

558/01



JOINT INSTITUTE FOR NUCLEAR RESEARCH

A

2000-310

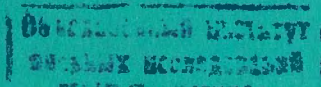
I.V.Puzynin, T.A.Strizh

LABORATORY OF INFORMATION TECHNOLOGIES

**REPORT ON RESEARCH ACTIVITIES
IN 2000**

Report to the 89th Session
of the JINR Scientific Council
January 18–19, 2001

Dubna 2000



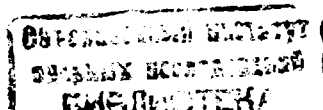
I.V.Puzynin, T.A.Strizh

LABORATORY OF INFORMATION TECHNOLOGIES

**REPORT ON RESEARCH ACTIVITIES
IN 2000**

Report to the 89th Session
of the JINR Scientific Council
January 18–19, 2001

Dubna 2000



The main tasks of the Laboratory of Information Technologies (LIT) of JINR were formulated at the 88th session of the JINR Scientific Council in frames of reorganization of the Laboratory of Computing Techniques and Automation (LCTA) into the Laboratory of Information Technologies (LIT):

"The main LIT tasks will be the maintenance of operation and the development of the computing and networking infrastructure."

The computing and networking infrastructure (JINR CoNet) as a JINR BASIC FACILITY includes:

1. Telecommunications Services and Channels (External Networking);
2. Local Area Network (LAN) & High Performance Computing Centre (HPCC);
3. User support of standard software and development of Computer Physics.

To support these activities, a new structure of the Laboratory has been worked out. The main directions in the activities were headed by the LIT deputy directors. The new structure for the chief engineer services was worked out including the JINR LAN technical support.

In 2000, the scientific programme of the Laboratory of Information Technologies covered three first-priority topics of the "Topical Plan for JINR Research and International Cooperation in 2000". The Laboratory staff participated in 9 more topics of the Topical Plan in collaboration with other JINR Laboratories on the project level and in other 16 topics on the level of co-operation. The main aim of the Laboratory is the performance of research in the field of "Development and Maintenance of the Networking, Information and Computing Infrastructure at JINR (Project CoNet)" (topic 09-6-1019-96/2001, headed by R.Pose and V.V.Korenkov) and on "Nonlinear Problems of Computing and Mathematical Physics: Algorithms, Investigation and Software" (topic 6-0996-93/2000, headed by I.V.Puzynin). Main results of the investigations performed within this topic have been published in the well-known journals, proceedings of the scientific conferences and preprints. About 100 scientific publications, reports at conferences and JINR preprints were published and presented in the year 2000.

The top-level investigations performed at the LCTA/LIT Computational Physics Department allowed organizing the Second International conference "Modern Trends in Computational Physics" in 2000. The scientific programme of the Conference covered various fields of research in computational methods and tools for simulation and analysis of physical processes, mathematical modelling, numerical methods and algorithms, computer algebra methods, software for physics experiments, etc. The conference enabled one for the first time of holding conferences at JINR to provide real-time access to the plenary meetings through the Internet. The Proceedings of the First Conference was published in a

special issue of the European Physics Society journal "Computer Physics Communication" (*CPC*, 126(2000)).

In the year 2000, a number of scientific projects by LIT staff members have received grants of the INTAS Foundation, the Commission of the European Community in the framework of the EU-Russia collaboration, and 12 projects by the Russian Foundation for Basic Research.

Telecommunication systems

Since 1999 JINR has used fully the 2Mb/s channel to Moscow M9-IX with a granted capacity of 512 kb/s for JINR in international networks. That means 1,5Mb/s for Russian networks integrated in RNet and other 512 kb/s using TELEGLOBE as a main partner of RNet. For this purpose, an agreement has been signed with ROSNIROS (the Russian Institute for Public Networks). Since September 2000, JINR has had about 1 MB/s in the external channel RNet, but in the common traffic.

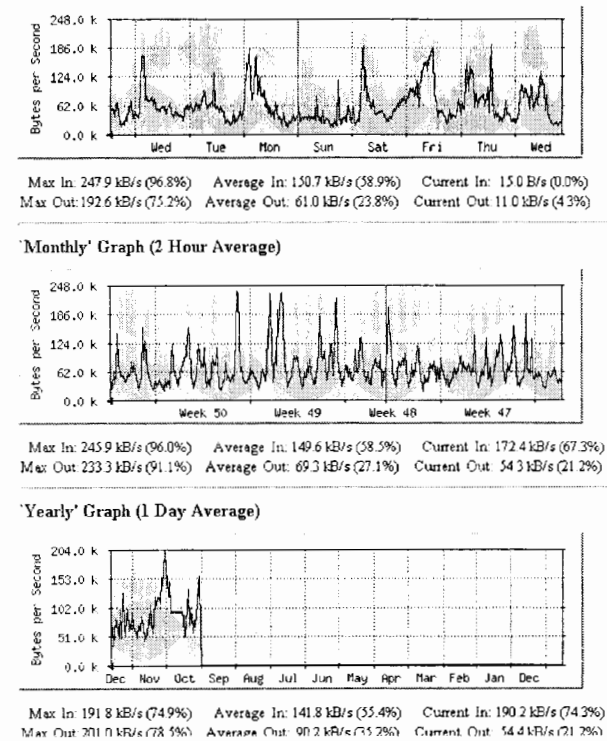


Fig. 1. Statistics of the load of the link to Moscow.

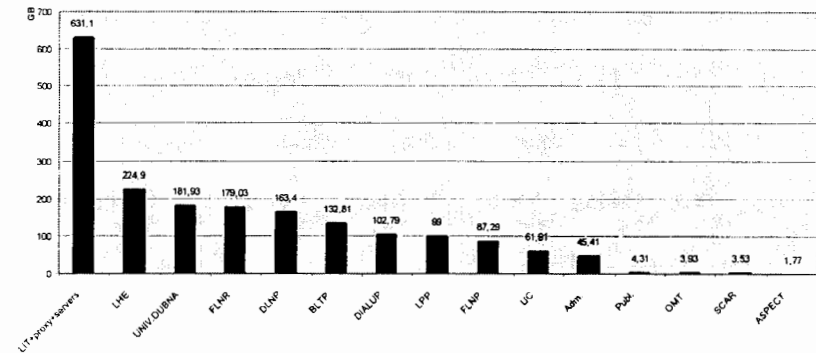
The satellite computer communication link RADIO/MSU-DESY was used for co-operation with the nuclear physics centres CERN, DESY, etc. in frames of the RUHEP community.

The channel of the CONTACT-DEMOS company was utilized as BACKUP for the reliable operation of the JINR's network. 256 kb/s at 5% load has been agreed.

However, such a throughput of the channel is inadequate to satisfy the JINR's needs. Fig.1 shows the peak load (grey colour) of the link to Moscow at daytime in October - December 2000.

Fig.2 shows the incoming JINR traffic from 2000.03.06 to 2000.11.12 (total 1.88 TB) distribution among the JINR divisions. The University of Dubna (UNIV-DUBNA) and the modem pool (DIALUP) take a noticeable share in the common traffic.

Fig.2 Incoming JINR traffic from 2000.03.06 to 2000.11.12 (total 1.88 TB)



The JINR Top20 local hosts on traffic usage are presented on fig.3.

JINR Top 20 local hosts
Total bytes : 1.88 TB
Total daily average : 7.65 GB
Average daily loading : 742.83 KB/s

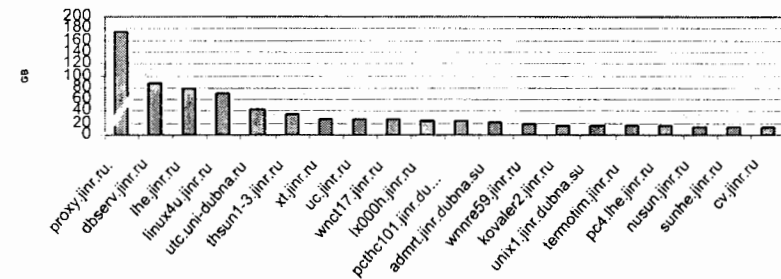


Fig.3. The JINR Top20 local hosts on traffic usage.

The perspectives of the development for the JINR external telecommunications were discussed at a workshop «Strategy for the development of the JINR external computer communication links» in June, 2000. The proceedings of the workshop and the projects presented at the workshop are published at the webpage http://noc.jinr.ru/LCTA/E_Publications/Workshop/.

JINR Local Area Network

The JINR LAN continued operating in 2000.

However, the increase in the network load resulting from the growing number of the elements connected to the network (at present the IP addresses database contains 3105 registered network elements) and from breaking down part of the equipment of the ATM BackBone has set the task of re-organizing the JINR LAN and changing to modern technologies. Projects on modernization of the network topology and on selection of an adequate technology of its design are in development stage now. Fig.4 shows a modern JINR LAN topology.

The JINR modem pool works round the year for JINR staff. The chart on Fig.5 shows the statistics of the modem pool used by various JINR divisions.

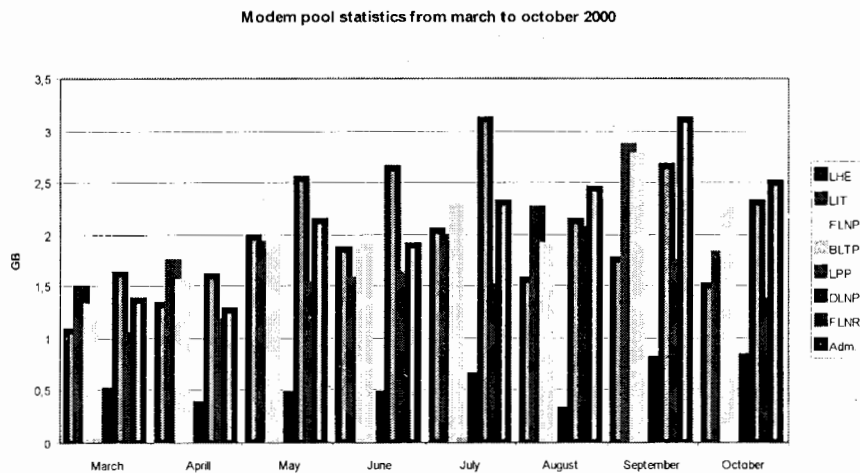


Fig.5. The modem pool used by various JINR divisions.

Systematic work on the LAN management was performed by the Network Operation Centre (<http://noc.jinr.ru>). The rules for users of JINR Computing & Networking Infrastructure have been worked out and approved by JINR Directorate.

Computing service

More than one thousand staff members of JINR and other research centres are the HPCC users. JINR HPCC is one of the five largest Russian centres. It actively co-operates with other leading centres - Intergovernmental Supercomputer Centre, Institute of high-performance computations and data bases (St.Petersburg). In collaboration with the leading nuclear physics centres of Russia, HPCC JINR participates in creating the Russian Regional Center for LHC Data Handling (RRC-LHC).

JINR High Performance Computing Centre (HPCC) main components.

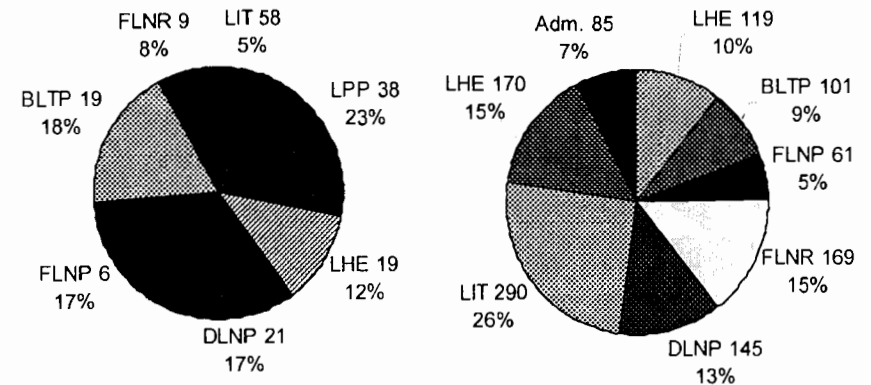
	Peak performance MFLOPS
HP Exemplar S-Class (SPP -2000)	5760
Convex C3840	960
APE100	1600
PCFarm	9200

Total: 17520

ATL 2640 Integrated Library System

Library Capacity	10.56 TB
Cartridge Capacity	20/40 GB
Drive Transfer Rate	1.5MB/sec.
Library Throughput	16.2 GB/hr.

Fig.6 shows the relative intensity of the SPP200 and the CONVEX-220 computing servers used by the Institute laboratories during 11 months.



Statistics on SPP-2000
58 000 hours of useful CPU-time.
Percentage of CPU-time use: 161 user,
97% average CPU-load.

CONVEX-220.
Number of users (mail-service, www-service).
Total number of users: 1140

Fig.6. The relative intensity of the SPP200 and the CONVEX-220 computing servers used by the Institute laboratories.

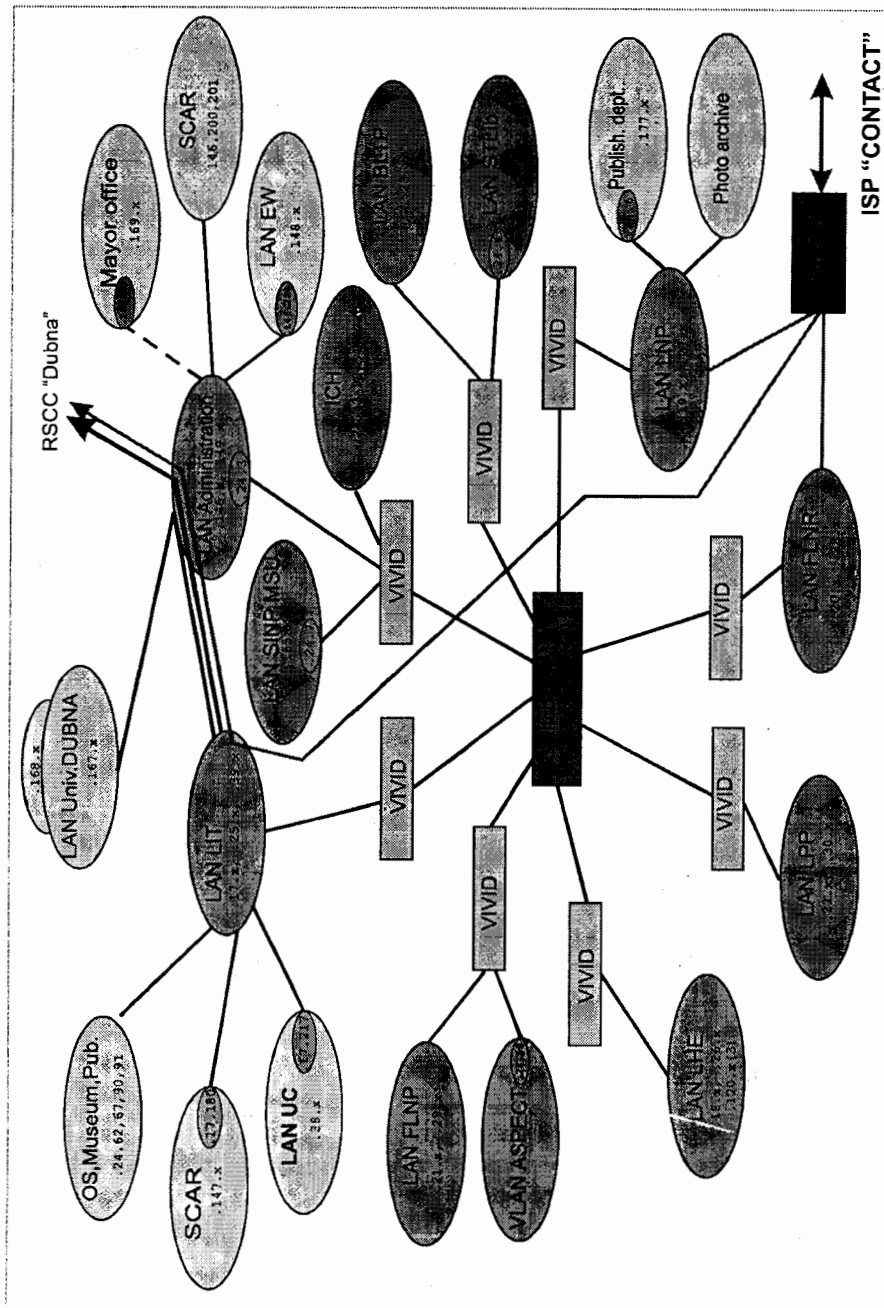


Fig.4 JINR Network 159.93.x.x

Software development

Information and computer support of the JINR participation in the experiments at CERN, DESY and BNL was in progress in 2000. The technology of designing object-oriented applications and databases (GEANT4, Objectivity/DB, ROOT) was under study. A new version of the LHC++ Library has been installed on the LIT/JINR computing PC farm.

LHC Computing Support

For the last few years JINR has been involved in three projects on LHC: ALICE, ATLAS and CMS. The issue of continuation of the co-operation of Russian institutes in the LHC projects after starting up the accelerator (in the year of 2005) and the experimental installations is connected directly with the necessity of providing a way for processing and analysis of experimental information directly in Russia. For this reason, by the end of 1999 a joint project "Russian Regional Center for LHC Data Handling" (RRC-LHC) was worked out. JINR and 9 leading Russian physics institutes participating in LHC are involved in the project.

For the period of less than a year, LHC-oriented PC farms have been created in ITEP, IHEP, SINP MSU, LIT and LNP of JINR. The program environment of these farms is completely unified and corresponds to the current state of the specialized software used at CERN. Thus, a beginning in the improvement of the prototype of the Russian regional center has been made.

In September-October, a run of a mass production of physical events was started at a PC-farm LIT JINR (16 processor units of 500 MHz) for the CMS high level trigger. The volumes of simulated data up to 20 GB are generated at the LIT PCfarm within a day. The data production is performed with the use of the pythia (v.6136) program and CMSIM (v.120), a program for simulation and reconstruction of events for the CMS experiment; the data are written in a zebra-format (fz) in blocks of an order of 1 GB - approximately 500 events in a file. The data obtained will be transferred to CERN for inclusion into the object-oriented database (Objectivity/DB) that will be used for the definition of the Basic Units of Information, optimization of algorithms of the trigger and event reconstruction. The availability of the mass memory system at JINR HPCC provides a way of testing various models of work with enormous data volumes as well as improving the technology of a common use of the mass memory together with Moscow institutes.

Investigations for paralleling computations

A 32-processor APE100 complex of the 2x2x8 configuration has been installed at HPCC of JINR this year. The project APE has been worked out and is being developed by a group of Italian physicists - theorists specializing in QCD. Members of the LIT group made central contributions in the present reworking of the TAO compiler kernel, such that the performance on APEmille

can be improved. This rework already takes into account the architecture specific modifications necessary for porting the compiler to apeNEXT. This development has to be completed in order to obtain a stable prototype of a stand-alone TAO-compiler for apeNEXT and in order to allow the combination of the TAO compiler with a C compiler.

Maintenance of the JINR Program Library

New documents have been prepared and introduced in WWW. They include realization at JINR of electronic access to the texts of the program library CPCLIB (Belfast, Northern Ireland) and the Elsevier Publishing House (Amsterdam) for the readers of the CPC (Computer Physics Communications) journal; maintenance of the NAG Library; maintenance of CERNLIB on the JINR computer platforms; filling the JINRLIB with the new codes was in progress.

DATABASE and WWW SERVICE

A systematic supplement and maintenance of the earlier constructed databases and information systems continued taking into account the users' needs. Among these are:

- Information system «JINR Topical Plan for Research» (<http://dbserv.jinr.ru/~deadhead/tp/>);
- System for accounting and statistics of operating the JINR basic facilities (<http://wnct132.jinr.ru/basic-fac/>);
- Publications registration server (<http://wnct132.jinr.ru/student/marina/>). The client - server system with an interface in the «Internet - Intranet» environment allows the users to register data on their publications;
- Information system IPDB - a web-interface of the JINR IP addresses database;
- Information system «Consolidated financial report of the JINR subdivisions» for the JINR Accounts Department;
- Information system for the interactive monitoring of the installation and taking data of the experiment COMBAS (http://noc.jinr.ru/LCTA/E_Publications/A-D_Presentation_files/frame.htm);
- According to the plan and taking into account the requests of the JINR Board, the development of soft- and hardware tools has been carried out to provide work with administrative databases;
- Digitizing of graphics at users' requests, preparation of bibliographic data on HEP for the PPDS database(<http://www.jinr.dubna.su/~diginfo/>).

A number of issues has been solved in the field of information management, namely:

- access to the international data bases and information systems via the Internet;
- development and maintenance of the main information centre established for organizations of applied nuclear physics and fundamental properties of matter (project BAPHYS). A program Htdig has been started up. It allows a quick key word search for documents at the servers of the BAPHYS environment. This service (<http://dbserv.jinr.ru:8008/htdig/baphys.html>) provides a search within 14 servers;
- creation of information retrieval systems "Java Station" based on applying the CORBA standard, WWW, languages of Java and C++ type , HTML, XML, MathML, VML (<http://dbserv.jinr.ru/js/>).

One of the most important activities was the development of the system of WWW/FTP servers of the Institute's subdivisions and the maintenance of the main WWW/FTP Server of JINR. In order to maintain and develop a specialized WWW/FTP server FAXE (<http://faxe.jinr.ru> and <ftp://faxe.jinr.ru>) with program products for the JINR users, its hard- and software facilities have been modernized. Fig.7 gives data on the statistics of using the WWW/FTP server FAXE.

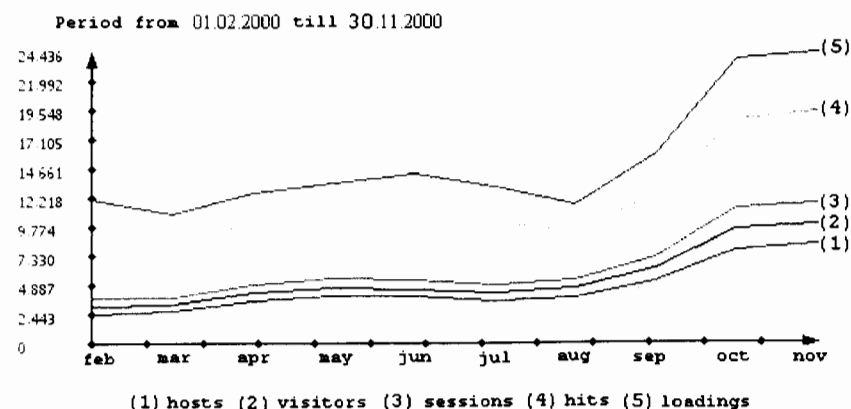


Fig.7. Statistics of using the server FAXE.

Among the activities related to the main JINR and LIT servers (<http://www.jinr.ru>, <http://jicom.jinr.ru/LCTA>), the following work should be noted: actualization of the divisions in accord with the main scientific results and the programs of JINR activities; information on conferences, schools and workshops held at JINR; News; updating the presentation about JINR and Dubna.

The XML (eXtensible Mark-up Language) technology has been studied. It is a new industrial standard that specifies the architecture of the Internet program-

ming tools of the next generation (*Galaktionov V.V., JINR Comm., P10-2000-44, Dubna, 2000*).

A converter `xcvt` has been developed in the Java language for processing XML documents. The program comprises style tables for transforming XML documents into HTML and LaTeX. A practical investigation of the Internet applications designed under the aegis of the W3C consortium and applied in WWW has been undertaken: Mathematical Mark-up Language, Vector Mark-up Language, and XHTML. These investigations can be effectively applied to

- visualization of mathematical formulas by using MathML and Amaya in combination with the package of analytical computations «Mathematica»;
- plot (diagram) construction directly in a Web-site by using the VML tools in the standard browser MSIE5.0.

A program WDK (Web Development Kit) has been designed in the Java language as an instrumental package for designers of the Internet applications in languages HTML, JavaScript, Java, XML.

Software for data visualization

Scientific visualization is an effective tool for deep insight and analysis of the object or process under investigation. Real time visualization allows one to reduce huge arrays of multidimensional data, which are the results of measurements or simulation, into a visual picture and therefore essentially enhances the effectiveness of investigations. LIT supports and utilizes several advanced visualization systems. Two the most powerful of them, the so called modular visualization systems, are ConvexAVS and Iris Explorer.

Some investigations are performed in the field of development and maintenance of the special codes for data visualization. For example, the PICASSO code was developed for visualization and interactive analysis of the results obtained by the GEANT-DIRAC simulation program. It is needed for debugging the program and investigation of processes in the DIRAC set-up (*P.Zrelov, to be publish.*). Another example is the "Juno" program (Fig.8). "Juno" is a tool for handling, conversion and statistical analysis of large experimental data bulks. It has unique features enabling a non-programmer user perform complex manipulations on data, build one- and two-dimensional statistical distributions, accomplish rare events recognition by applying filters and additional criteria. "Juno" needs no special settings. It is implemented in Visual C++ environment and runs under Windows 9X/NT. The program is used to handle data gained at experimental installations for heavy ions physics research (*V.Krylov to by published*).

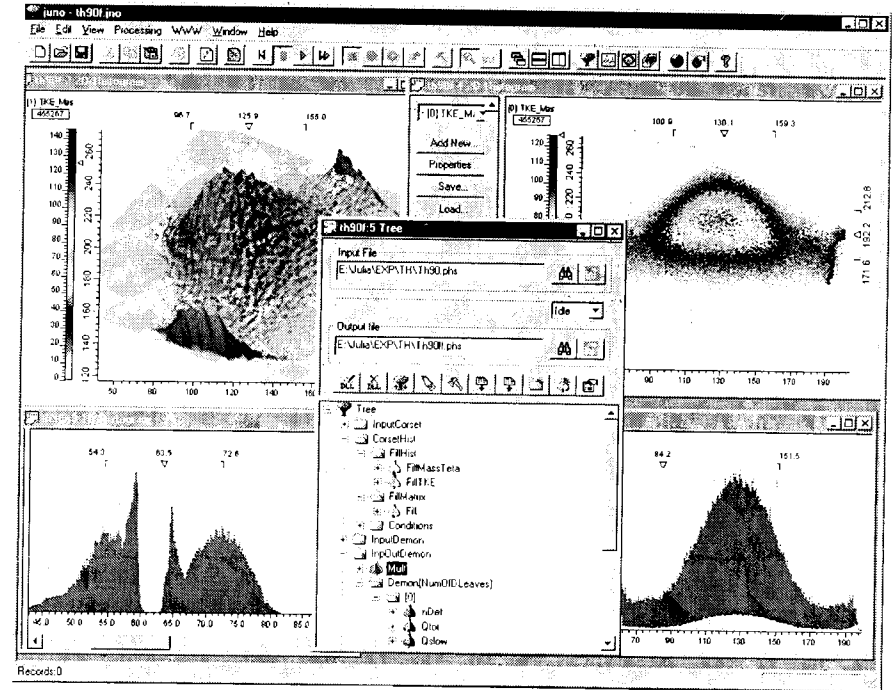


Fig.8. "Juno" Application Screenshot.

Computational Physics

Main tasks for Computer Physics at JINR are:

- Design of applied software and information maintenance systems to study mathematical models in theoretical and experimental physics using distributed computing systems, special processors, computer graphics, and integrating analytical, numerical and graphic methods in the modern programming techniques.
- Installation of a computer-aided base of methods, algorithms and programs.
- User support for the effective functioning of the JINR High Performance Computer Centre.

Mathematical modeling for experimental investigations

Properties of the experimental facility, a sub-critical assembly in Dubna (SAD) driven with the existing 660 MeV JINR protons accelerator have been investigated by using the particle transport codes: LCS, MCNP4B/DLC189, CASCADE (*Polanski A., Acta Phys. Polonica Vol. B11, No.1, p. 95, 2000, Barashenkov V.S. et al., JINR, P2-2000-131, A.N.Sissakian, I.V.Puzynin, A.Polanski to be publish.*). The assembly consists of a central cylindrical lead target surrounded

by a mixed-oxide (MOX) fuel ($\text{PuO}_2 + \text{UO}_2$) and a lead reflector (Fig.9). A dependence of the energetic gain on the proton energy, the neutron multiplication coefficient, and the neutron energetic spectra has been calculated.

The calculations show that for the subcritical assembly with a mixed-

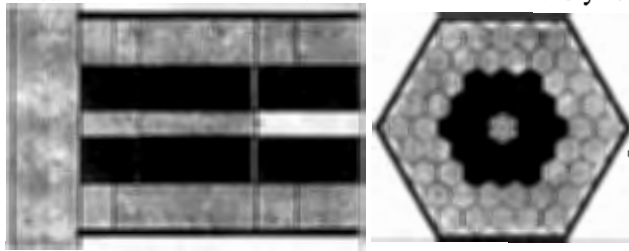


Fig.9. Sub-critical assembly in Dubna .

oxide (MOX) BOR-60 fuel (29% PuO_2 +71% UO_2) the multiplication coefficient k_{eff} is equal to 0.947, the energetic gain is equal to 30, and the neutron flux density is $10^{12} \text{ cm}^{-2} \text{ s}^{-1}$.

In frames of the project SAD, a first stage of the experimental investigation was carried out at LNP phasotron. The main object of the experiment was to study the differential characteristics of the secondary radiation field around the thick lead target irradiated by protons. Such experimental data are needed for verification of the calculations of the internuclear cascade of secondary particles generated by primary protons within the target. Fig.10 demonstrates the com-

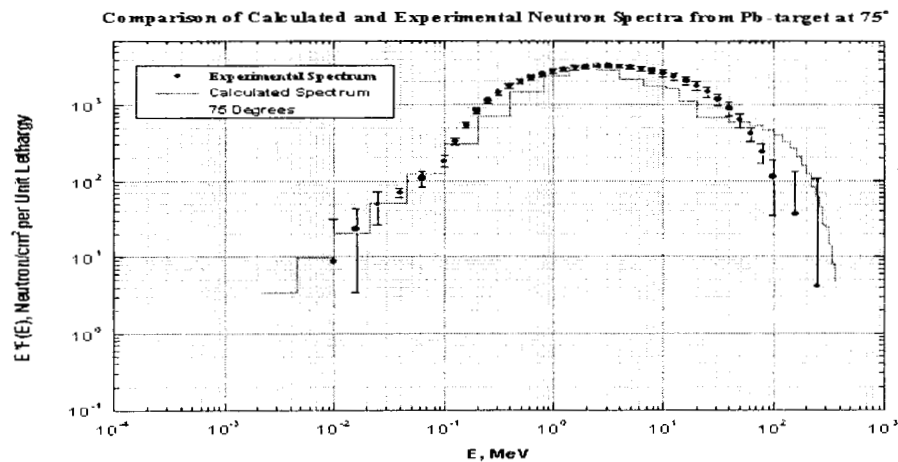


Fig.10. Comparison of the calculated and experimental neutron spectra from Pb-target at 75° .

parison of the calculated and experimental neutron spectra from Pb-target at 75° (Bamblevski V.P., Krylov A.R., Polanski A. et al. *Subm to NIM*).

One of the important problems of particle physics is the question of existence of abnormal - narrow multiquark states predicted in a series of theoretical studies. An experimental solution to the question about the existence of exotic hadrons and study of their internal properties and the character of the processes with their formation are of particular importance for obtaining basic ideas about the nature of hadron matter. The analysis of events was performed at LIT on the basis of experimental data with a two-meter hydrogen bubble chamber CERN in π^-p - interactions at 16 GeV/c. The width of the structure is comparable with the experimental resolution (Karnaukhov V.M., Coca C., Moroz V.I. - *YAF*, 2000, v.63, p.652). When analyzing the structure $K(1630) \rightarrow K^0_s \pi^+ \pi^-$, kinematic features of its formation and decay were found which distinguish the group of events from the structure's interval and other intervals of the mass spectrum. The probability of a casual manifestation of these features is less 10^{-7} . Conclusion has been made about the observation of the physical effect. The results have been accepted by the Particle Data Group for the Review of Particle Physics (*The European Physical Journal C*, v.15, num.1-4, 2000, p.536).

Methods and software for complex physics system calculations

In collaboration with the Computational Science Division, Advanced Computing Center of the Institute of Physical and Chemical Research (RIKEN), Japan, research on the molecular dynamics simulation of clusters-beam-surface impact processes for metallic phases was performed. An optimised version of the DL_POLY molecular dynamics simulation code (K.Kholmurodov, W.Smith, K.Yasuoka, and T.Ebisuzaki, *Comput. Phys. Commun.* 125, pp.167-192 (2000)), has been used. The interaction of energetic clusters of atoms with solid surfaces is investigated with the use of the Finnis-Sinclair many-body potential. The characteristics of the collision range from a soft landing ($< 0.1 \text{ eV/atom}$) up to higher impact energies ($> 1 \text{ eV/atom}$). The penetration of the cluster into the solid substrate results in such dynamical processes as a plastic deformation of the material and shock waves. Shock waves or thermo-elastic effects generated in materials are the essential factors for the analysis of new nontrivial structures on the surface and may be used to explain the structural-phase changes of the surface treated. Modification of the surface exposed to high energy cluster-beams, is studied by monitoring the molecular dynamics configurations of the system in real time and defining the critical impact energies, necessary to produce implantation (Fig.11) (I.V.Pyzynin, K.Kholmurodov, K.Yasuoka, T.Ebisuzaki, *JINR E11-2000-228, subm. to Intern. Conf. "Modern Trends in Computational Physics", Dubna, 24-29 July 2000*).

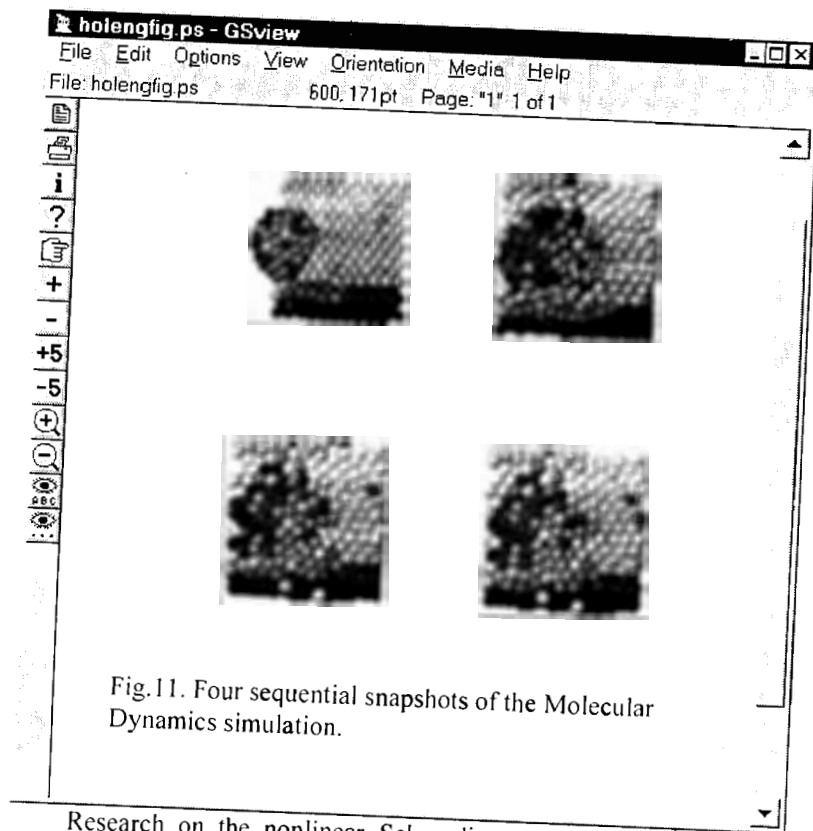


Fig. 11. Four sequential snapshots of the Molecular Dynamics simulation.

Research on the nonlinear Schroedinger equation was performed in collaboration with the University of Capetown (SA). It has shown that the parametrically driven nonlinear Schroedinger equation has a wide class of travelling soliton solutions, some of which are stable. For small driving strengths stable nonpropagating and moving solitons co-exist while strongly forced solitons can only be stable when moving sufficiently fast (*Barashenkov I.V. et al. JINR E17-2000-147, subm. to Phys.Rev.E*).

A mathematical model of the evolution of the thermoelastic momentum arising in metal exposed to an ion source is investigated. On the basis of the numerical calculation, a relation between the thermoelastic wave form and the form and location of the source as well as a condition of extension and putting out of the thermoelastic waves were studied. A temperature influence on the velocity of the thermoelastic waves was established (*I.V. Amirkhanov, E.V. Zemlyanaya, I.V. Puzynin, T.P. Puzynina, I. Sarhadov JINR P11-2000-263*).

Elastic spinless charge particle scattering on nuclei has been considered by using the strong absorption model put forward by Ericson for the S-matrix in the angular momentum representation. The derived uniform asymptotics for the

scattering amplitude offers a fresh sight at the origin of diffractive patterns in the elastic heavy-ion angular distributions. Special attention has been paid to the Coulomb-nuclear interference (particularly, the refractive phenomena) for the scattering inside the classically - allowed region (the "illuminated" region) and the classically - forbidden region (the "shadow" region). Unlike the existing analytical results, the obtained solutions of the diffraction problem give no reasons for drawing any deep parallels neither with the Fresnel diffraction in optics nor with the rainbow scattering in classical mechanics. Qualitative conclusions made with the aid of these solutions have been confirmed by numerical calculations (*Shebeko A.V., Zemlyanaya E.V. - JINR preprint P4-2000-115, Dubna, 2000. Subm. to the journal of "Nuclear Physics"*).

An effective algorithm for calculation of the wavefunctions of the continuous spectrum is proposed. For solving this problem, a finite-differential scheme of 4th-order and the continuous analog of Newton method are applied. The wavefunctions of the continuous spectrum of the two-center problem of positive molecular ion of hydrogen together with the phase shifts and with matrix elements between the continuous and discrete spectrum were calculated. The absolute accuracy of the calculated phase shift is order 10^{-6} for the electron momentum $k \geq 1$ and order 10^{-4} for $k \sim 0.1$ (*Pavlov D.V., Puzynin I.V. et al., JINR, E11-2000-185*).

Software for computer modelling of relativistic heavy ion collisions in the framework of the fluid-dynamic model for various equations of states was developed. The mathematical methods include a PIC-method (Particle-in-Cell) for modelling of nuclear matter moving, Newton and other iteration methods for solving the equation of state and numerical integration methods for calculation of observables. The Fortran and C++ codes were used for computation and IDL (Interface Definition Language) for visualization of computation results.

The development of the elasto-dynamic method in the theory of nuclear matter and its application to nuclear fission physics and neutron stars astrophysics was in progress. The model constructed predicts a two-mode character of fission: a spheroidal mode (S-mode) and a torsion one (T-mode). It should be noted that the barriers of nuclei fission for the T-mode lay higher than for the S-mode. Since the T-mode is characterized by a compact fission configuration, one can expect that the total kinetic energy (TKE) of the flying apart fragments will be higher than TKE for the S-mode. Data on such a TKE behaviour have been received in experiments on uranium isotopes fission induced by fast 8-10 MeV neutrons. A comparison of the fission barriers calculated in the elastodynamical model (S-mode and T-mode) with the experimental data allow one to conclude that the rotating mechanism of fission covers well the region of fission of middle nuclei (with the mass numbers of $170 < A < 210$) (*Bastrukov S., Papoyan V., Podgainy D., Weber F. Nucl. Phys. B 80 (2000) p.242; Bastrukov S.I. and Lai P.Y.: Physica Scripta, 61, No 3 (2000) p.369; Bastrukov S., Yang J., Podgainy D., Streltsova O. in "Hot Points in Astrophysics", Dubna 2000*).

A proof has been complete of the re-parametrized invariance (i.e. the invariance with respect of replacement of coordinates) of the Feynman integral in paths (of a conversion amplitude - in quantum mechanics, a partial function - in statistical mechanics, a generating function - in the field theory) in a functional approach (i.e. without using a finitely multiple approximation) on the perturbation theory in 2 loops started in 1999. All the problems related to the determining of the integrating measure and to the existence of the contraterms arising at a quantum level have been completely solved (*H. Kleinert and A. Chervyakov Phys. Lett. B 477, 373 (2000); Phys. Lett. A 269, 63 (2000); Phys. Lett. A 273, 1 (2000); Europhys. Lett. (2000), FU-Berlin preprint 2000 (quant-ph/0002067)*). The main application of the investigations consists in the fact that their result allows one to apply a standard method of the perturbation theory for a functional integral to the problems with (topologically) nontrivial boundary conditions.

Modern computational tools in experimental data processing

In frames of software development for the HERA-B Outer tracker (OTR) a new fast seeding algorithm for the tracking program RANGER was developed on the basis of Radon-Hough transform method. It was implemented as a C++ program. An algorithm of the very fast robust fit of a circle arc to drift radia in XoZ plane of Magnet Chamber was developed, implemented and tested on real data of MC superlayers.

A multifractal analysis of atomic Force Microscope (AFM) images of Nb thin film surfaces has been performed. The perspective of new mechanism of order parameter suppression on superconductor-vacuum boundary is proposed. (*Altaisky M.V. et al. Particles and Nuclei, Letters No.2[99]-2000*).

Physics fields and particles transport calculations

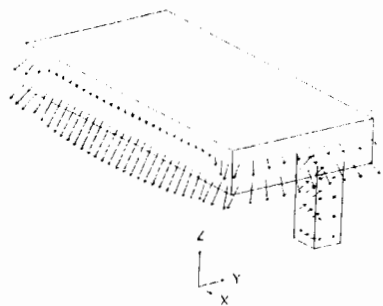


Fig.12. 3D calculations of forces in winding, in poles, and in polarization tips for ITEP project with polarized target.

In frames of the engineering work within the ALICE experiment (CERN), three-dimensional calculations were performed for the magnetic system comprising a 3L magnet, a muonic filter and a dipole magnet. The results of the computations have been reported at the CERN expert council. 3-dimensional calculations of the electric field for the NA45 experiment (CERN) also were performed. The results of the computations have been reported at a meeting of the NA45 collaboration in Darmstadt. Fig. 12 shows 3D calculations

of forces in winding, in poles, and in polarization tips for ITEP project with polarized target.

Mathematical processing of experimental data in particle physics

A synthesis of soft- and hardware platforms has been realized for modelling and processing the data taken from the particle physics experiments. One of the basic properties of the local cluster - the process of its reconfiguration and scaling - allows one to move aside the state of their moral aging which is one of the main disadvantages of the alternative approaches. The local cluster RISC is applied as an instrumental and, what of particular importance, effective purposeful tool for solving the problems of processing physical data. All mathematical processing of the experimental data obtained at the EXCHARM installation is carried out at this cluster. The data banks - the results of mathematical processing of initial experimental information - have been generated and transferred to the EXCHARM collaboration participants for a further physical analysis.

The cluster RISC is also used for modeling (the inverse problem) the experiments on studying the processes with charmed and strange particles at the U-70 accelerator in Serpukhov.

In frames of the CMS/LHC software activities testing and modifying CMSIM(ftn) and ORCA(C++) programs for muon tracks reconstruction in end-cap muon system were performed (*I.Golutvin, Y.Kiriouchine, S.Movchan, G.Ososkov, V.Palichik, E.Tikhonenko, CPC, 126 (2000) pp.72-76.; I.Golutvin, S.Movchan, G.Ososkov, V.Palichik, E.Tikhonenko, in Proceedings of CHEP200, pp.128-132 2000, Padova, Italy*).

Computer Algebra

In the year 2000, the following investigations were performed:

- Algorithmization of Dirac method for calculation and separation of bindings for dynamical systems of a polynomial type based on using involute polynomial bases (*V.P. Gerdt. In: "Problems of Modern Physics", JINR D2-99-263, 2000, pp.164-171*).
- Effective realization in the REDUCE system as well as in the programming languages C and C++ of original algorithms of reducing the systems of nonlinear algebraic equations to a canonic Ganeu basis (that is the Grebner basis of a special form) which is convenient for research in the systems and their solution.
- Computation of cohomology of Lie Superalgebras of vector fields was performed (*V.V. Kornyak. International Journal of Modern Physics C, v.11, No.2 (2000) 397-414.*)
- Calculation of a second coefficient in the decomposition of the core of the thermal conductivity operator for a nonminimal differential operator on the torsion curved manifold (*V.V. Kornyak, In: "Computer Algebra in Scientific Computing", Springer-Verlag, Berlin, 2000, pp. 273-284*).

- Explicit solution to recursion relations for the Feynman integrals written with respect to the 'space - time' dimension (*O.V. Tarasov. Nucl.Phys.B (Proc Supl) v.89 (2000) 112-116*).
- A close relation between the Ganeu and Pommareu bases has been stated (*V.P. Gerdt. In: "Computer Algebra in Scientific Computing", Springer-Verlag, Berlin, 2000, pp.115-137*).

The algorithms mentioned and the results given are the pioneer ones. The computer programs written in the C and C++ languages (C and C++ on fig.13), at the expense of the original algorithms embedded, exceed the best foreign (Singular on fig.13) programs realizing the classical Buchberger algorithm for calculation of Grebner bases. An important physical magnitude was first cal-

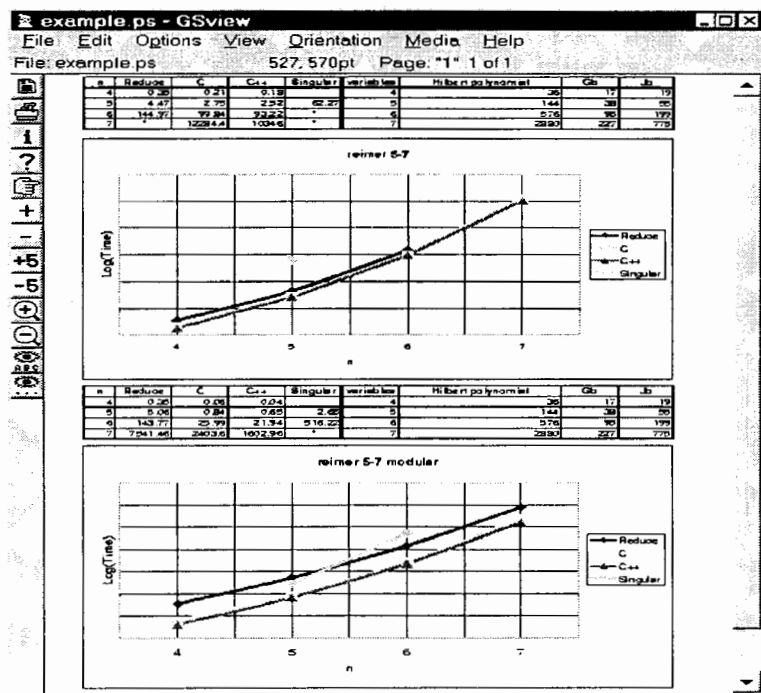


Fig. 13. Comparison of the computer programs written in the C and C++ languages and the best foreign program "Singular".

International co-operation

In accordance with the Agreement between JINR and the Research Centre Rossendorf, Germany, about a co-operation in the field of application and development of computing systems, in particular for the «Zentrale Nutzerdatenbank» project, LIT takes part in the creation of an automated system of administrating a

computer complex using the WWW technology as a tool of access to the ORACLE database via the Internet. The LIT personnel provided a Java-service - the development of programs in the Java language working under the operating systems Microsoft Windows and UNIX (Linux, AIX) and controlled by the standard WWW facilities - browser Netscape Communicator and Internet Explorer. These programs in the form of Java applets provide in a dialog mode a graphic user interface (GUI) to work with the database Oracle. The network access to the database was provided also by the Java-JDBC language.

In co-operation with CERN and Brookhaven National Laboratory the following work has been carried out:

- A new subsystem that provides creation of OO models of hierarchically composed data, has been introduced in the official version of the package ROOT. The subsystem includes a number of classes for creation and navigation of such objects. The subsystem represents an extra service and provides an effective input/output, an interactive monitoring and a graphical 2D and 3D representation of its results (<http://root.cern.ch/root/R2000Welcome.html>). At present the subsystem of 3D graphics allows one to obtain volume stereo images and possesses an additional entry to the object-oriented system of 3D graphics Open Inventor that opens outstanding possibilities for integration of this system with the ROOT package (<http://conferences.fnal.gov/acat2000>).
- The development of the working environment for using the object-oriented technologies for «large» experiments in nuclear physics and high energy physics has been completed. The «technological line» created on its basis for reconstructing events from the largest installation STAR has been officially put into operation in Brookhaven. In summer 2000, in the course of the first session at the largest accelerator RHIC, 10 TB of experimental data were processed and 3.3 TB DST were obtained with its help. It should be noted that all of the 4 experiments (STAR, PHENIX, BRAMS, PHOBOS) at the RHIC accelerator did choose the ROOT package as a main tool for development of their subsystems for data processing and monitoring.

Together with SCAR the LIT staff participated in the work done under the JINR-CERN Agreement

- A new version of the LabVIEW software (ver.6i) and BridgeVIEW (v.3.0) were installed, tested and supported for the wide range of users in the ATLAS, CMS and other experiments, as well as for the LHC test and control systems.
- LabVIEW libraries were upgraded and tested for new version of LabVIEW for Windows-2000 and Linux (Red Hat 6.2).
- The measurement scheduler software ("Test Master") for LHC Dipole series measurements has been developed and successfully tested.
- CERN LabVIEW/BridgeVIEW Users Database with Web-based user inter-

- face has been developed and is in operation since August 2000.
- The LabVIEW/BridgeVIEW Web-site is supported, the site documentation was regularly extended and updated during the year.
- Support and upgrade of NICE in accordance with new releases of the commercial software (new version of Netscape, v.4.75, for all platforms, extension of web services, etc).
- The start of Windows 2000 integration into NICE at CERN and at JINR.
- Integration of new commercial software into NICE at CERN.

In co-operation with Slovak researches qualitative and numerical investigations of the nonlinear system of ODE describes the existence and stability of disclination vortexes in elastic matter are started. By means of computer algebra system MAPLE an asymptotic of singular and nonsingular vortexes at zero point is obtained. A behavior of vortexes for large r depending on the problem and asymptotic parameters were numerically investigated. Fig.14 shows a singular vortex and a phase portrait for two values of the asymptotic parameter.

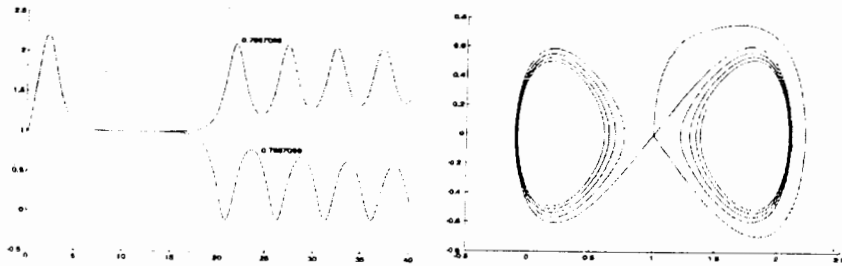


Fig.14. A singular vortex and a phase portrait for two values of asymptotic parameter.

The effective co-operation with the International Salway Institute of Physics and Chemistry (Brussels, Belgium) progressed in 2000. New integral software for electrocardiogram analysis was developed (V.V.Ivanov and P.V.Zrellov: *New Approach to ECG's Features Recognition Involving Neural Networks*, (submitted)). Research on analysis of results of optical coherent tomography of the human skin microstructure (P.G.Akishin, et al; "Computer Physics Communications", vol. 126, No. 1/2, 2000, p.1-11132, 139) was undertaken. Resonances, correlation, stabilization and control over complex systems were studied (I.Antoniou, P.Akritas and V.Ivanov: "Chaos, Solitons and Fractals", 11 (2000) 337-344; I.Antoniou, Yu.S.Gorshkov, V.V.Ivanov and A.V.Kryanev: "Chaos, Solitons and Fractals", 11 (2000) 223-229; P.G.Akishin, M.V.Altaisky, I.Antoniou, A.D.Budnik, V.V.Ivanov: "Chaos, Solitons and Fractals", 11 (2000) 207-222, I.Antoniou and V.V.Ivanov: *Computational Methods and Tools for Modeling and Analysis of Complex Processes*, (submitted)).

Co-operation with Polish Institutes

LIT conducts its investigations in co-operation with scientific research organizations in Poland.

The researches from Soltan Institute for Nuclear Studies (SINS) in Warsaw, Institute of Mathematical Machines (IMM) in Warsaw, Niewodniczanski Institute of Nuclear Physics (NINP) in Krakow and University of Mining and Metallurgy (UMM) in Krakow and others perform joint research on the LIT topics.

In cooperation with SINS an internuclear cascade model was development. The intranuclear cascade model overestimates the multiplicity of produced mesons in nucleus-nucleus interactions without taking into account meson and baryon resonance production. Inclusion of the resonances leads to decreasing multiplicity of mesons, neutrons and protons. In order to overcome the problem, it is proposed to use the FRITIOF model adapted to low energies in combination with the reggeon theory inspired the model of nuclear destruction. It is shown that the combination allows one to reproduce satisfactory the meson and baryon yields in the nucleus-nucleus collisions at the energy of 3.3 GeV/nucleon. The combined model works faster than typical quantum molecular dynamic model, and allows one to estimate the data needed for creation of electro-nuclear amplifier.

In co-operation with IMM, a computer code for face recognition by a new type of neural networks was proposed. They are suitable for a direct handing of digitized images of human faces and need much less time for training than ordinary multilayer perceptrons with the back propagation algorithm. The tolerance ability to various image distortions was tested.

Theoretical investigation on Quantum theory with a vector time was performed in co-operation with NINP.

In co-operation with UMM, the properties of the experimental facility - a sub-critical assembly in Dubna (SAD) - driven with the existing 660 MeV JINR protons accelerator have been investigated. A dependence of the energetic gain on the proton energy, the neutron multiplication coefficient, and the neutron energetic spectra has been calculated.

Future plans on year 2001

1. Telecommunications Services and Distributed Information Systems

- a) Development of the JINR external communications - creation of a high-speed computer communication link JINR - Moscow:
 - to provide a granted traffic for JINR in the international channel at the level of 2-4 MB/s in frames of the development of the network RBNET;
 - equipping a premise for regular teleconferencing.
- b). Creation of a prototype of the Russian segment EU-data GRID on the basis of the infrastructures of JINR, RINP MSU, ITEP (the work is carried out in frames of the projects financed from RFBR, the Ministry of Industry, Science and Technology, a grant of INTAS and European Community).

c). Development and maintenance of the software for distributed computations based on the metacomputing technology (GRID):

- Monitoring of nodes of the distributed computing system;
- Network security;
- Installation of the system GLOBUS as a main tool for distributed computations.

d). Computer Science at LIT - participation in projects APE-100, APE-NEXT (in co-operation with INFN, DESY):

- Modernization of the TAO compiler for APE-100;
- Participation in the creation of the C compiler for APE-NEXT;
- Transition of the mathematical program libraries to the APE platform.

2. JINR CoNet Technical Support

- Complex monitoring and support by the JINR Network Operating Centre (NOC). Development NOC Web server using modern Internet technologies.
- Provision of uninterrupted operation of the JINR BackBone. Joint monitoring and management of operating the JINR ATM and ETHERNET sub-networks on the basis of the ATM SYSTEM Manager and the HP Open View. Analysis of the possibilities of the perspective development of JINR network on the basis of Gigabit technologies.
- Development of a complex monitoring of the external communications and the traffic of the JINR local area network.
- Development of a segment of the security system for the JINR computer network to increase reliability of information storage and protection from unauthorized access.

3. Software and Informational Systems for Physics & Services

- Maintenance of the JINR Program Library, and the specialized libraries CPCLIB, CERNLIB, NAG including analysis, selection and information support. Participation in LHC Software Design (LHC++, ROOT, GEANT4).
- Object Oriented Programming development in the frame of collaborative requests and HEP computing.
- Data Bases/Digital Libraries – creation and maintenance (Corporate Information Systems, JINR Digital Library, Data Bases of Simulated Events).
- Software for Data Processing including specialized program packages for experimental data representation, data archiving, fast data access, distributed data management.
- To establish the JINR Scientific Information Internet-Center.

4. Computer Physics

- Development of statistical methods for the mathematical modeling of interactions of particles with nuclei and substance. Creation of a modern version of the program DUBNA-CASCADE for Monte-Carlo simulation of transport and interaction of particles with nuclei.
- Development of methods for modeling and processing experimental data, including the development and introduction of new methods for data filter-

ing and data compression as well as pattern recognition. Introduction of the results in the software of experimental investigation.

- Creation of methods and numerical algorithms for physics fields calculation and particle beams transport. Introduction and maintenance of modern computer programs for magnetic fields calculations.
- Creation of numerical methods and software for mathematical simulation of complex physics systems. Development of a program library for calculation of the stationary and dynamic models of quantum mechanics and the field theory oriented to vector-parallel computer systems.
- Development of methods, algorithms and software of computer algebra. Introduction and maintenance of modern systems of analytical calculations.
- Development of numerical and analytical methods for a research in nonlinear models of theoretical physics.
- Creation of systems for experimental data processing in particle physics, including the development of algorithms, software and architecture of computing clusters. Application of the developed systems for mathematical processing of experimental data.
- Development of the program packages for simulation, processing and visualization of data with the use of systems ROOT, GEANT, LAHET, FRI-TIOF for experiments STAR, COMPASS, HEND, SPHERE, FAZA.
 - STAR - Research in the spatial - temporal characteristics of the nuclear substance in the course of nuclear collisions, simulation of spin effects in the experiments with the polarized beams.
 - COMPASS - Development of a method and algorithms for calculations of the cross sections of diffraction processes in πp , pp , pA , and πA collisions. Creation of a mathematical model to achieve a high efficiency of the pattern recognition when restoring events. Development of algorithms for particle identification on the data from the RICH-detectors. Development specialized COMPASS PC-cluster at LIT together with SCAR.
 - HEND - Creation of a mathematical model of the neutron and gamma irradiation of the Mars surface on the basis of the measurements of the fast neutrons.
 - SPHERE, FAZA - Simulation of the processes of the neutron fields generation; development and maintenance of the programs - event generators for modeling the processes of nuclei fragmentation, processes of complete destruction of nuclei and dynamics of nuclear interactions on the basis of measurements on the installations.
 - HERA-B - Increasing the efficiency of the track reconstruction program for external track detector.
- Development of the program packages for simulation, processing and visualization of data for experiments DUBTO, CORSET, DIRAC, DEMON:

- DUBTO - Creation of a mathematical model, participation in the development of the program on data monitoring. Participation in analysis of the experimental data obtained.
- DEMON, CORSET - Development of the program for a real - time analysis and visualization of data. Participation in analysis of the experimental data obtained.
- DIRAC - Development of tracking and simulation programs. Optimization of the installations geometry, liquidation of the background sources, valuation of its resolution, development of the neural network trigger. Participation in analysis of the experimental data obtained.

Received by Publishing Department
on December 22, 2000.