E1-2001-91

L.M.Soroko

THE PERMANENT FORWARD

(Some Episodes from the History
of the Laboratory of Nuclear Problems, 1949–1999)

1. INTRODUCTION

Out of about 6000 scientific investigations, performed at the Laboratory of Nuclear Problems during 50 years of its activity, there were chosen the most brilliant ones coupled by the common motto; to be always the permanent forward. The quality category of the investigations under this motto was different. It way be either the priority inside JINR, or priority of USSR or Russia, or, finally, the priority at the world-wide renown fame. The scale of the investigations presented in this review was also different. But always we have the newness of the idea, the robust of the approach and the simplicity of the technological solution.

2. TEMPERATURE OF THE EXCITED NUCLEUS

The "Scattering Chamber" as a device for investigation of the interactions of deuterons and α-particles with matter and for clearing up of the properties of the excited nuclei was manufactured in 1948 at the Laboratory No 2 of the Academy of Sciences of USSR in Moscow at the department, the chief of which was M.G.Mescherjakov. The beams of deuterons and α-particles with energy 15.5 MeV and 26.4 MeV, respectively, were accelerated by means of big cyclotron of the Laboratory No 2 under the leadership of L.M.Nemenov. The chief engineer of this cyclotron was A.V.Chestnoy. As a director, L.M.Nemenov demanded the ideal cleanness in the accelerator room. The doing up must be finished before 8 hours in the morning. The cleanness of the floor covered by the glazed tile was tested by L.M.Nemenov himself by the handkerchief. A.V.Chestnoy shortly after went to Dubna for construction of the great synchrocyclotron of the Laboratory of Nuclear Problems.

The secondary particles from the nuclear interactions were detected in the "Scattering Chamber" simultaneously at various directions by means of the nuclear emulsion casting on the glass backing. The nuclear emulsion layers were located fan-shaped with 10° angular intervals. At that time, in 1948, we cannot buy the nuclear emulsion, and therefore it was prepared by D.M.Samoilovich at the Laboratory No 2. Only at 1950-1951 we can get the nuclear emulsion ILFORD-G5.

The manufacturing of the "Scattering Chamber", exhibited now as an scientific exponate in the Museum of the History of the Science and Technology of JINR, and the experiments with this device were performed under the leadership of M.G.Mescherjakov by the scientific group consisting of A.A.Reut, E.L.Grigoriev, L.M.Soroko, N.P.Bogachev and V.V.Barchugov in 1948-1949.

The experimental results, presented in the scientific reports of the Laboratory No 2 of the Academy of Sciences of USSR, were gathered in the doctoral thesis of M.G.Mescherjakov which was defended in 1950 at the Institute of Atomic Energy (Laboratory No 2 of Academy of Sciences of USSR). The participants of these investigations were invited at the defend ceremony. The chief of the scientific consey was L.A.Artzimovich – academician secretary of the Department of General Physics and Astronomy of Academy of Sciences of USSR. He noted as the most interesting one chapter of the M.G.Mescherjakov thesis in which there has been estimated experimentally the temperature of the excited nuclear. To find this parameter it was sufficient to present the proton energy spectra in the logarithmic scale. This operation could be made with confidence at that time only by the followers of L.A.Artzimovich, I.I.Gurevich and A.B.Migdal, the brilliant lectures of which we have listened at the physical-engineer Faculty of the Moscow Mechanical Institute in 1947-1948.

Now, from the knowledge of 2000, the investigations described here may be seemed as trivial ones for most of the readers. But in 1948-1950 each step in the unnowness was accompanied by many discussions and debates.

For example, there were the disagreements in the elementary nation "effective cross section" of nuclear processes, observed in the "Scattering Chamber". Some workers insisted that the probability of the observation event does depend both from depth of the foil target and from the width of the particle beam.

The creative spirit of the young physicians just graduated MIPI and Moscow State University defined the high scientific potential and the international trust to the investigations performed at the Laboratory of Nuclear Problems, gained long before entering into the JINR.

3. ČERENKOV PARTICLES COUNTER

By 1954 the electron multipliers were used allover for registration of scintillations induced by the charged particles. B.S.Neganov wanted to see the flash of the Čerenkov radiation produced by the fast charge particles of the cosmic radiation. Just "see", as the signal from the output of the photomultiplier was sent at the input of very sensitive oscillograph working in the mode without sweeping. The radiator was the rod made of high purity acrylic plastic of the length 0.5 m, oriented to the zenith. The charge particle of the cosmic rays went a long the axis of this rod very seldom. Therefore the spectator of such events must wait for up to 10 minutes before to see the bright pulse of high amplitude on the screen of the oscillograph. But everybody wanted to detect this event directly by the counter.

In the same room there was an electronic device for registration of β-γ coincidence event constructed by A.S.Kuznetsov and L.M.Soroko. To detect the Čerenkov radiation of the particle in the water, a special vessel with walls of the acrylic plastic has been made. The internal part of this vessel was pasted over with aluminum foil, having windows for outgoing of the light flash onto two photomultipliers. This system was filled with pure water of the high 2 to 8 cm. The number of the coincidence events in two channels of this device was detected at various depths of the water layer. The counter characteristic curve had a peculiar plato versus water depth. The dip of the curve was at the water depth of 2 cm.

The interesting results of this experiments gained currency very fast over the Laboratory. There were constructed the more courageous devices, in particular, a counter telescope of several particle counters, one of which was a Čerenkov radiation counter. Such exotic counter telescope was made by Yu.D.Prokoshkin in the department of M.S.Kozodaev, as well as by G.I.Selivanov in the department of B.M.Pontecorvo.

The β-γ coincidence device with two photomultipliers was indeed a long-lived one due to its simplicity and to robust working characteristics. This device had used by V.P.Afanasjev in the Laboratory of Radiochemistry for several investigations.

4. TARGET OF LIQUEFIED GASES

At the very beginning the physicists used two targets, one made of polyethylene and another of carbon. To detect the processes of proton-proton interactions we had accomplished two runs, one with CH_2 target and another one with *C* target. The difference effect thus detected had high statistical error. To get more precise results we needed the target with liquefied hydrogen.

The first liquid-hydrogen target was made in LNP in 1956 under the leadership of V.M.Sidorov. Because of its restricted observation geometry this target suited only for measurement of the total cross section. O.V.Savchenko and L.M.Soroko used a dewar with glass walls, which was filled before the experiment by liquid hydrogen, prepared at the Hydrogen Station of LNP. The transportation of this target was made by hand in accordance to the safety engineering.

Later M.S.Korenchenko made the target for liquid hydrogen in the form of the container from expanded polystyrene with nitrogen thermal screen.

Meanwhile neither of these variants of targets with liquid hydrogen did not suit to physicists, and, in particular, did not permit the filling of these targets by liquid deuterium. Only in 1958 the universal target for liquid hydrogen and liquid deuterium had been constructed in LNP by A.V.Bogomolov, V.G.Wowchenko, V.V.Swjatkovsky, L.M.Soroko and I.A.Shtyrin. The vertical cylindrical container of 42 mm diameter was made of brass foil of thickness 40 μm. The epoxy resin was used for the first time to stick together the brass foils. This universal target had a system for refilling of the working volume by the liquid hydrogen, the level indicator of the liquid hydrogen, the system of gaseous deuterium feed and regenerator of the deuterium. The background counting rate from the empty target was recordedly small. All the manufacturing operations were accomplished in the Experimental Workshop of the LNP under the leadership of K.A.Baycher and in the Hydrogen Set with participation of V.P.Dmitrievsky, Yu.A.Kuznetsov and A.V.Chekmenjev.

This universal target with liquid gases had been used more than 10 years by the physicists of the scientific groups of L.M.Soroko, S.B.Nurushev, Yu.D.Prokoshkin and V.I.Petrukhin.

5. COMPLETE EXPERIMENT

The complete experiment for investigation of the π-mesons production by nucleons has been performed for the first time in the Laboratory of Nuclear Problems. The episode with "isobar" was before this. At that time the physicists were under the press of the family of "varitrons" errorneusly announced by A.I.Alikhanov and A.I.Alikhanjan. The idea of "varitrons" gave no moment peace to M.G.Mescherjakov as well. There has been constructed a great spectrometer for observation of secondary particles in the range of energy 280 MeV. Just in this region the “isobar” was expected to exist.

I myself did not participate at this noncorrected experiment, as I estimated it as an adventuristic one. The physicists of the L.D.Landau school and in the first place prof. Ya.A.Smorodinsky did not share the approaches of M.G.Mescherjakov. Thus as far as in 1955 I rejected completely the conception of “isobar” and with my like-minded persons Yu.K.Akimov and O.V.Savchenko we began the preparation of the program of the complete experiment. Ya.A.Smorodinsky and L.I.Lapidus gave the supporting of our program.

At that time the leadership of the LNP has been transferred from M.G.Mescherjakov to V.P.Dzhelepov, and the experimental performing of this program were accomplished with the lay down program. The journal references to our classical investigations made by Yu.K.Akimov, K.S.Marish, O.V.Savchenko and L.M.Soroko were cited on the pages of the scientific journal from 1959 until 1971.

In the course of the processing of the experimental data we used the maximum likelihood technique developed by I.P.Klepikov and S.N.Sokolov in 1958. The notions “matrix of the experiment” and nondiagonal elements of this matrix were the novelty for many physicists.

The focusing system of the polarized proton beam was also quite new. It consisted of very simple bars of iron, placed inside the gap of the deflecting electromagnet. This system was developed by V.I.Danilov and O.V.Savchenko in 1958 as a very effective equivalent of two quadrupole lenses, for construction of which we had neither time nor resources. The focusing system did not take additional working place, additional electropower and was extremely simple. The density of the polarized proton beam has been increased three fold.

It is interesting to mention an episode about the theory of interaction of the secondary particles in the final state. The scientific seminars in the LNP were the center of the scientific ideas. The active participants of these seminars were I.Ya.Pomeranchuk, Ya.A.Smorodinsky, A.B.Migdal, as well as other physicists from Moscow and Leningrad. At one of these seminars there were I.V.Kurchatov, N.N.Semenov, Ya.B.Zeldovich, A.A.Kompaneetz, L.D.Landau and E.M.Lifshitz.

On coming in Dubna, I.Ya.Pomeranchuk posed before me, the secretary of this seminars, one standard question: ‘What is passing?” He want to know the scientific news. I presented the news also to A.B.Migdal. Once day he was excited by the experimental spectra of the secondary particles in the process of the π-meson production. During two days and nights in Dubna A.B.Migdal founded the theory of the particle interaction in the final state. This was done independently from the American physicists.

6. ELECTRO-OPTICAL TRANSDUCER (EOT)

In spite of unsuccessful trial of construction of three-cascaded EOT’s in Germany and USA at the beginning of 40 years the manufacture of the multi-cascade EOT’s in USSR has been accomplished by E.K.Zavojsky with participant of M.M.Butslov. The first multi-cascaded EOT was made in 1953 by M.M.Butslov, A.G.Plahov and G.E.Smolkin. By means of this device there was firstly detected the separate photons and the amplified image of the particle track in the scintillator. By using of EOT's E.K.Zavojsky and S.D.Fanchenko founded out that the lifetime of miniature electric spark was equal only to 10^{-10} s. So the idea of new type of the particle counter named now as spark counter has arisen. The two electrode particle counter of this type was demonstrated in 1957 at the Exhibition of National Economic Achievement and was rewarded by the golden medal.

The great success of the E.K.Zavojsky's group was such unexpected that nobody abroad could not even repair these experiments during 10 years. The scientific priority of this approach has received the international recognition after the publication of the paper "Luminescent chamber" in the Journal Reports of Academy of Sciences of USSR in 1955.

The natural logical continuation of the pioneer works of E.K.Zavojsky was the making of the first isotropic charge chamber in LNP in 1963. The formation of the particle tracks in the gaseous medium of this chamber was accomplished at the restricted gaseous amplification of the primary ionization by means of the gaseous discharge. Thus the registration efficiency and the brightness of the particle track did not depend on the angle between the particle trajectory and direction of the pulse electric field in this chamber.

To see the weak particle track, a multi-cascaded EOT was used by M.M.Butslov, V.I.Komarov and O.V.Savchenko. The evident advantage of the isotropic charge chamber over the streamer ones have been demonstrated in 1966 by V.I.Komarov, V.I.Petrukhin and O.V.Savchenko in the experiments on the measurement of the lifetime of π^+- and π^--mesons by means of the device with stopped muons in gas by V.I.Komarov, O.V.Savchenko and N.S.Fedjaev, and then in 1968 for measurements of the probability rate of the heavy charge particle emission in the course of the capture of μ^--mesons by Ne-nucleus in the experiments performed by V.I.Komarov and O.V.Savchenko.

The scintillation filaments of the 1 mm diameter have been made from the melt of polystirene with scintillation admixtures by O.V.Savchenko in 1959. The controlled luminescent chamber on the basis of the scintillation block of the volume 2.5 l consisting of these scintillation filaments was made by Yu.K.Akimov, M.M.Butslov, O.V.Savchenko and L.M.Soroko. One chamber and multi-cascaded EOT's have been used.

The next developing step of the registration technique of the particle track by means of EOT's in LNP was directed to suppression of the geometrical distortions in EOT's. For this aim the multi-cascaded EOT was placed in such strong magnetic field that the larmor radius of the electron was smaller than the dimensions of the amplified image element (M.M.Butslov, V.I.Komarov, G.E.Kosarev and O.V.Savchenko, 1969). The non-stability of the EOT observed in these conditions has been eliminated by means of the non-uniform magnetic field. Such a system containing EOT without geometrical distortions has been used in the isotropic charge chamber with stereoscopic registration system.

In the experiments on elastic back scattering of the fast protons on light nuclei, V.I.Komarov, G.E.Kosarev and O.V.Savchenko have got an estimation of the upper bound limit of the cross section of the elastic back scattering by ^{6}Li nucleus. High stability of the image in this perfect variant of the isotropic charge chamber opens high oportunity for performing of other precise measurements.

7. DOUBLE CHARGE EXCHANGING

The term "Double charge exchanging" is used for processes of the transition of π-meson of one sign into π-meson of the counter-sign, when the initiating π-meson interacts with nucleus at energy lower than the threshold of the direct π-mesons production by π-mesons. The discovery of this new process represents the most striking brilliant of the achievement crown of LNP at the world level. The references to this discovery made by Yu.A.Batusov, S.A.Bunjatov, V.M.Sidorov and V.A.Yarba in 1964, were permanently in the scientific journals during more than 30 years.

Meanwhile at the very beginning of these experiments, some physicists including the authors of these investigations, estimated the experimental results as a nontreated plain diamond. Only after active support of D.I.Blokhintsev and L.I.Lapidus, the facets of this diamond began to sparkle.

The double charge exchanging of π-mesons has been discovered due to application of the modern technique of the nuclear emulsion chamber and due to very good organization of its survey. The process of the double charge exchanging can be induced both positive and negative π-mesons.

The theoretical model of the double charge exchanging accepted in the calculation of Yu.A.Batusov, V.I.Kochkin and B.M.Maltsev in 1967 was in agreement with the experimental data.

In the analogous nuclear emulsion chamber the ^{8}He-nucleus, produced at the capture of the negative π-mesons by the carbon-nucleus or oxygen-nucleus, were detected in 1966 by Yu.A.Batusov, S.A.Bunjatov, V.M.Sidorov and V.A.Yarba. The decay of the ^{8}He-nucleus into two α-particles and two electrons in the nuclear emulsion is seen as the distinctive hammer. The mass of the ^{8}He-nuclear has been estimated.

8. DILUTION REFRIGERATOR

B.S.Neganov is indeed a founder of the technique for production of superlow temperatures by means of dilution of the liquid ^{3}He in the ^{4}He. With this type of the dilution cryostat of the continuous action constructed in LNP in 1965, a temperature 0.05 K and the refrigerating capacity 1800 erg/s at the temperature 0.1 K were reached.

One of the next dilution refrigerator of the B.S.Neganov's construction has kept for a long time a record of the extreme low temperature 0.0055 K. Thus the B.S.Neganov's construction became the basic one for production of the temperature in the region 0.01 K. By means of the combination of the Pomeranchuck's technique of the nuclear demagnetization and of the Neganov's dilution refrigerator we can produce the temperature 0.001 K.

The epochal invention of B.S.Neganov made available for physicists the temperature regions, which are 10^3 times lower, in comparison to the helium ones. Later B.S.Neganov constructed more powerful dilution refrigerators and thus gave the oportunity to use this low cryogenic techniques in the nuclear physics and in the physics of high energy. In particular, one such refrigerator constructed on the basis of the dynamic polarization of the hydrogen stood the heat load (duty) 100 mW at the temperature 0.3 K and enabled the polarization of the frozen proton close to 100%.

The development of the dilution refrigerators has been performed in LNP by the group of physicists: B.S.Borisov, M.Yu.Liburg, Yu.F.Kiselev, V.N.Matafonov and E.I.Bunjatova. This investigation received a high appraisal in USSR and the zealous resonance abroad. The M.V.Lomonosov's price was awarded to B.S.Neganov by Presidium of Academy of Sciences of USSR for a series of refrigerators by dilution of ^{3}He isotope in ^{4}He for production of superlow temperatures.

The aim of the investigations performed by B.S.Neganov on the helium cryogenics in 1957 was the manufacture of the polarized target for use in the high energy physics. Meanwhile some colleagues and the chief of this department estimated at that time the posed aim as a extreme reckless and therefore did not believe in its reality at the absolute fashion. But B.S.Neganov not only disproved the opinions of sceptics but also founded inside the LNP the up-to-date laboratory of the low temperatures.

And now about the current step of B.S.Neganov's investigations in the field of the relativity theory of A.Einstein. The main point of these investigations is the Thomas precession which was opened as delayed child only 20 years after the creation of the relativity theory of A.Einstein, though this phenomenon was indeed a direct corollary of the noncommutativity of the Einstein's law of the noncollinear velocity addition.

The majority of this last-born child came also very late. Only in 1986 there was formulated completely the properties of the Thomas precession and the mathematical formulation of this phenomenon. And finally B.S.Neganov introduced in 1989 a new physical phenomenon – a local Thomas precession, which follows directly from the Lorentz transformation, but does contradict to the relativity theory of Einstein. Thus a local Thomas precession does permit to mark the inertial coordinate system to distinguish one system from another.

B.S.Neganov proposed a key experiment (experimentum crucial) to solve the existing dilemmas. It can be performed in the laboratory conditions. For this aim we must construct an experimental model of the atom with electron orbit radius 0.2 m with electrons moving at velocity close to the light velocity. With such set up we may receive the answer to the question if do the daily and annual variations of the local Thomas precession axist or not? Either of these two answers will have the fundamental value for modern physics.

9. HOLOGRAPHY

Professor B.M.Pontecorvo and professor Ya.A.Smorodinsky proposed me in 1964 to prepare an overview on the topics: "Hologramme. What does it mean?" With this report I began a voyage over the waves of the holography and coherent optics. A JINR preprint "Lecture on holography" was published in 1966. In this preprint there were gathered my lectures on holography held in JINR, MPTI, IAE, IPH, FIAN and ITEP. This preprint was republished at IAE in Moscow and at Kiev State University.

A permanent working seminar on holography and coherent optics has been founded in 1966-1967 in MPTI at the sub-faculty of the quantum electronics. A "Synopsis on holography" was published in 1967 by MPTI, and the fundamental monography "Holography and coherent optics" has been written in 1968. Then it was published by the printing house "Nauka" in Moscow in 1971 under direct support of L.A.Arzimowich, the secretary-academician of the Nuclear Physics Department of the Academy of Sciences of USSR. The translation in English of this book was edited in USA by the Plenum Press in 1980.

A cycle of lectures on holography was presented in 1972 in GDR in Dresden Technical University and in the Carl Zeiss Company, Jena.

The contribution of the LNP into the development of holography in USSR and in Russia was fixed at the Processing of the School-Symposium on holography in various cities of USSR. At the last, anniversary XXV school on holography in Yaroslavl city, it was mentioned that the prehistory of the school on coherent optics and holography is coupled with L.M.Soroko, the chief of the seminars in MPTI.

Prof. Ya.A.Smorodinsky (JINR) interested in the problems of holography. Several discussions on this topics were concluded with publication of two booklets for "foot-passengers" written by us: "Physics of holography" (JINR, 1968), and "Progress in holography" (M., Znanie, 1970).

Meanwhile the direct application of holography as its classical variant in the high energy physics was principally incorrect due to specific properties of the objects detected by the track chambers. Here it will be sufficient to use the convergent coherent light beams and the Fourier-optics. Just on this approach can be solved the problem of the depth focus in the great volume of the track chamber, as well as, in the nuclear research emulsion.

To this end a meso-optics, new branch of the coherent optics, has been arisen. In meso-optics we use conical wave fields instead of spherical ones. It was proved that conical wave fields represent the compacted support of the information about the position of the straight light segment in space. The investigations on meso-optics and Hilbert-optics were performed in LNP with collaboration of IAEl on Sibirean Department of Academy of Sciences of USSR.

10. LAMB SHIFT POLARIMETER

The source of the polarized ions is indeed an integral part of the modern accelerators of the charge particles. The source of the polarized protons for power phasotron of LNP (JINR) was developed since 1970. To get the polarized atoms a simplified construction of the dissociator was used. This device did require no fine tuning of the high frequency autogenerator. The separation of the hydrogen atoms in accordance to superfine structure has accomplished a sextupole separating magnet with varying aperture. The radio-frequency polarimeter was founded on the adiabating passage in the low magnetic field. The polarization degree of the protons was 90%. The high vacuum Penning discharge in the high magnetic field was used in the ionizer of the polarized hydrogen atoms. The ionization efficiency was 0.4% and was not lower than in the best ionizers in other laboratories over the world.

And, what was very important, we used Lamb shift polarimeter to control the polarization degree of the proton beam at the output of the ionizator. The traditional control system consisted of the acceleration of the particle up to the energy higher than the threshold of the nuclear reaction and to subsequent measurement of the axial asymmetry of the reaction's products. Thus, to measure the tensor polarization of the deuterons in the reaction $d + T \rightarrow n + \alpha$ we must accelerate deuterons up to 100 keV.

Yu.A.Pliss and L.M.Soroko resolved this problem by removing of the acceleration stage of the polarized ions. For this aim there was used pure atomic process, namely, the Lamb shift of the hydrogen atoms levels. The general idea of this approach was in the air, but was realized for the first time at LNP in 1974.

The main element of the Lamb shift polarimeter was a cesium cell heated from outside up to 140°C and two photon counters for wave length 121.6 nm. With this device we succeded to estimate the polarization degree of the polarized protons at the output of the ionizer. As a result there was no need to construct a bulky and expensive system of the static acceleration of the particles and of the transferring of the operational information from device which was at the electrical potential 400 V with respect to the ground.

After the establishment of the Lamb shift polarimeter in LNP we had a fundament for performing of the next stages, in particular, for construction of the injector of the polarized beam into the phasotron. But just at this moment the development of the polarized proton source were ceased. All the program of the complex development has been teared up by the roots from the basis, the creation of which lasted more than six years.

As strange paradox there is ringing the fact that now only LNP has niether source of the polarized ions, nor accelerated primary polarized particles. And at that time LNP was at the most forward line.

We both found ourselves unengaged. Thus, we had no choice but to transfer our experience and knowledge to our own brother, the Laboratory of High Energies, where at that time the development of the source of the polarized deuterons was started at the Department of Yu.K.Pylypenko.

Academician A.M.Baldin noted recently, that the devotion to the science of L.M.Soroko is expressed in that his creative activity did not restricted only to the interests of LNP, and that L.M.Soroko was indeed the pioneer of the acceleration of the polarized particles in JINR.

11. OPTICAL MICROSCOPE WITHOUT DEPTH SCANNING

The main element of the meso-optical Fourier-transform microscope intended for selective observation of the straight line particle track in the nuclear photoemulsion without depth scanning, was a mirror, which transforms a point on the optical axis into a narrow ring. At small displacements of this point a narrow ring changes its parameters: radius, excentricity and orientation. These properties of this meso-optical mirror enables one to remove the depth scanning, though the information about Z-coordinate of the particle track is kept completely and goes in the compact form onto photodetector.

Problem of the manufacture of this meso-optical mirror with ring responce could not solve at any of the optical institutes. And what is more, the specialists from the State Optical Institute as well as from Leningrad Optico-Mechanical Association contended that it is impossible in general to made the ring of width as small as 2 μm.

But the specialist from the factory "Red Proletarian" in Moscow considered this problem as a completely soluble. In this factory there was a system of the precise diamond turning controlled by the multipath interferometer. Just at this factory a meso-optical mirror with ring response was manufactured for the first time in the world. The width of the meso-optical ring was 1.5 μm instead of the theoretically expected 1.4 μm.

The developments of meso-optical Fourier-transform microscope were accomplished in the frame of the USSR-Hungary collaboration. The staff of the Dubna group includes A.Ya.Astakhov (LCTA), Yu.A.Batusov, V.I.Krasnoslobotsev (LCTA), L.M.Soroko and V.V.Tereschenko. The staff of the Hungarian group includes D.Benze, A.Kisvaradi, J.Molnar, L.Molnar and J.Torma. The meso-optical Fourier-transform microscope has been presented in the CERN Courier, 1990, 30, No 4, p. 13. A model of the meso-optical mirror with ring response is presented as an exponate in the Museum of the History of the Science and Technology of JINR.

The term "MESO-OPTICS" has been introduced at LNP in 1982. Later, in 1984, this term was accepted at XIII Congress of the International Commission on Optics in Sapporo, Japan. Now meso-optics is a part of the coherent optics, in which we study the properties and applications of the conical wave fields. A unique monography on meso-optics has been published in Singapore – L.M.Soroko, MESO-OPTICS, Foundations and Applications, World Publ.Co., Singapore, 1996.

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Сороко Л.М. E1-2001-91
Всегда впереди
(некоторые эпизоды из истории
Лабораториии ядерных проблем, 1949–1999)

Из примерно 6000 научных работ, выполненных в Лаборатории ядерных проблем ОИЯИ за 50 лет ее существования, были отобраны те, которые можно считать наилучшими достижениями ЛЯП на мировом уровне (эпизоды 5–8, 10, 11), на уровне России (эпизоды 2, 3, 9) или, наконец, на уровне лабораторий ОИЯИ (эпизод 4). Автор являлся либо участником, либо непосредственным свидетелем описанных эпизодов.

Работа выполнена в Лаборатории ядерных проблем им. В.П.Джелепова ОИЯИ.

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Out of about 6000 scientific investigations, performed at the Laboratory of Nuclear Problems of the JINR during the 50 years of its activity there were chosen those ones which can be regarded as the world scale (episodes 5–8, 10, 11), on the Russian scale (episodes 2, 3, 9) or, finally, on the JINR's scale (episode 4). The author was a participant or the direct witness of the episodes described in this paper.

The investigation has been performed at the Dzhelepov Laboratory of Nuclear Problems, JINR.

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