version for high performance parallel computing implemented on the cluster. Comparison with the High-Performance Linpack benchmark outputs obtained on the new supercomputing system installed at LIT-JINR sheds light on the effective use of parallel computing resources [26].

In frames of the international cooperation with the University of Metz (France) [27], cross sections $(e, 3\text{–}1e)$ and $(e, 3e)$ for a double ionization of a helium atom and a hydrogen molecule and a thrice differential cross section (e, $2e$) for ionization of a nitrogen molecule at large transmitted energy were computed. The calculations explore the parametric two-center Coulomb functions of continuous spectrum constructed within first Born approximation. Comparison with the results of recent experiments has been performed that allowed one to reveal two-center interference effects.

CONFERENCES, WORKSHOPS

A traditional two-day Workshop on Computer Algebra was held in Dubna on May 24–25, 2007. It was the eleventh of the joint seminars on Computer Algebra conducted by JINR, the Faculty of Computing Mathematics and Cybernetics and SRINP of Moscow State University. The workshop attendees discussed algebraic methods for nonlinear polynomial and differential equations, symbolic-numeric methods, computer algebra algorithms and software packages, application to theoretical and mathematical physics.

On 10–17 September, Varna, Bulgaria, hosted the 21st International Symposium on Nuclear Electronics and Computing (NEC'2007). For the fourth time JINR organizes this forum in cooperation with the Institute of Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences (INRNE BAS) and CERN. Attending were more than 100 participants from 12 countries — Russia, Bulgaria, Switzerland, Great Britain, USA, Germany, Poland, Czech Republic, Romania, Vietnam, Ukraine and Georgia. 57 oral reports and 37 posters, among them 22 oral reports and 25 posters from JINR were submitted. The symposium program comprised the following sections: detector and nuclear electronics, trigger systems and data acquisition systems, automated management systems for experiments and accelerators, information and computing systems, application of network technologies for physical experiments, Grid and LHC computing as well as computer applications and new methods in scientific research. A detailed programme and presentations of the Symposium can be found at the NEC'2007 website http://nec2007.jinr.ru/programme.asp.

It should be noted that 20% symposium attendees were young people of 35 years old and younger, and they have made an important contribution to the symposium scientific programme with 13 oral reports and 4 poster presentations. Participation of young scientists and students from Russia, Romania and Georgia became possible due to the grants provided by the JINR and CERN Directorates.

On 15–19 October, LIT was the host of the 4th International Workshop «Quantum Physics and Communication». The purpose of the Workshop was to provide a compact and comprehensive overview of recent advances in quantum information theory and quantum computing, to discuss new experimental and theoretical results, to focus on mathematical and computing aspects of quantum information processing. It should be noted that the quantum methods of data processing are a new research field at the intersection of quantum physics and computing techniques. The presentations of the reports delivered by the workshop attendees are available on the workshop website at http://lit.jinr.ru/QPC2007/.

REFERENCES

1. *Sapozhnikov A. P., Sapozhnikov A. A., Sapozhnikova T. F.* // Proc. of the 6th Intern. Conf. «Large-Scale Scientific Computing», Sozopol, Bulgaria, June 5–9, 2007. LNCS 4818. Springer, 2007. P. 700–707.
2. *Soloviev A. G. et al.* // http://www.jinr.ru/programs/jinrlib/fitter/index.html
   Soloviev A. G. // http://www.jinr.ru/programs/jinrlib/gluplot/indexe.html
3. *Dikoussar N., Török Cs.* // Kybernetika. 2007. V. 43, No. 4. P. 533–546.
4. *Akishina E. P. et al.* JINR Commun. E10-2007-17. Dubna, 2007.
5. *Akishina E. P. et al.* // Part. Nucl., Lett. 2008. V. 5, No. 2(144). P. 202–218 (in Russian).
6. *Airiyan A. et al.* // Tver Univ. Herald. 2007. No. 17[45]. P. 15–26 (in Russian).
7. *Kulchitsky Yu., Tsiareshka P., Shigaev V.* // http://indico.cern.ch/conferenceDisplay.py?confId=27029
   Kulchitsky Yu., Tsiareshka P., Shigaev V. // http://indico.cern.ch/conferenceDisplay.py?confId=22213
8. *Polansky A. A., Sosnin A. N.* // The 20th Intern. Conf. on Transport Theory (ICTT-20), July 22–28, 2007. Obninsk, 2007. P. 212–213.
9. *Chuluunbaatar O. et al.* // Comp. Phys. Commun. 2007. V. 177. P. 649–675;
   Chuluunbaatar O. et al. // Proc. of SPIE. 2007. V. 6537. P. 653706-1-18;
   Chuluunbaatar O. et al. // Comp. Phys. Commun. 2007. doi:10.1016/j.cpc.2007.09.005;
   Chuluunbaatar O. et al. // J. Phys. A. 2007. V. 40. P. 11485–11524.
10. *Voskresenskaya O. O. et al.* // Part. Nucl., Lett. 2007. V. 4, No. 1(137). P. 36–41 (in Russian).
11. *Donets E. E., Hayryan E. A., Streltsova O. I.* // gr-qc/0711.3994v1 (submitted to Phys. Rev. D).
12. *Adam G., Adam C.* JINR Preprint E17-2007-83. Dubna, 2007; J. Phys A: Math. and Theor. (submitted).
13. *Lukyanov K. V. et al.* // nucl-th/0708.3586; Eur. Phys. J. A. 2007. V. 33. P. 389–400.
14. *Lukyanov K. V. et al.* // Bul. Rus. Acad. Sci. Phys. 2008. V. 72, No. 3. P. 381–385 (in press).

15. *Barashenkov I. V., Woodford S. R., Zemlyanaya E. V.* // Phys. Rev. E. 2007. V. 75. P. 026603.
16. *Amirkhanov I. V. et al.* JINR Preprint. P11-2007-106. Dubna, 2007 (in Russian); Surface (submitted).
17. *Gerdt V. P., Severyanov V. M.* // Part. Nucl., Lett. 2007. V. 4, No. 2. P. 225–230.
18. *Gerdt V. P., Kragler R., Prokopenya A. N.* // Computer Algebra Systems in Teaching and Research (CASTR-2007). Univ. of Podlasie, Scieldce, Poland, 2007. P. 135–144.
19. *Gerdt V. P., Kragler R., Prokopenya A.* // Computer Algebra and Differential Equations. Acta Academiae Aboensis. Ser. B. 2007. V. 67, No. 2. P. 28–38.
20. *Gerdt V. P., Blinkov Yu. A* // Programming and Comp. Software. 2007. V. 33, No. 3. P. 34–44 (in Russian).
21. *Gerdt V. P., Khvedelidze A. M., Palii Yu. G.* // Computer Algebra in Scientific Computing (CASC-2007). LNCS 4770. Berlin, 2007. P. 145–159.
22. *Kornyak V. V.* // Computer Algebra Systems in Teaching and Research (CASTR-2007). Univ. of Podlasie, Scieldce, Poland, 2007. P. 192–201;
Kornyak V. V. // Computer Algebra in Scientific Computing (CASC-2007). LNCS 4770. Berlin, 2007. P. 236–251;
Kornyak V. V. // Programming and Computer Software. 2007. V. 33, No. 2. P. 41–49;
Kornyak V. V. // Acta Academiae Aboensis. Ser. B. 2007. V. 67, No. 2. P. 155–167.
23. *Serdyukova S. I.* // JCM&MP. 2007. No. 2 (in Russian).
24. *Andreeva J. et al.* // J. Phys.: Conf. Ser. CHEP'2007 Proc. (in press).
25. *Belov S. et al.* // Proc. of ACAT-07 Conf., Amsterdam, Proc. of Sci., PoS(ACAT). 2007. 030.
26. *Adam Gh. et al.* // Rom. J. Phys. 2007 (submitted).
27. *Naja A. et al.* // J. Phys. B. 2007. V. 40. P. 3775–3783;
Naja A. et al. // J. Phys. B. 2008. V. 41. P. 025204-1-7.