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R.Pose

ANNUAL REPORT
OF THE LABORATORY OF COMPUTING
TECHNIQUES AND AUTOMATION
FOR 1999

Report to the 87th Session
of the JINR Scientific Council
January 13–14, 2000

Dubna 1999

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In 1999, the scientific programme of the Laboratory of Computing Techniques and Automation covered two first and two second-priority topics of the "Topical Plan for JINR Research and International Cooperation in 1999". The Laboratory staff participated in 18 more topics of the Topical Plan in collaboration with other JINR Laboratories. The main aim of the Laboratory is to obtain new results 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 on the last topic have been published in the well-known journals, proceedings of the scientific conferences and preprints. More than 100 scientific publications, reports at conferences and JINR preprint were published and presented in the year 1999.

The main directions of the CONET project are as follows:

JINR Local Area Network (LAN) development;
Telecommunication systems;
Computing service;
Software development;
Information support/

JINR Local Area Network

In 1999, all JINR Laboratories put into operation the network equipment for the high-speed JINR backbone based on the ATM technology. Thus the ATM backbone of JINR LAN has been realized and is operating now. The JINR Computing&Networking Infrastructure is shown schematically on the fig.1.
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 must be approved by JINR Directorate.

Telecommunication systems

Since 1997, JINR has served as a RBNet node and uses for external telecommunications the RBNet facilities and DEMOS provider. The main task of 1999 - to increase the telecommunication channel capacity and throughput within the frames of the programme for National Computer Telecommunications Network- was fulfilled.

The change-over to the worldwide channel RBNet was done. Today JINR uses 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 RBNet and other 512 kb/s using TELEGLOBE as a main partner of RBNet. For this purpose an agreement has been signed with ROSNII-ROS (the Russian Institute for Public Networks).
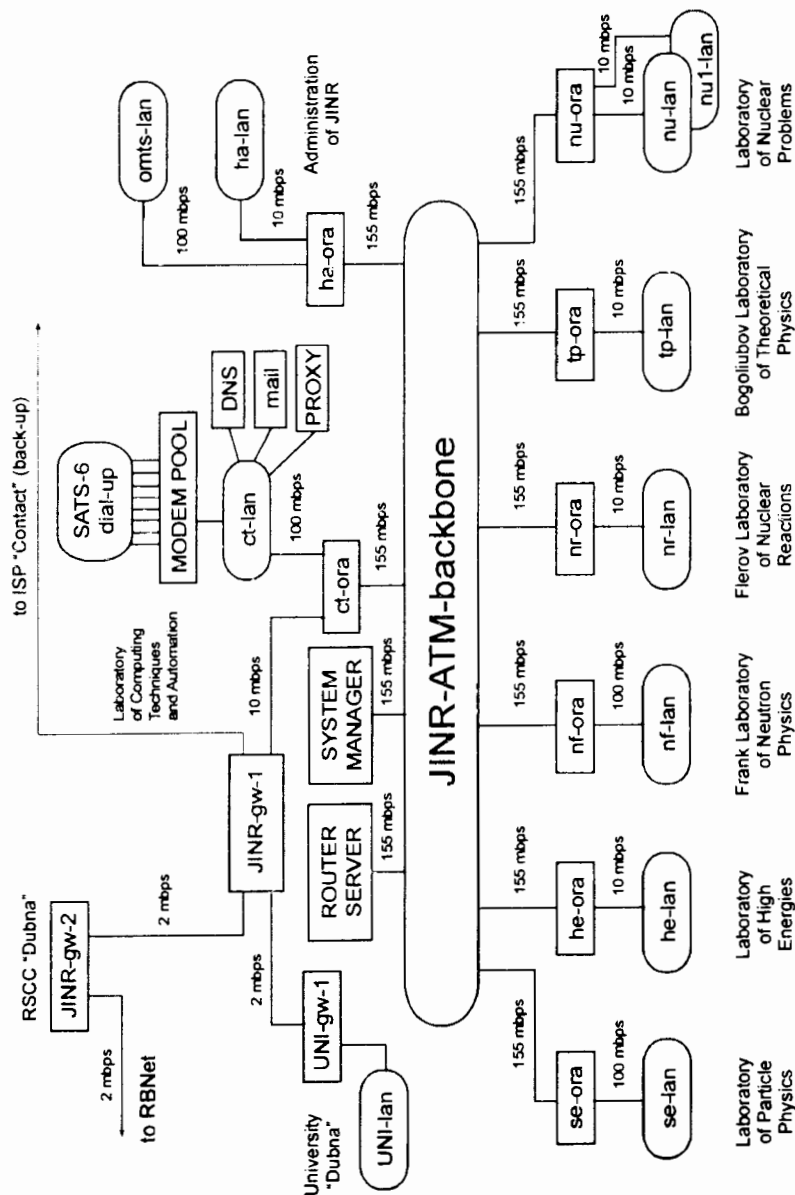
Fig.1 Scheme of JINR LAN

Fig.1 Scheme of JINR LAN

If the operation of the channel shows its reliability and effectiveness, an increase in its throughput for JINR will be discussed.

The satellite computer communication link RADIO/MSU-DESY is expected to be used for cooperation with the nuclear physics centres CERN, DESY, etc. in frames of the RUHEP community.

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

The fig.2 shows the current state of JINR communication links.
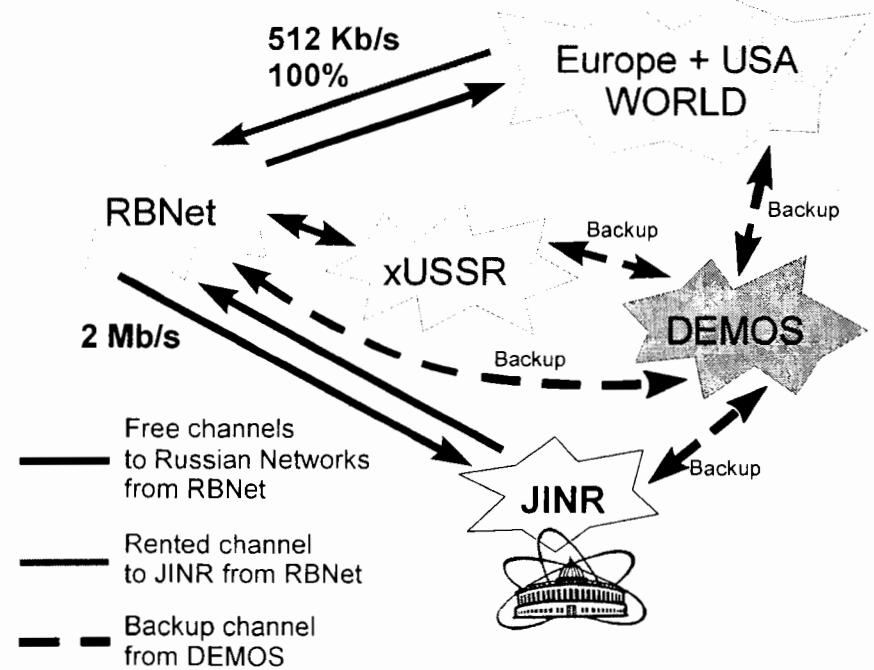

Fig.2.

In 1999, a computer program was created for processing statistics of using the JINR external computer communication links. This allows one

- to analyze data in the interval of the requested dates sampling by sub-networks,
- to analyze subdivisions and leaders in the subdivisions,
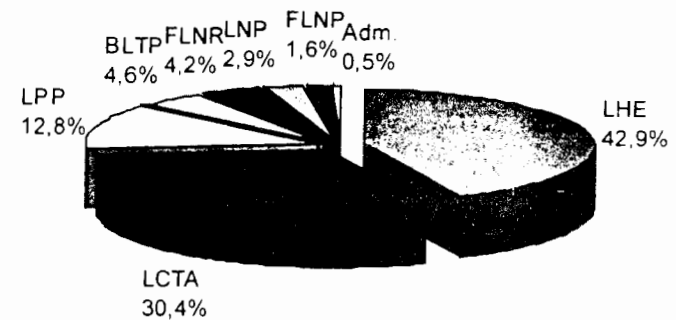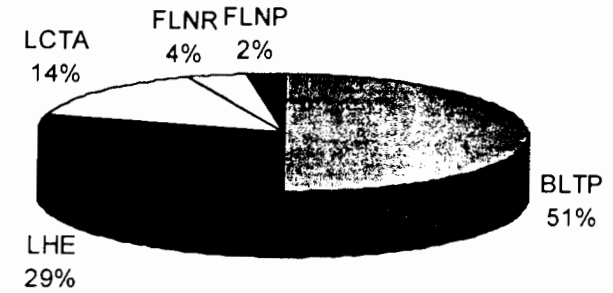- to extract the main sites which they had the biggest traffic with.

Computing service

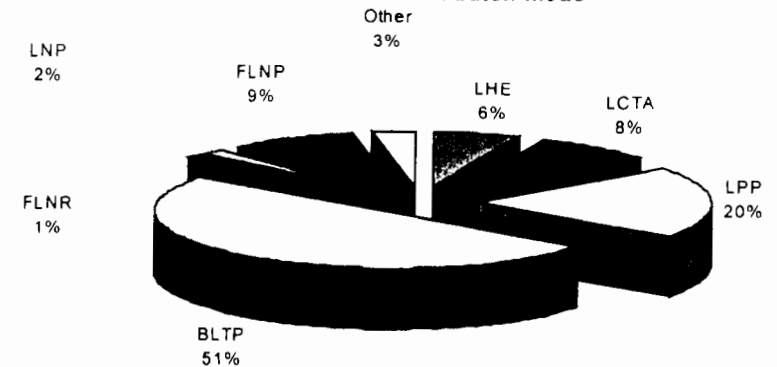The table below shows the main JINR servers which are under LCTA maintenance:

Router	JINR – gw -1	CISCO AGS+
Provision of the JINR's back-bone operation (ATM-backbone)	ATM ROUTER server ATM System Manager	SUN SPARC 5
Domain Name Server (DNS), NEWS, MAIL-RELAY, Modem pool	JICOM JIMEX	SUN SPARC 20 SUN 1+
PROXY	PROXY	
MAIL-SERVER		SUN Ultra 10
FILE SERVER + MSS	DTMAIN	HP D370+ ATL2640
Visualization and network monitoring server HP Open View	DTSERV	HP J282
Central Data Base server	DBSERV	DEC ALPHA 2100
Administrative Data Bases	ADM	
Computing servers	SPP BCV	HP SPP-2000 CONVEX 3840
WWW-servers	CV JICOM	CONVEX 220 SUN SPARC 20
Electronic library (JINR Library, Publish. Dept., Photo archive)	LIB PD01	
General purpose servers	CV MAIN1, MAIN2	CONVEX 220 VAX 8800
FTP-servers	FAXE CV DBSERV	CONVEX 220 DEC ALPHA 2100
Servers of applications	ULTRA LINUX4U NICE NT	SUN ULTRA 1

Below is given the relative intensity of the CONVEX and SPP200 computing servers usage by the Institute laboratories during 11 months of the year 1999.


CONVEX C-3840 Load

LCTA 14%
FLNR 4%
FLNP 2%
BLTP 51%
LHE 29%

BLTP 4,6%
FLNR 4,2%
LNP 2,9%
FLNP 1,6%
Adm. 0,5%
LPP 12,8%
LHE 42,9%
LCTA 30,4%

SPP2000 Load in batch-mode

LNP 2%
FLNP 9%
Other 3%
LHE 6%
LCTA 8%
LPP 20%
FLNR 1%
BLTP 51%

The JINR modem pool was working all year for JINR staff. The next chart shows the modem pool used by various JINR divisions

Other 0,6% BLTP 0,5%
DRRR 1,1%
Adm. 7,7%
LPP 5,7%
LHE 16,1%
FLNR 10,0%
LNP 23,7%
LCTA 19,6%
FLNP 15,1%
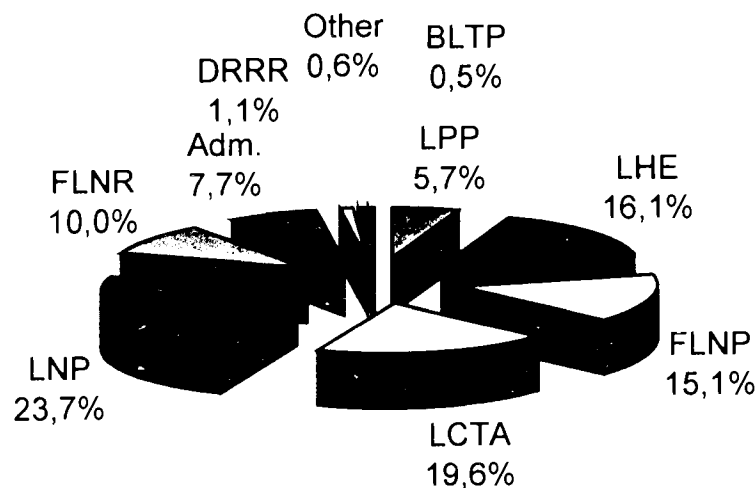
Software development

CMS Computing Support.

During the last 3 years JINR was the only RDMS (Russia-Dubna Member States) CMS institute where the complete support of CMS computing has been organized. The software environment of the Sun CMS cluster at JINR is similar to the Sun CMS clusters at CERN. JINR specialists from several JINR laboratories (LPP, LHE and LCTA) participating in the CMS experiment have had a full possibility to accomplish their studies for CMS at JINR, at Sun CMS cluster (a number of users- about 50 persons): simulation of setup and processes, beam test data processing etc. The SPP-2000 computer has been also widely used for the CMS activities as there exists the proper environment including CMSIM, the main CMS simulation program. Almost 6500 hours of the SPP-2000 processor time were used for CMS studies at JINR in 1999. The centralized archiving of working design documents (in particular, design drawings) has been organized for supporting RDMS CMS design activities of JINR, IHEP(Protvino), ENTEK(Moscow) and HTTC (Minsk, Belarus). The further support of the official RMDS CMS www-server (http://sunct2.jinr.ru) has been accomplished during this year: a lot of new documents on RDMS CMS activities have been located at the server.

The main points in Computing for LHC Experiments are:

- Design and development of computing configuration and software for Russian Regional Computing Centre for LHC experiments according to **MONARC** (**M**odels of **N**etworked **A**nalysis at **R**egional **C**entres for LHC Experiments) Project requirements.
- Creation of software tools and environment for using LHC++ Library in design and development of software for teams of physicists participating in LHC experiments.
- Adaptation and support of LHC++ Library for PC-farm under LINUX platform.
- Technical and programming assistance while using the LHC++ Library for development of software for LHC experiments.

To provide information and computer support of the JINR participation in the experiments at the installations of CERN, DESY and BNL, learning the technology for creation of object-oriented applications and data bases (GEANT4, Objectivity/BD, ROOT) was in progress in 1999. A program library LHC++ which is oriented on various types of OS and includes the components listed above (including OODBMS Objectivity/DB) has been received from IT CERN and installed at the JINR machines (SUN-cluster of the RDMS collaboration, two Windows NT stations).

Investigations for paralleling computations

In 1999, the LCTA staff members performed experimental study of MPI-technology for paralleling computations on a multiprocessor SPP-2000 computer.

With the help of the LCTA an all-purpose computer program GAMESS for modelling a molecular structure of a substance was successfully transferred to SPP. For the first time a problem of paralleling computations in very large programs has been solved at JINR. At present the program is capable of using all the available SPP processors simultaneously. A computer program was prepared for visualization of results achieved by the GAMESS. It works on PC in the Windows NT environment.

Another example is a paralleling of computations in the MICODE program. This work was done successfully and with no essential changes in the author's algorithm. It should be noted that the work was done without specialized program packages. The available OS Unix only was used. Despite this circumstance, the speed of computations grows proportionally to the quantity of the processors used.

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 - Information about the rules for work with the NAG Library at JINR have been prepared and introduced in WWW;
- Maintenance of CERNLIB on the JINR computer platforms;
- Filling the JINRLIB was in progress. Almost 25 computer programs have been tested on the platforms VAX, SPP, Convex and PC and provided with a doubled accuracy.

The staff members from LCTA in JINR DAQ/Trigger group has been participating in the development of ATLAS DAQ prototype "-1" project on the Resource Manager (RM) Software Component, including design, implementation, debugging and testing in the full DAQ prototype system. The purpose of the RM is to formalise the allocation of Resource DAQ (both hardware and software) which, at times must be shared to allow independent and simultaneous use different groups to work in parallel without interference. This is what has been done in the current year:

- RM test plan document produced (*I.Alexandrov, V.Kotov, V.Roumiantsev* - *http: //atddoc.cern.ch/ATLAS/postscript/Note130.ps*),
- RM implementation and user guide document produced,
- integration with process manager,
- RM integrated in IGUI,
- new helper RM classes for RM users,
- RM_Client class improved,
- Possibilities of how to load partition resources from configuration extended, (use DAL,etc.)
- RM GUI improved,
- set of new helper programs (RM check, load, consistency check etc.),
- first scalability and portability tests.

DATABASE and WWW SERVICE

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);
- creation of information retrieval systems based on applying the CORBA standard, WWW, languages of Java and C++ type;
- introduction of object-oriented systems for data base management of ORACLE8 and Objectivity/DB types.

External data bases (bibliographic, full text, factographic ones) which are of particular interest for the research under way at JINR, are as follows:
- data bases and documentation prepared by the collaborations ATLAS, CMS etc.;
- PPDS (data base on elementary particle physics, Russian participants - IHEP, ITEP and JINR);
- HEP-SPIRES (data bases of electronic publications in HEP);
- unified base for CERN preprints and Los Alamos HEP collection;
- RPP (materials of Review of Particle Physics);
- INSPEC (bibliographic base on physics, electronics, computer technologies), etc.

The software of the WWW system developed at the expense of the joint use of such languages as HTML, Java and JavaScript, became a universal interface for users to the Internet. The scope of these resources available from Internet has been extended (earlier they were accessible in off-line mode only). Extension of the proxy - server possibilities aided a partial development of these links in 1999.

One of the information section available on the BAPHYS server and increased essentially in 1999 is the section of CORBA/JAVA technology (http://dbserv.jinr.ru/js/). It currently includes documentation, education materials, programs and references, which are useful for the programmers and users involved with the distributed object-oriented inter-operated computer system. This section provides a way for obtaining an evolution-version of such program packages as JDK for Windows95/98NT and Solaris, VisiBroker, OrbixWeb3.1 and ILU.

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 the framework of this activity a reference division «Physics Information Servers and Data Bases» developed.

Among the activities related to the main JINR and LCTA 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.

In 1999, the activities within the RFBR grant for electronic libraries and development of the information system for the JINR Library and Publishing Department included the following:
- introduction of a new system Liber Media to maintain the Institute's Scientific Library and its readers, maintenance of the Library's Web-site;
- formation of electronic collections with Web - interface to provide access to them (for bibliographic databases of the JINR Library, full- text publications of the JINR Publishing Department and photoarchive).

Finally, 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. This is particularly true for the following information systems:

- «Topical plan for JINR research and international cooperation»;
- «Monitoring of the JINR Basic Facilities operation»;
- «Consolidated report on finances at JINR's subdivisions» for the JINR Accounts Department;
- «Law Information» for the Public Library;
- «Accounting of persons to be accounted, at the JINR Accounts Department;
- «Cash Accounting»;
- «JINR report to the Pension Provision Foundation»;
- «Consolidated register on salaries and wages of the JINR staff members including those working on short-term contracts».

Computational Physics

Considerable advances have been made in 1999 in the following areas:

- *Modern computational tools in experimental data simulation (artificial neural networks and cellular automata),*
- *Monte-Carlo simulation of physics processes,*
- *Magnetic field calculations,*
- *Methods and software for complex physics system calculations,*
- *Computer algebra.*

In the series of papers (*G.Ososkov- Czech.J.Phys., v.49/S2 (1999) 145-160; G.Ososkov, A.Shitov - Comp.Phys.Comm., v.119(1999) 1-9; G.Ososkov Nuclear Ins.Meth. A433(1999) 274-278; Kolganova E.A., Ososkov G.A. - Czech. Journal of Physics, 1999, v 48/S2, pp.169—172; A.Linka, G.Ososkov, J.Picek, P.Volf - Czech.J.Phys., v.49/S2 (1999) 161-168. 93-97*) problems of data processing for Cherenkov detectors of the RICH type are considered. The main stages of data processing are expounded on the basis of the mathematical model of the RICH data. On the first stage of measurement clustering in order to obtain photon hits two new methods of hit accuracy improving are described: numerical approximation method and the wavelet analysis method The main efforts are focused on the approach of direct processing of raw RICH data, which is especially actual for the high granularity RICH detectors like CERES and COMPASS. The raw data approach is based on applying of the robust technique at both stages of the further data analysis: for Cherenkov ring recognition and for particle identification. This technique is based on a least-square method with special recalculated weight functions depending not only on the distance of pads from the filled circle but also on the signal amplitudes in pads. The proposed method leads to reliable parameter reconstruction from parameters and are then successfully used for the particle identification. Figure 3 show CERES RICH Image of Au-Pb event and simulated image of two overlapping rings with 100% of noise. Darker pads relate to higher amplitudes. Circles indicate fitting result.
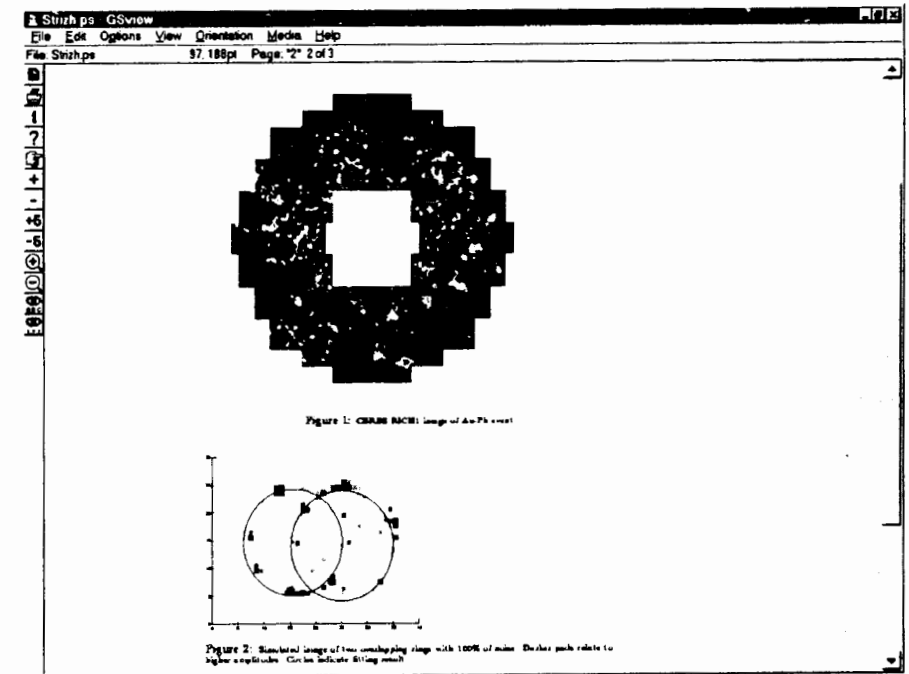

Fig.3.

Within the cooperation with the Technical University of Cosice, Slovakia, a study has been conducted in the area of applying a wavelet transformation. The key question of the investigation is the prediction gain analysis, how much information about the future values of a process can be obtained from the past. New predictor components have been found. A new promising tool has been developed for a description of de-noised signals obtained by wavelet shrinking due to the criterion introduced (*Török Cs., Bernhard H.P. – JINR Communication E5-99-221, Dubna, 1999.*)

A multi-fractal analysis of the images obtained by "Galileo" mission to Jupiter in 1997 has been performed at LCTA in cooperation with the Space Research Institute, RAS. The spectrum of Renyi dimensions Dq calculated for a given set of conditional colors shows the crack network on Europa surface to be multi-fractal. This supports the hypothesis that the cracks are produced by strong internal load, since the brittle fracture experiments on solids performed in terrestrial conditions give similar dimension spectra (*Altaisky M.V. et. al. - JINR Preprint P10-99-191, Dubna, 1999.*)

A new application of the optical coherence tomography (OCT) for analysis of a skin microstructure has been recently developed. At present a compact system for imaging in real time of human tissues in vivo is under construction. The OCT database destined for storing and management of the information about patients, their lesions and tomograms have been worked out. It was developed in the framework of Microsoft Access 97 using Visual C++, Visual Basic and Quick Camera application (*Akishina E.P. et al. – JINR Preprint E10-99-150, subm. "Computational tools and Industrial applications of Complexity"*).

The investigation of seismic processes as applied research is in progress at LCTA. This processes are well known to be self-similar in both spatial and temporal behavior. At the same time, the Burridge-Knopoff (BK) model of earthquake fault dynamics, one of the basic models of theoretical seismicity, does not possess self-similarity. An extension of the BK model, based on the introduction of nonlinear terms for the inter-block springs of the BK model, which results in the self-similarity of earth crust elastic properties being accounted for directly was presented. Phase space analysis of the model reveals the behavior of a system of randomly kicked coupled oscillators. The nonlinear stiffness terms cause synchronization of the collective motion and produce stronger seismic events (*P.G. Akishin et al.- Chaos, Solitons & Fractals, Vol. 11 (1-3) (2000) pp. 207-222*).

A new approach to reconstructing and predicting discrete chaotic maps is developed. It is based on the feed-forward neural network which decomposes the analyzed chaotic map in orthogonal Chebyshev polynomials. It was showen that the Chebyshev neural network significantly exceeds the traditional multilayer perceptron in learning rate and in the accuracy of approximating an unknown map (*P. Akritas, I. Antoniou and V.V. Ivanov - Chaos, Solitons & Fractals, Vol. 11 (1-3) (2000) pp. 337-344*).

New more effective and simple modules of the programming complex for modelling the nuclear physical processes in a substance exposed to high energy particles and nuclei, have been designed (*V.S.Barashenkov, A.G.Soloviev, A.N.Sosnin - JINR P2-99-125*). The properties of various variants of the designed electronuclear installation "PLUTON" have been studied by way of mathematical experiments due to the type and the configuration of the reflector, the type of the fissionable substance and target. (V.S.Barashenkov, A.Polyanski, I.V.Puzynin, A.N.Sissakian. JINR E2-99-206: presented at Prague conference).

Integral High-Energy Nuclon-Nucleus Cross Sections for Mathematical Experiments with Electronuclear Facilities have been obtained. Parameterization of the integral cross sections σ_{nonel}, σ_{el}, σ_{tot} for the elastic, nonelastic and total proton- and neutron-nucleus interactions was considered at medium and high energies. On the basis of this parameterization a code was created for the interpolational calculations of the integral cross sections for arbitrary target nuclei at proton energies E = 1 MeV — 1 TeV and neutron energies E=12.5 MeV— 1 TeV. (*Barashenkov V.S., Gudowski W., Polanski A. – JINR preprint E2-99-207,*

Dubna, 1999; subm. to 3rd International Conference on Accelerator Driven Transmutation Technologies).

In cooperation with Moscow Radiophysical Institute, experimental and theoretical research have been performed in possibilities for neutron generation in plasma strimmers arising in gaseous matter inside the SHF-resonators.One may be succeded in using such devices as a neutron source (*V.S.Barashenkov et al. - JINR P9-99-276*).

In collaboration with the Royal Technological Institute (Stokholm) and on a basis of the created data base, a precised version of "Electronic guide to cross-sections" has been designed. It provides a way for calculating a cross-section of pion-and nucleon-nucleus interactions for various values of mass and charge numbers of nuclei in the energy range of 10 MeV - 1000GeV. The new version allows one to perform much more fast and precise computations of the electronuclear processes. Fig.4 shows how well the agreement is between the data of the guide and the experimental points (*V.S.Barashenkov, A.Polyanski, W.Gudovski - JINR, E2-99-207, reported at a conf. in Prague).*
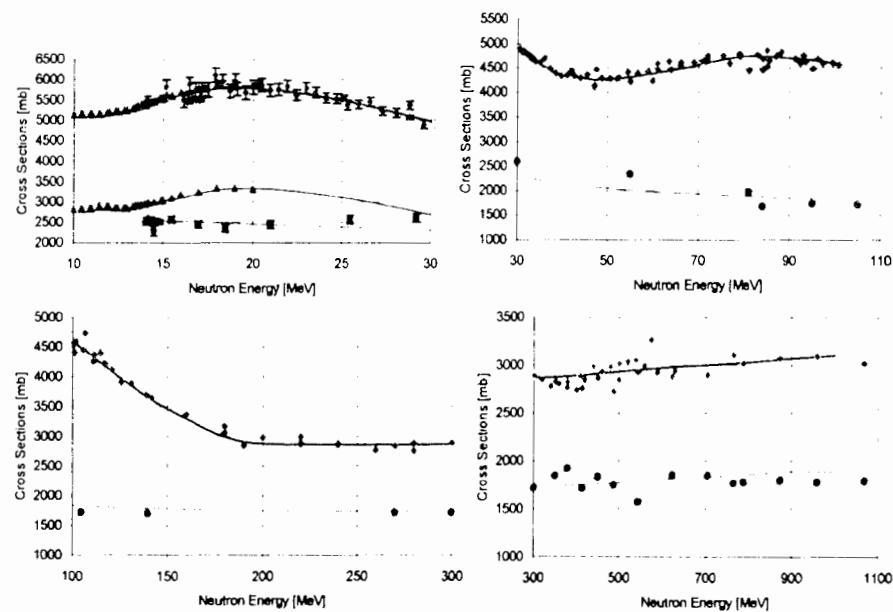

Fig.4

The problem of modeling the magnetic systems containing superconducting screens was considered. The nonlinear volume and boundary integral equations were proposed for a description of distribution of magnetization and surface currents. A special investigation was performed for digitization of

equations and for solving nonlinear problems. Fig.5 shows numerical results for ALICE experiment magnetic system modeling without and with a superconducting screen.
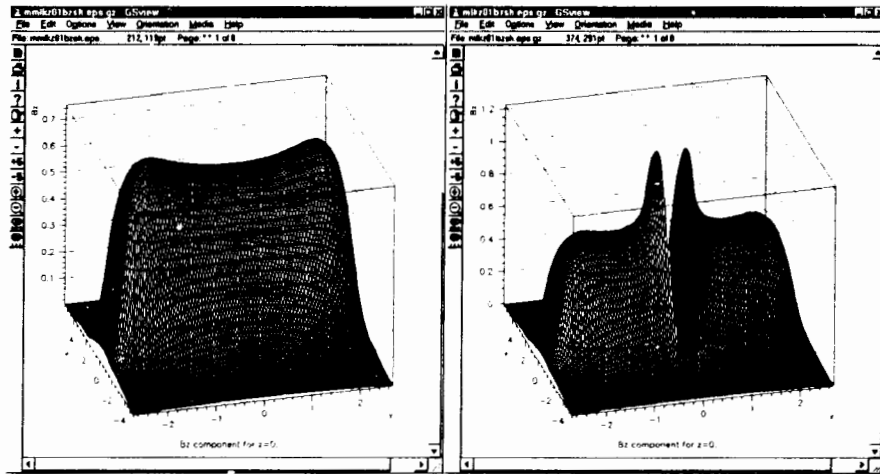

Fig. 5

A field distribution for two work modes has been simulated, the experimental data being available for one of them. The calculated distribution has been compared to an experimentally measured one which was satisfactory. By comparison of two calculated distributions an algorithm for recomputation of the magnetic field from a mode with the experimental known data into another mode, has been obtained. Magnetic field's maps have been composed for two modes of the EXCHARM installation. The results are intended for experimental data processing at the 10-th session of the EXCHARM experiment. By the numerical modeling it is shown that the creation of the magnetic field with the homogeneity level 25KGs±0.02 % is possible in the field of the target polarization.

A bicubic model for the local smoothing of functions related to pivot points (marks) of a searching surface has been constructed. Such an approach allows reducing the dimension of a matrix of normal equations more than twice. The algorithms constructed by using the offered model can be used both in applications and development of global methods of smoothing and approximation of surfaces.(*Dikoussar N.D., Török Cs. - JINR communication P10-99-223, Dubna, 1999.*)

Investigations on the solitonic complexes stability of the nonlinear Shrödinger equation were performed. The investigation shows that this equation does support solitonic complexes, with the mechanism of their formation being

different from the standard tail-overlap mechanism. One of the arising stationary complexes is found to be stable in a wide range of parameters, others are unstable (*Barashenkov I.V., Zemlyanaya E.V. - JINR Preprint E17-99-124, Dubna, 1999; subm. to "Phys. Rev.Lett."*).

A numerical investigation of relativistic equations for a bound-state problem with coulomb and linear potentials was in progress. These models are described by three-dimensional relativistic equations with various generalizations of coulomb and linear potentials in the momentum space. Algorithms and codes are developed for numerical investigations of these equations. The modified generalized continuous analog of Newton's method is used. (*Amirkhanov I.V. et al. - JINR preprint P11-99-159; subm. "Math. Modelling"*).

In the cooperation with the Technical University, Košice (Slovakia), an algorithm for a numerical solution of the inverse problem for two-dimensional Shrödinger equation has been worked out. The problem reduces to reconstruction of a symmetric five-diagonal $M*N$ matrix with a given spectrum and given first N components for each of basic eigenvectors. But in difference with one-dimensional case all N components can not be chosen arbitrary. It is stated that they must satisfy $(N-1)^2(M-1)$ additional conditions (*Serdyukova S.I., Pavlush M. - JINR Rapid Communications No.3[95]-99*).

A simple iterative method is proposed for the local approximation and the smoothing of functions using a three-point cubic spline. The method is based on the 4-point transforms and the recursive least squares method. A recurrent third order smoothing digital filter is derived. The speed of convergence is not worse than $1/n^3$. The algorithm uses small resources of memory and can be applied to digital signal processing, contour and track finding as well as for a numerical solution of practical problems (*Dikoussar N.D. - JINR Communication P10-99-168, Dubna, 1999*).

A dynamics of solitons has been studied in 1+2D space for a large number of integrable nonlinear equations (NLS, derivative NLS, KDV, MKDV). A relation between these equations and calibration field theories, gravity and Heisenberg model was observed. One of the most important results is the proof on a 3-loop level (by way of explicit calculation) of invariance of a functional integral with respect to random transformations of field variables using a dimension regulation scheme (*Chervyakov A. and Kleinert H - Phys.Lett. B461,12,(1999) Phys. Lett. B464, 257, (1999)*). This result makes unneeded a procedure of introducing an additional potential element (contrelement) at the quantum level (of h^2 order) at this transformation.

A process of division of a cluster into constituents was described on the base of an elastodynamic model. The issues of stability were studied, too (*Bastrukov S.I.,et al.- Phys. Nucl. Part. 30, N4 (1999) p. 992*).

A random Manna model was considered to investigate the avalanche propagating through the medium. The distribution processes of active conditions on lattice correspond to a system of the reaction – diffusion differential equa-

tions. The system of equations was supplemented by the boundary conditions of a general form and by the introduction of noise on each time level at digitization of the system by the finite differences method. The numerical solution of the obtained system of equations is in a good agreement with computer simulation of avalanche propagation on lattice corresponding to the Manna sandpile.

The programs of acceleration of the short-lived radioactive nuclei are widely realized in the world (CERN (ISOLDA), GANIL (SPIRAL), RIKEN, Gatchina, Dubna). The life-time of isotopes varies from microseconds to hours. The process of diffusion of nuclei from the target is the slowest process while transporting the reaction products of interaction of the primary bundle with the target The mathematical modeling of processes of diffusion from target and of processes of nuclei passage on the pipe is carried out with the purpose of studying and optimization of the target characteristics. The dependence of diffusion time exit of the nuclei from a cylindrical target and of diffusion time of nuclei by the pipe *(M.G. Airapetyan, E.A. Ayrjan, G.G. Goulbekyan, O. Seles, A.V. Fedorov – JINR Preprint, P11-99-102, 1999)* upon the geometric sizes of a target is simulated. The simple analytical formulae describing these dependencies (associations) are constructed.

A discrete spectrum of the two-center Coulomb problem of $\bar{p}He^+$ system was studied. For solving this problem the finite-difference scheme of 4th-order and the continuous analog of Newton's method was applied. The algorithm for calculation of eigenvalues and eigenfunctions with optimization of the parameter of the fractional-rational transformation of the quasiradial variable to a finite interval was developed *(Pavlov D.V., Puzynin I.V. and Vinitsky S.I. – JINR Preprint E4-99-141, subm. to "Yadernaya Fizika")*.

The integral boundary conditions for the time-dependent Shroedinger equation describing an atom with the laser interaction in dipole approximation was formulated. The boundary conditions are imposed on the solution on a surface (boundary) which may be at a finite (but sufficiently remote) distance from the atom. For numerical integration of the Shroedinger equation, this exact conditions may be used to replace diffuse absorbing potentials or mask functions. This method allows to substantially reduce the size of the space domain where integration is carried out numerically *(Ermolaev A.M., Puzynin I.V. et al. – JINR Preprint E11-99-156, subm. to Phys.Rew. A)*.

Within the work on computer algebra, a number of the programs have been created at LCTA which are pioneer and have no analogy in the world due to the novelty of the algorithms embedded in them.

Algorithms of Dirac method for computation and separation of relations for dynamic systems of a polynomial type have been created and realized in the Maple language *(Gerdt V.P., Gogilidze S.A. In: "Computer Algebra in Scientific Computing",V.G.Ganzha, E.W.Mayr, E.V.Vorozhtsov (Eds.), Springer-Verlag, Berlin, 1999, 139-146)*.

Algorithms have been created of the most general methods for completion of nonlinear algebraic equations and linear differential equations to involution and realized in Mathematics language *(Gerdt V.P., Kornyak V.V., Berth M., Czichowski G. In: "Computer Algebra in Scientific Computing", V.G.Ganzha, E.W.Mayr, E.V.Vorozhtsov (Eds.), Springer-Verlag, Berlin, 1999, 147-157)*.

A computer program written in the C language for computations of cohomology of algebras and superalgebras Li of vector fields is far in excess of the best computer programs of analogous purpose ever written worldwide in the Reduce and Mathematics languages *(Kornyak V.V In: "Computer Algebra in Scientific Computing", V.G.Ganzha, E.W.Mayr, E.V.Vorozhtsov (Eds.), Springer-Verlag, Berlin, 1999, 241-249)*.

Software has been designed at LCTA which allows the users of the system REDUCE to use a large number of numerical routines written in C and FORTRAN in symbolic-numerical computations. A symbolic-numerical interface of the Standard LISP interpreter - GSL together with debugging and profiling tools of the dynamically loaded object modules for symbolic or numerical computations have been developed and realized *(Raportirenko A.M. - JINR communication P11-99-230, Dubna, 1999)*.

Cooperation with Russian Federation

The Laboratory of Computing Techniques & Automation conducts its investigations in a close cooperation with scientific research organizations in Russia. The researchers from more than 40 Russian institutes of Moscow, St.Petersburg, Saratov, Kazan, Troitsk, Puschino, Protvino, Novosibirsk, Chernogolovka, Obninsk, Tver and others perform joint research on the LCTA topics.

For example, the main direction of the development of the JINR telecommunications is the coordinated work with the Russian programmes and projects to enter the National Telecommunication Network. The Russian Ministry for Science and Technology and the Russian Institute for Public Networks via the network RBNet participate in these projects and programmes. As mentioned above, since 1997 the JINR has been a node of RBNet, and presently all the information stream goes through this channel.

The second direction of the LCTA activities the financing of which is provided within a federal programme is the creation of a high performance-computing centre of JINR. In 1999 its operation was provided in a mode of a basic computing machine for computer simulation and theoretical calculations.

One of the most important directions is our participation in the development of a project on creation of a Russian regional distributed informational - computational complex (RDCC) for LHC. In order to provide a full-scale participation of JINR and Russian scientists in physical analysis of data from experiments at the Large Hadron Collider (LHC) at CERN, a memorandum has been signed and a project on creation of RDCC LHC has been worked out. The computing facilities available at LCTA/JINR today and the experience on crea-

tion and maintenance of informational - computational complexes allow one to consider JINR as one of the nodes of such a distributed informational - computational complex. LCTA specialists in a close cooperation with colleagues from INP MSU, ITEP, IHEP and other Russian RDMS CMS institutes are participating in activities on creation RDCC for LHC in Russia. The Project on the creation of RDCC in Russia has been developed by Russian institutes with an active participation of LCTA specialists.

The Laboratory of Computing Techniques & Automation JINR acts as a deviser of the project BAPHYS - creation and development of a unified scientific and informational field of the Russian nuclear physics institutes. The project has been realized on the basis of RFBR grants and supported by the Ministry for Science and Technology of Russia in the framework of a comprehensive Russian intergovernmental programme "Creation of the National Computer Communication Network for Science and Higher School". Together with JINR, the participating institutes are the Research Institute for Nuclear Physics MSU (Moscow), Nuclear Physics Division RAS (Moscow), Institute for High Energy Physics (IHEP Minatom RF, Protvino), Institute for Theoretical and Experimental Physics (ITEP, Minatom, Moscow), Institute for Nuclear Research (Troitsk), St.Petersburg Nuclear Physics Institute (St.Petersburg). The realization of the project in the participating institutes has resulted in creation and development of the servers of the BAPHYS environment://dbserv.jinr.ru/, //www.ruhep.ru/, //dbserv.ihep.su/, //wwwppds.ihep.su/, //wwwtheor.itep.ru/, //face.itep.ru/, //alpha.npi.msu.su/, //depni.npi.msu.su/, //inr.troitsk.ru/, //dbserv.pnpi.spb.ru/, //xxx.itep.ru/, //dbserv.npi.msu.su/.

These servers contain data bases and knowledge bases, including the unique ones in fields of scientific research under way at the participating institutes. For example, a web-site has been created for the collaboration RDMS CMS representing participation of Russia and JINR at the development of a muonic detector CMS for experiments on the LHC at CERN. Other institutes' sites contain information on programmes for research, experimental installations, bibliographic and factographic data on results of scientific research and other information. The general concept of the project is grounded on utilizing a client –server architecture, local and global networks for data transfer (Internet, Russian BackBone and others), hyper-text and multimedia representation of information and corresponding hard- and software tools.

The main resource for the extra budgetary financing of the research under way at LCTA is 15 grants of the Russian Foundation for Basic Research. Part of them is carried out in cooperation with the Russian research organizations.

A token of prestige of the scientific research under way at LCTA is the dissertation council working at LCTA. 6 of 21 council members are professors of Moscow institutes. For the last 5 years 11 dissertations were defended by the scientists of the Russian research institutes conducting joint research with LCTA and JINR.

International cooperation

In cooperation with CERN and Brookhaven National Laboratory the following work has been carried out:

1. Development of an object-oriented program environment (framework ROOT) for the solving of a wide class of scientific problems using workstations and personal computers;
2. Development and realization of an information model for acquisition, reconstruction and physical analysis of data for large experiments;
3. Promotion of up-to-date object-oriented technologies for experiment STAR.

The activities mentioned in item 3 have resulted in creation of 3 fresh versions of the ROOT package that includes the versions of the package for the OS Windows and a set of classes for 3D graphics. The amount of the distributed copies of this package has reached 4000. The results were reported at the «US HENP ROOT Users Workshop» on 23-25 March, 1999.

A general model of the problem for reconstruction of the events obtained at the accelerators' experiments, has been complete. On its basis a library of base classes for the STAR experiment has been designed. The model was presented at the «US HENP ROOT Users Workshop» on 23-25 March, 1999 (http://runiicomputing.fnal.gov/root/) and at a meeting of the STAR Experiment Collaboration BNL http://sol.star.bnl.gov/~fine/ Publications/ STARJuly99 Meeting/ .

A geometric model has been designed for detectors and a package of 3D geometry and graphics on the base of the formal description obtained from the package GEANT 3.21. With the help of these classes, a 3D model of detectors STAR and ATLAS has been designed. Both models were written in ROOT-format and are accessible for interactive use via Web.

All the designed program products including the ROOT package and the software for the STAR experiment have been installed at JINR.

An automated system for administrating the computer complex in the research centre of Rossendorf (Germany) has been realized in the framework of cooperation and usage of some elements of the Java technology.

A protocol of cooperation with the University of Sofia in the area of application of such technologies has been signed.

In accordance with an agreement between JINR and the Research Centre Rossendorf, joint work was conducted on the project Zentrale Nutzerdatenbank» (Users Data Bank). The purpose of the project is the creation of an automated system of administrating a computer complex by using WWW technologies as a tool of access via the Internet to the database ORACLE.

In frames of these activities a new concept of a computer program for registration of users and work groups on the NT platform has been worked out. This concept takes a unified approach (and a unified program code as an ideal) to

registration of users on any POSIX - compatible platforms based on utilizing a centralized database for users and a unified (using the HTTP protocol) procedure for access to it.

A possibility was studied for a unified (standard) approach to the development of an automated procedure for registration of users within the POSIX specifications.

Future plans on Information Technologies Research at JINR

Networking/Telecommunication

Security, Organization, Rules for JINR LAN Monitoring, Resource Management for JINR LAN

Implementation of new Network Technologies

Large Software Systems

Design and Implementation of JINR-specific CASE-Tools

Participation in LHC Software Design (ROOT, LHC++)

Object Oriented Approach

Data Bases/Digital Libraries

Corporate Information Systems

JINR Digital Library

Base of Simulated Events

Computer Development

Regional Centre for LHC Data Handling

Computer Farms

Distributed Computing

Data Handling

Algorithms and Methods for Pattern Recognition and Data Extraction for JINR Experiments

Experimental Data Representation

Data Archiving

Fast Data Access

Computing

Modeling and Simulation of Physical Processes

Numerical Methods and Software Support for Theoretical Investigations

Methods and Algorithms of Computer Algebra

Nonlinear Models in Theoretical Investigations

Numerical Algorithms and Methods for Magnetic Field Calculations

Main Issues from Information Revolution

Unified information environment of JINR