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**A. V. Belushkin**

**SCIENTIFIC PROGRAMME  
OF THE FRANK LABORATORY  
OF NEUTRON PHYSICS:  
Report for 2001 and Prospects for 2002**

**Report to the 91st Session  
of the JINR Scientific Council,  
January 17–18, 2002**

**Dubna 2001**

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## INTRODUCTION

In 2001, the FLNP scientific program was realized under the auspices of five research themes of the JINR Plan of Scientific Research and International Scientific and Technical Cooperation (PSRISTC) and it was aimed at obtaining new results in condensed matter physics (theme 07-4-1031-99/2003 "Neutron Investigations of Structure and Dynamics of Condensed Matter", headed by V.L.Aksenov and A.M.Balagurov) and neutron nuclear physics (theme 06-4-1036-2001/2004 "Nuclear Physics with Neutrons – Fundamental and Applied Investigations", headed by W.I.Furman and V.N.Shvetsov). To effect scientific research, work to develop, modernize, and construct the FLNP basic facilities, IBR-2 (theme 07-4-0851-87/2002 "Development and Upgrading of the IBR-2 Complex", headed by V.D.Ananiev) and IREN (theme 06-4-0993-94/2004 "IREN Project", headed by W.I.Furman and I.N.Meshkov) as well as the IBR-2 spectrometry and computation complex (theme 07-4-1012-96/2002 "Development of the IBR-2 Spectrometers Complex and Computation Infrastructure", headed by A.V.Belushkin and V.I.Prikhodko) continued. Also, FLNP took part in the JINR themes: «ATLAS. General-Purpose pp Experiment at the Large Hadron Collider in CERN» (theme 02-0-1007-94/2005, headed by N.A.Russakovich), «Theoretical and Experimental Investigations of the Electronuclear Method of Energy Production and Radioactive Waste Transmutation» (theme 03-0-1008-95/2002, headed by A.N.Sissakian, I.V.Puzynin and A.Baldin).

This report contains a brief account of 2001 scientific results and outlines the 2002 year plans of the Laboratory reflected in the JINR Plan of Scientific Research (PSRISTC) submitted for approval to the present session of the JINR Scientific Council. The FLNP annual report for 2001 will give a more detail account of 2001 results.

## 1. SCIENTIFIC RESULTS IN 2001

### 1.1. Condensed Matter Physics

**Experimental investigations. Diffraction.** The crystalline and magnetic structures of the new complex layered manganese oxides  $A_2MnGaO_{5+x}$  ( $A=Sr, Ca$ ) have been investigated. The crystalline structure which is a derivative of the perovskite structure belongs to the brownmillerite type and consists of alternating  $(CaO)$ ,  $(MnO_2)$ ,  $(CaO)$  and  $(GaO)$  or  $(GaO_{1+x})$  layers. The valence of manganese changes from  $Mn^{3+}$  to  $Mn^{4+}$  as the oxygen index changes from 5 to 5.5. Like in the classical system  $(LaSr)MnO_3$  in brownmillerites one may expect the appearance of a ferromagnetic metallic state at intermediate valence of Mn. Several facts of principal importance for the construction of a model have been established. It appears that in spite of an essentially layered character of the structure (distances between the nearest Mn atoms in

the- and perpendicular to  $\text{MnO}_2$  planes differ about 2 times) the magnetic structure has a 3D character. The two studied compositions,  $\text{Sr}_2\text{GaMn}^{3+}\text{O}_5$  and  $\text{Sr}_2\text{GaMn}^{4+}\text{O}_{5.5}$ , are the antiferromagnetics with the Neel temperature  $T_N=160$  K and 100 K, respectively, but their spin configurations are different: neighbouring antiferromagnetic  $\text{MnO}_2$  planes in  $\text{Sr}_2\text{GaMn}^{3+}\text{O}_5$  are coupled antiferromagnetically while in  $\text{Sr}_2\text{GaMn}^{4+}\text{O}_{5.5}$  they are coupled ferromagnetically.

The influence of high pressure on the atomic and magnetic structures of the manganites  $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$ ,  $\text{Pr}_{0.8}\text{Na}_{0.2}\text{MnO}_3$  with a colossal magnetic resistance effect has been studied. In  $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$  there is observed a transition from ferromagnetic to antiferromagnetic state at a pressure of 4 GPa as the temperature decreases. In  $\text{Pr}_{0.8}\text{Na}_{0.2}\text{MnO}_3$  a change in the type of the antiferromagnetic structure is observed with increasing pressure.

Magnetic phase transitions in binary manganese compounds –  $\text{MnAs}$ ,  $\text{Mn}_2\text{Sb}$ , have been investigated. In  $\text{MnAs}$  at the pressure  $P = 4$  GPa and the temperature below 80 K we have observed a magnetic phase transition to an earlier unknown phase. The atomic and magnetic structure of the high pressure phase is determined. In  $\text{Mn}_2\text{Sb}$  at  $P=2.8$  GPa and room temperature a spin-reorientation magnetic phase transition resulting in a deviation of Mn magnetic moments from the axis  $c$  of the tetragonal structure is observed.

**Polarized neutrons and neutron optics.** Measuring the reflection of neutrons from a Fe/V bilayer at temperatures larger or smaller than 5 K, the critical temperature of superconducting transition for bulk vanadium, we obtained the results pointing to the existence of a superconducting state at a temperature above the critical or to the existence of a temperature-reversal superconductivity. This is a new observation in the case of bilayer systems and it is necessary to be verified.

The interaction between neutron radiation and an ultrasonic wave-excited structure has been investigated. For this purpose, measurements of the neutron reflection coefficient as a function the momentum transfer at total reflection from glass, diffractive reflection from a layered Fe/Cr structure, neutron wave enhancement in a wave resonator and at neutron wave channeling in a titanium layer were conducted. The measurements were carried out with longitudinal and transversal sonic waves. It is obtained that in the case of transversal waves, the reflection probability is 5 times larger than in the case of longitudinal waves. This possibly points to the fact that in the case of longitudinal waves, the reflection of neutrons is from the nodes of the standing sonic wave. The phenomenon of a sound-stimulated transition of neutrons from one to the other channeling mode is observed. The probability of such transition is determined by the roughness of the interface, which can be used to increase the sensitivity of determination of the parameters characterizing the interface (correlation length, mean square amplitude).

**Inelastic neutron scattering.** The vibrational spectra of the ammonium halides  $\text{NH}_4\text{Cl}$ ,  $\text{NH}_4\text{Br}$ ,  $\text{NH}_4\text{I}$  were investigated at up to 8-10 GPa, which is a record pressure in the case of inelastic neutron scattering. In the area of the phase transition from

disordered cubic to ordered cubic structure of the type CsCl, in  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{Br}$  there was observed a breaking on the pressure dependence of the librational mode of ammonium. In  $\text{NH}_4\text{I}$ , at pressures higher than 6 GPa hybridization of the transverse optical and librational modes was observed.

Inelastic neutron scattering investigations of crystalline electric field effects (CEF) in the systems  $\text{RAgSb}_2$  ( $\text{R}=\text{Er, Tm, Ho}$ ) have been performed. The CEF parameters, level schemes and the wave functions of each compound were determined. The temperature dependence of magnetic susceptibility calculated along different crystallographic directions is in good agreement with the results of measurements of single crystals. An analysis of the results shows that the magnetocrystalline anisotropy in such compounds is mainly caused by CEF.

Incoherent inelastic neutron scattering investigations of the dynamics of the metal-organic compounds  $\text{A}_2\text{MeX}_4$ , where A is the organic radical  $(\text{N}(\text{CH}_3)_4)^+$ ,  $(\text{N}(\text{C}_2\text{H}_5)_4)^+$ , Me is a metal (Zn, Cu, Cl), X is a halide, were conducted over a wide range of temperatures above and below the phase transition points. Such compounds are of interest because of a strong complex effect of a complete or partial replacement of the organic group on the structure organization and different types of structural instability. As a result of the conducted investigations, a mechanism of the observed phase transitions is proposed.

**Small angle scattering.** Structure and properties of tetramethylammonium bromide in aqueous solutions were studied via SANS under different conditions. It has been shown that size of the micelles decreases with temperature and the shape of the micelles is not, as usually assumed, spherical but is anisometric. The same system was studied in NaBr aqueous solutions. It was observed that the shape of the micelles changes from spherical to rod-like with increasing NaBr concentration. It has been shown that a gradual dehydration of the micelles upon increasing of electrolyte concentration is the driving force of the shape transformations.

A systematic study of influence of bilogically active amphiphils with long linear hydrocarbon chains (*N-Dodecyl-N,N-dimethylamine N-Oxides*), which are widely used in agriculture, food industry, pharmacy and medicine, on structure of lipid membranes was done via SANS. It has been confirmed that this substances do influence cells at the biological membrane level. SANS study of structural changes of lipidic cubic phase *in real time* in course of crystallization of bacteriorhodopsin (BR) from *Halobium Salinarium* led to better understanding of mechanism of the crystallization.

**Applied research.** Unique experimental data on the texture of the crust and upper mantle rocks in the earth have been obtained. A collection of olivine-bearing mantle rock samples from different areas in Europe have been investigated. The quantitative texture analysis is applied to reconstruct the texture functions and the spatial distribution of elastic wave velocities in each of the investigated samples is theoretically modeled. The pole figures (PF) measured for olivine samples and the data

on the condition of plastic deformation in olivine are used as a basis for the determination of the systems of slipping, as well as possible thermodynamic conditions and depths of texture formation.

Samples of Archean rocks from a super deep (SD-3) borehole in Kola Peninsula have been studied. Their striking similarity in mineral composition and mineral component textures to the natural outcrop of rocks in a Kola series was discovered. Microstructural and neutronographic investigations of samples taken deep from the earth crust as well as of their analogs from the surface reveal new peculiarities in the texture of these rocks, e.g., a more perfect dominating orientation of hornblende than of plagioclase grains and of plagioclase compared to quartz grains. Complex experiments at different hydrostatic pressures showed that the anisotropy coefficients of amphibolites from different depths in the SD-3 well decrease as the pressure, and correspondingly the depth, grows. The results have made it possible to explain the character of rock anisotropy at different depths on the basis of the new model of a texturized inhomogeneous fractured-porous medium.

Investigations of the effect of one-axis compression on internal microstresses in dolomite samples were conducted using a special deformation device. Under the action of different external loads there was investigated the value of residual strains and stresses in these samples. From the experimental data the Young coefficient is obtained. The results of the texture measurements performed prior to the deformation experiments indicated the existence of a weak dominating orientation corresponding to the layered texture plane in dolomite.

Measurements of residual stresses in the elements of the VVER-1000 reactor jacket were performed in cooperation with research institutes of the RF Ministry of Atomic Energy. The investigated sample was a two-layer plate whose basic layer is made from the construction ferrite steel and the build-up layer is from the austenite stainless steel. The component  $\sigma_y$  of the shell templet of the reactor jacket was investigated as a basic metal and as a melt. An analysis of the diffraction peak intensities revealed a strong texture in the austenite phase of the melt.

## 1.2. Neutron Nuclear Physics

The 2001 experimental program in neutron nuclear physics of FLNP traditionally included the following directions: experimental and theoretical investigations of the electromagnetic properties of the neutron and the beta-decay of the neutron, studies of parity violation processes in nuclear fission; investigations of high-excited states of nuclei in the reactions of thermal or resonance neutron capture, obtaining of new data for the purposes of nuclear astrophysics; experiments with ultracold neutrons. In 2001, measurements of interference effects in the polarized neutron-induced fission of  $^{239}\text{Pu}$  at the IBR-30 booster were completed. The emission asymmetry of light and heavy fragments in relation to the neutron momentum - neutron

spin plane was measured. This, so-called left-right asymmetry, does not violate P-parity and is due to interference between s- and p-resonances. The results together with those of earlier measured forward-backward asymmetry will make it possible to obtain yet unavailable information on p-wave resonances in heavy nuclei.

Another measured effect is the parity violating asymmetry of fragments emission in and opposite the direction of the captured neutron spin. It is the first time that such data are obtained for plutonium resonances (Fig. 1). At present, the processing of the experimental data on both effects is nearing completion and the preparation of publications is under way.

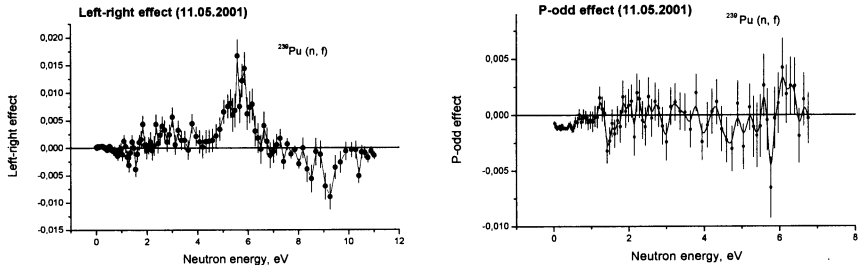


Fig. 1. The effects of the left-right and the parity violating asymmetry in the resonance neutron-induced fission of  $^{239}\text{Pu}$ .

Under the project **KaTRIn** the first tests of a neutron polarization system with laser pumping of  $^3\text{He}$  were performed on beam 2 of the IBR-30 reactor. The polarization of neutrons transmitted through a cell with a low-pressure  $^3\text{He}$  (5 atm) was about 23%. Measurements with a longitudinal magnetic field off showed that the residual longitudinal field in permalloy screens is sufficient for the optical orientation of rubidium to take place. In a real experiment, this makes it possible to do without a magnetic transport channel and avoid difficulties caused by mutually perpendicular fields of the channel and target.

Recent results from fundamental nuclear physics experiments indicate that the neutron-neutron interaction is stronger than the nuclear part of the proton-proton interaction, implying a breaking of charge symmetry in the strong nuclear force. The best way to verify this and to stimulate further development of the isotopic-spin invariance concept is to perform a direct measurement of neutron-neutron scattering by colliding free neutrons. The proposal for such an experiment - the ISTC Project 2286, which is a joint venture of the JINR (Dubna), VNITF (Snezhinsk), and TUNL (Durham, NC, USA) collaborators has been prepared and submitted to the International Science Technology Center. The experimental study of the thermal neutron fields formed by polyethylene converters inside the central channel of the aperiodic pulsed reactor Yaguar demonstrated that the reactor provides a required instantaneous value of about

$10^{18}$  n/cm<sup>2</sup>·s for the thermal neutron flux density during the neutron burst of 700  $\mu$ s duration. These results are reported at the Dubna ISINN-9 International Seminar.

In collaboration with PINP colleagues an experiment to measure p-odd correlation of the type  $a_\gamma \sim (\sigma_{n,p,\gamma})$  in the reaction  $^{10}\text{B}(n,\alpha)^7\text{Li}^* \rightarrow ^7\text{Li} + \gamma$  was conducted. The measurements were carried out on polarized cold neutron beams at the reactor in the Institute Laue Langevin (ILL), Grenoble, France. The aim of the experiment is the determination of the contribution of neutral current to weak nucleon-nucleon interactions. By theoretical estimates, in the presence of neutral current the asymmetry is on the level  $\sim 5 \cdot 10^{-8} - 10^{-7}$ . An accuracy of  $4 \cdot 10^{-8}$ , which is an order of magnitude better than in a previous experiment with the reactor VVRM of PINP in Gatchina, has been achieved so far.

A statistical analysis of the  $\alpha$ -widths distribution of  $^{147}\text{Sm}$  neutron resonances obtained in a joint experiment (Dubna, Oak Ridge, Lodz) with the ORELLA facility in Oak Ridge, USA was carried out. There was observed some indication to a possibly nonstatistical character of mean  $\alpha$ -widths in dependence on the excitation energy of compound nuclei.

A program for the calculation of neutron nucleosynthesis using parameters characteristic for hydrostatic burning of helium in massive stars (weak component in the s-process) has been created. Test calculations for the area S-CI-Ar show good coincidence with the results of other authors.

The cross sections and angular distributions of products from the reaction  $^{64}\text{Zn}(n,\alpha)$  at  $E_n = 5 \div 7$  MeV were obtained in a Van-de-Graaf experiment in the Institute of Heavy Ion Physics of Peking University.

Systematization of the (n,p) reaction cross sections on fast neutrons is developed on the basis of the principles of the statistical theory of nuclear reactions.

**Applied researches.** Successful application of nuclear analytical technique to the development of biotechnology and biochemistry, namely, to **Selenium- and Chromium-containing pharmaceuticals** based on blue-green algae (*Spirulina platensis*) has resulted in two patents in co-authorship with the Georgian scientists from the Tbilisi Institute of Physics named after Andronikashvili and a number of papers recognized by international journals. A combination of the above vitally important elements with protein-containing algae, called the "food of the future", allows to produce pharmaceuticals of great potential for treatment of a wide spectrum of diseases: from ischaemic heart disease - to enhancement of the immune system. Investigations on developing the technique of element content determination in *Spirulina platensis* are carried out at group of Neutron Activation Analysis.

The calibration of the fast neutron detector HEDN (High Energy Neutron Detector) for the American mission to Mars "Mars Surveyor Orbiter 2001" has been finished. These works have been performed in the frame of long-term collaboration with Institute of Cosmic Research of Russian Academy of Science. One of instruments has been installed at the cosmic apparatus and now is successfully working at the Mars orbit.



## 2. NEUTRON SOURCES

### 2.1. The IBR-2 Pulsed Reactor

In 2001 the IBR-2 reactor operated in accordance with the approved working schedule. It has operated 1800 hours in 8 cycles with the power  $W=1.5$  MW. The maintenance plan for the period from June to September, 2001 was fulfilled on time. It involved commissioning of Diesel-electric power station for the case of failure of standard power supply and transfer the movable reflector PO-2 from temporary storage to stationary one.

**Modernization project.** The PO-3 manufacturing is in progress. The MAYAK factory began to produce  $\text{PuO}_2$  tablets. Investigation of two exhausted fuel assemblies (FA) from IBR-2 started. Designing of the executive mechanisms of the control and emergency system finished. The design of special cryogenic helium plant is started.

### 2.2. The IREN Project

In 2001 an implementation of the IREN project was going on with serious difficulties. Main problem results from the lack of financing up to the end of August. So by September 20 the investments total 28.6 k\$ instead of the planned amount about 200 k\$. In spite of this some activity on implementation of the project was done and the time-tables of FLNP and PPL for year 2001 approved finally in February were fulfilled in many points.

First of all it was the activity connected with creation of elements of the linac LUE-200 carried out in the linear accelerator division of the PPL and the design bureau of the FLNP. As a result, the construction of all elements of the electron gun was completed and its mounting was started. The full set of working drawings of the linac assembly was prepared by the end of August. It allows one to fix precisely a position and sizes of all linac elements in accelerator halls of Bld. 43 of FLNP. It was completed also a geodesic survey of the axis of the old linac dismantling since August. The results of this survey will be necessary during mounting of the new linac which beam should be directed to the center of the multiplying target with high precision. A technological design of the magnetic focusing system was completed, the materials necessary for its construction were obtained and technological line for its mounting is installing now in PPL. A large work was carried out on full scale RF stand. During summer the vacuum system was installed and tested, the pressure of  $2 \times 10^{-8}$  Torr was achieved. After completion of some auxiliary systems the modulator M-350 together with the klystron 5045 SLAC was tested at the regime of enhancing of RF power. By the end of current year a start up of the RF stand with the first accelerating tube inside is planned. Last test experiments with long (210 ns) electron pulse and at high level ( 50 MW) of the RF

power are expected at linac prototype in BINP, Novosibirsk with participation of Dubna experts.

After final shut-down of IBR-30+LUE-40 neutron source at June 15 the activity for preparation of many necessary documents was intended so by the end of August the license of Russian Gosatomnadzor for decommissioning of the reactor IBR-30 has been obtained. Since this moment JINR got a right to begin real preparation for dismantling of IBR-30. In October a construction of the new building 117/6 for storing of activated elements of IBR-30 was started. By the end of current year the official project for decommissioning of IBR-30 completed by GSPI, Moscow in summer has to be approved in assigned Russian authorities. This process started in September. Large progress was achieved in working out of the modernized technical project of the multiplying target by NIKIET, Moscow. It planned to be finished by the end of the current year. With much lower rate a preparation of the general technical project of the IREN source was been carrying by GSPI, Moscow during last year. So a completion of the partial project necessary for official approval is shifted now at least for one quarter.

It is important to stress that all activity of the external partners was realized in debt due to "inertia of trust" after intensive financing in the end of previous year. The current time-table of the project for year 2001 corrected and approved by JINR directorate on 20 September foresees the investments total 360 k\$ by the end of the year. This number includes about 200 k\$ paid for the project by December. The corrected (with account of a real delay by the date) time-table of the project for years 2001-2003 approved preliminary by JINR directorate in September envisages the start up of the first stage of the IREN source by the end of 2003.

### **3. DEVELOPMENT OF THE IBR-2 SPECTROMETER COMPLEX AND COMPUTATION INFRASTRUCTURE**

Work on the theme went in keeping with the FLNP projects ICC, FSD, YuMo, Texture, PNS, Detectors, BMBF – ECS, etc. in the following main directions:

- Routine operation and development of the IBR-2 spectrometer complex.
- Creation of data acquisition and spectrometer control systems.
- Development of the information-computation infrastructure.

**Local area network and computing infrastructure.** In the year 2001, a transition to Fast Ethernet 100 Mbit standard was accomplished in two LAN segments (bldg 42a – NICM-division and bldg. 42 – PN-division). In bldg. 42a, the commutator Catalyst 2924XL (CISCO) was installed and commissioned, which increased data transmission rates and the reliability of this transmission in the NICM-division segment.

A contract was signed to purchase a data flow router for LAN in FLNP (CISCO router 8510) and the necessary preparation work to install it was carried out. The startup of the router, expected in early 2002, will make it possible to:

- Remove limits on the number of IP-addresses.
- Increase the actual transmission capability of network by 50-60% without changing physical interfaces.
- Perform analysis and filtration of traffic in the net.
- Create virtual subnetworks for user groups irrespective of their geographical position, etc.

**Data acquisition systems.** In the reported year the detector systems in a number of spectrometers were modernized. In particular, the new low-noise electronic blocks for the detector “NEW” in YuMO were developed, manufactured and tested, debugging of the 32-channel detector in SPN was executed, detector electronics in KDSOG was completely renewed, and a linear PSD with a resistive wire was introduced into the DN-2 scheme.

In the spectrometer Epsilon a unified VME-system for data acquisition was put into operation. It, in addition to a standard set of functions, executes, by electronic means, the correction of the neutron time of flight (time focusing).

A second TDS/DSP data acquisition block with a PCI interface for the detector MSGC (HMI, Berlin) was manufactured and debugged using a programmable generator of events. At present, the block is being used in FLNP for the development and testing of software products.

Work continued to develop and install on the spectrometers of a SONIX unified complex of programs for data acquisition.

**Development of the IBR -2 spectrometer complex** In the reported year the spectrometer equipment was prepared and operated to serve eight IBR-2 cycles.

The development of the sample environment systems continued:

- New executive mechanisms adapted to the existing step-motor-based control systems were incorporated into the spectrometer schemes.
- Certification of the existing devices, including furnaces, refrigerator heads, etc., continued with the aim of creation of a data base on temperature control and regulation devices in the spectrometers HRFD, FSD, PNS, YuMO, DN2 and the X-ray diffractometer DRON.
- Research into how to connect two control elements (for the heater and refrigerator) to one Eurotherm regulator of the type 902S or 906S was carried out. The results are used on the DRON diffractometer. The precision of the control system is +/- 0.03 degrees.
- A second channel for control of the temperature of the annealing furnace in the sample preparation room is completed and put into operation.
- To develop a RGD-1245 refrigerator-based cryostat for 4.2 K was carried out and at present, the manufacturing is being completed.

The design, plans and specifications for the construction of a “Clean room” and a gas rig for assembling of gas detectors are prepared.

The main spectrometer development effort focused on SPN, YuMO, FSD, and DN-12.

#### 4. SCIENTIFIC RESEARCH PLAN FOR 2002

The 2002 FLNP Scientific Research Plan contains 5 first priority themes.

Theme	Leader	Priority	Code
Neutron investigations of the structure and dynamics of condensed matter	V.L.Aksenov A.M.Balagurov	1	07-4-1031-99/2003
Study of the fundamental properties of neutrons and nuclei	W.I.Furman V.N.Shvetsov	1	06-4-1036-01/2004
Upgrading of the IBR-2 complex	V.D.Ananiev E.P.Shabalin	1	07-4-0851-87/2002
Realization of the IREN project	I.N.Meshkov W.I.Furman	1	06-4-0993-94/2004
Development of the spectrometer complex and computation infrastructure of IBR-2	A.V.Belushkin V.I.Prikhodko	1	07-4-1012-96/2002

In the year 2002, in the framework of theme 1031 investigations in condensed matter will be carried out in the following directions:

*The plan of methodological work foresees an increase of the number of detectors in the FSD diffractometer and the start of regular experiments with it. FSD will be mainly exploited to carry out the program of investigations based on orders from MINATOM establishments. NSVR spectrometer will be tested and adjusted after its moving to the new place. Neutron beam will be adjusted at the SPN spectrometer. It will allow us to carry out experiments in two small angle modes: at bulk samples and layered structures.*

*The program of scientific research will base on experimental proposals selected by experts' committee and the approved long-term projects. It will include, in the main, the research directions traditionally investigated at the IBR-2 reactor and will focus on obtaining of new data about the microscopic properties of the investigated systems and experimental verification of theoretical predictions and models.*

The following research program will be realized in the frame of 1036 theme:

*Measurements of  $(n,p)$ ,  $(n,\alpha)$  reactions cross sections in energy range 3 – 6 MeV.*

*Precision measurement of full neutron cross section on gaseous argon as a first stage of the  $(n, e)$ -interaction investigation.*

*The theoretical analysis of the data obtained in experiments with measurement of angular assymetry of aligned  $^{235}\text{U}$  nuclei fission fragments, P-even and P-odd assymetries at the  $^{235}\text{U}$ ,  $^{233}\text{U}$ ,  $^{239}\text{Pu}$  nuclei fission by resonance neutrons.*

*Preparation and realization of test experiment with JAGUAR reactor (Snezhinsk, Russia), in the frame of the project of neutron-neutron scattering length direct measurement.*

*Experiment on the cold neutrons “weak heating” will be continued in ILL on the new spectrometer made in FLNP.*

*Mathematical and physical modelling of fast neutrons detectors for neutron fields measurement on space apparatus will be continued.*

The following main problems are to be solved in the year 2002 in the framework of theme 1012:

- *Create and test a wide-aperture analyser of neutron polarization in the reflectometric shoulder of SPN and continue the development of the SPN sample environment.*
- *Further modernization of the YuMO spectrometer.*
- *Manufacture four elements of the  $90^\circ$ -detector ASTRA and develop unified software for the spectrometer FSD.*
- *Develop a new detector on the basis of a ZnS scintillator for the spectrometer DN-12.*
- *Continue routine operation on line with the modernisation of the measuring and control systems of the IBR-2 spectrometers.*
- *Install and commission an information flow router in the FLNP local area network. Extend the configuration of the router to allow connecting to it of the SUN-cluster servers.*
- *Optimize the characteristics and increase the reliability of the data acquisition VME-systems on the IBR-2 spectrometers.*
- *Develop the VME-PCI interface software and integrate PC into the data acquisition systems.*
- *Develop, manufacture and test unified data acquisition electronics with a PSD reading out the data from the delay line.*
- *Develop software for analysis of the neutron scattering data.*

The following main tasks are to be accomplished in the year 2002 in the framework of theme 0851:

- *Providing of 2000 hrs-beam time for physical measurements (8 cycles a year).*
- *Manufacturing of the PO-3 movable reflector up to middle of 2002.*
- *Beginning of manufacturing of the reactor vessel.*
- *Continue working with new fuel loading.*
- *Developing of the cryogenic mashine project.*

## **5. CONFERENCES AND MEETINGS**

In 2001, FLNP organized the following meetings:

1. *IX International Seminar on Interaction of Neutrons with Nuclei ISINN-9, May 17-20.*
2. *School on Neutron Scattering and Synchrotron Radiation, March 19 - April 27.*
3. *IBR-2 in the XXI century. User's Meeting, May 24-26.*

In the year 2002, FLNP will organize the following meetings:

1. *X International Seminar on Interaction of Neutrons with Nuclei ISINN-9, May 22-25.*
2. *School on Neutron Scattering and Synchrotron Radiation, February 8 - March 7.*
3. *JINR-Romania Workshop on Material Science, March 22-25.*
4. *IBR-2 User's Meeting, June 17-19*

**Макет Т. Е. Попеко**

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