JINR PROGRAMME IN HIGH ENERGY PHYSICS

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Abstract

Information about the current status of Joint Institute for Nuclear Research and its High Energy Physics programme is presented.

1. GENERAL INFORMATION ABOUT JINR.

1.1. Historical background.

The Joint Institute for Nuclear Research (JINR) is situated in Dubna, a small town located about 120 km north of Moscow. This town appeared in the late 1940s in hard times after the end of World War II as part of the USSR Nuclear Defense Programme on the initiative of Igor Kurchatov, an outstanding Soviet scientist who was responsible for the Programme at that time and who also had a perfect understanding of the importance of fundamental research.

JINR — as the international centre — was founded in March of 1956 (in Khruschev times) on mutual agreement of the governments of Albania, Bulgaria, China, Czechoslovakia, Hungary, the Socialist Republic of Vietnam, the German Democratic Republic, the Democratic People's Republic of Korea, Mongolia, Poland, Romania, and the Soviet Union. The USSR handed over to the new institution two laboratories located in Dubna. After the establishment of JINR — an international organization for fundamental research in nuclear science — Dubna became an open town.

It is necessary also to mention that the formation of various scientific fields of research at JINR was initiated by a number of some outstanding scientists of the Institute's Member States including the first directors Dmitri Blokhintsev and Nikolai Bogoliubov.

1.2. JINR's Charter; membership and internal organization.

The Joint Institute was created in order to unify intellectual and material potential of Member States to study fundamental properties of matter.

The Charter of JINR was adopted in 1956, later on it was revised and newly adopted in 1992.

In accordance with the Charter the activity of the Institute is realized on the basis of its openness, mutual and equal cooperation for all interested parties to participate in research.

The main governing body of our Institute is the Committee of the Plenipotentiaries of the Member-State Governments. Each State contributes to the JINR budget.

The JINR structure is illustrated on Figure 1.

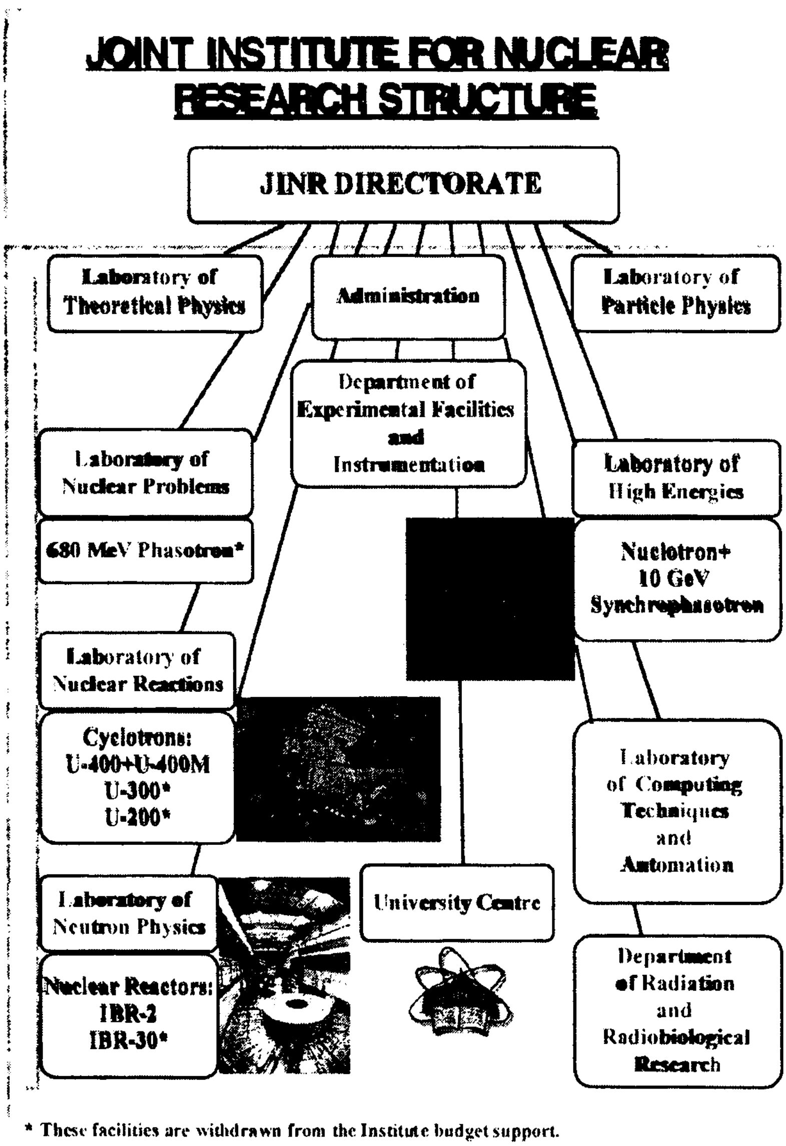


Figure 1. Joint Institute for Nuclear Research Structure.

In accordance with new Charter more than 1/3 of Scientific Council now consists of non-member state scientists (from CERN, France, Germany, Italy, USA). H. Shopper, P. Spillantini, G. Piragino, F. Legar, B. Peyod, F. Dydak, C. Detraz, G. Trilling, M. Della Negra, L. Masperi, et al. are among the members of SC.

The aim of the Institute is:

- to carry out theoretical and experimental investigations on adopted scientific topics;
- to organize the exchange of scientists in carrying out research, of ideas and information by publishing scientific papers, organizing conferences, symposia etc.;
- to promote the development of intellectual and professional capabilities of scientific personnel;
- to maintain contacts with other national and international scientific organizations and institutions to ensure the stable and mutual cooperation;

- to maintain contacts with other national and international scientific organizations and institutions to ensure the stable and mutual cooperation;
- to use the results of investigations of applied character to provide supplementary financial sources for fundamental research by implementing them into industrial, medical and technological developments.

The results of investigations carried out at the Joint Institute for Nuclear Research can be used solely for peaceful purposes to the benefit of mankind.

So until the late 80's Dubna was a centre which unified the efforts of leading research groups of nuclear sciences of the so-called "socialist countries" and the Soviet Union.

After the disintegration of the USSR the membership of JINR underwent the following changes: The majority of East European countries, such as Poland, the Czech and Slovak Republics, Bulgaria, Romania continue to be Member States of our Institute and contribute in the budget. Germany stays as an observer and makes a substantial financial contribution. Most of the former Soviet Union republics which became independent states of the CIS (Common-wealth of Independent States) entered JINR as new members.

I would like here to remind you the words of great Russian writer A. Chekhov who said:"…there is no national science as no national multiplication table. If the science is a national one — this is not a science anymore…". JINR is a perfect illustration of this idea…

The participation in the Institute can be realized in different forms: on the basis of membership, bilateral and multilateral agreements to perform particular scientific programmes. JINR Member States contribute financially to the Institute's activity and have equal rights in its management.

JINR has at present 18 Member States (Table 1).

Table 1
JINR Member States

Armenia	Moldova
Azerbaijan	Mongolia
Belarus	Poland
Bulgaria	Romania
Cuba	Russian Federation
Czech Republic	Slovak Republic
Georgia	Ukraine
Kazakhstan	Uzbekistan
D.P. Republic of Korea	Vietnam

JINR has special cooperation agreements concluded on governmental level with:

- Germany (in the field of theoretical physics, heavy ion physics, condensed matter physics and high energy physics);
- Hungary (in the field of condensed matter physics);
- Italy (in the field of intermediate and low energy physics);

Recently the Agreements were signed with UNESCO and CLAF (Latin America Centre on Physics).

Among the major partners with whom JINR has long-term cooperation agreements are:

- CERN, in the field of high energy physics;
- IN2P3 (France), in the field of nuclear and particle physics;
- INFN (Italy), in the field of nuclear and particle physics;

- FNAL, BNL, SLAC and other research centres in USA.

JINR is also an associated member of EPS, has observer and/or members in ICFA, ECFA, IUPAP and other international unions. The latest political changes in Eastern Europe and especially in Russia have been making JINR more and more open. New collaborating countries are welcomed to join JINR.

Today JINR is a large centre with a total staff close to 6000 including services and workshop. Approximately 1100 scientists work in it. Among them there are about 40% from member-states (but Russia).

The internal JINR organization is determined by scientific specialization. There are 7 Laboratories in the Institute:

- Bogoliubov Laboratory of Theoretical Physics (BLTP);
- Laboratory of High Energies (LHE);
- Laboratory of Particle Physics (LPP);
- Laboratory of Nuclear Problems (LNP);
- Flerov Laboratory of Nuclear Reactions (FLNR);
- Frank Laboratory of Neutron Physics (FLNP);
- Laboratory of Computing Techniques and Automation (LCTA).

Each Laboratory (but BLTP) has its own design and construction divisions which develop and manufacture non-standard equipment for particle accelerators, detectors and other experimental facilities. The staff of these divisions totals about 370 engineers, technicians and workers.

A number of associate Experimental Physics Workshops are also part of the Institute.

The personnel of the JINR Experimental Physics Facilities Division totals about 400. It is equipped with everything necessary to manufacture large-sized non-standard facilities, electronics, and has technological lines for constructing detectors for high energy physics. It was there that the main units of JINR's heavy ion cyclotrons U-400 and U-400M were constructed in recent years, as well as the Nuclotron — a new superconducting accelerator for relativistic nuclear physics. It is an excellent result especially taking into account a difficult economic situation in Russia of the last years.

As certainly known well, nuclear science and in particular its frontier Particle Physics or High Energy Physics is rather an expensive field of research. Of course it is very well understood now that deep fundamental studies have always resulted in huge technological benefits. And the great discoveries of the past such as electricity, magnetism, etc. have never been paid off, and all the investments to fundamental science in the whole world is still a negligible part compared to the benefit that mankind got from it. It would be fare to say that mankind is eternally indebted to fundamental science.

Now few words about JINR's international cooperation.

Despite the present hard economic and financial situation in most of JINR's Member States, which of course has greatly affected the ongoing research programme of the Institute, many scientific groups from Dubna continue to participate in largest projects of world's major centres.

The intensity of JINR international cooperation events can be demonstrated by the following:

- approximately 1200 our specialists participated in 1997 in joint experiments and international conferences in outside JINR;
- more than 1000 scientists from collaborating laboratories and centres visited Dubna annually;

- each year JINR organizes about 50 conferences, workshops and other scientific meetings (among them the International Conference for HEP accelerators — HEACC-98 — was held in Dubna on September, 1998);
- Together with CERN JINR participated in the organization of the European School on HEP annually (formerly JINR-CERN School of Physics since 1970);
- JINR scientists participated in more than 150 international conferences held world-wide annually.

1.3. On forthcoming JINR reforming.

Since the beginning of 1998 JINR started a programme of new reforms to be accomplished within 3-4 years. The urgency of reforming JINR is dictated by a number of factors, and first of all by the difficult economic and financial situation, that will most probably continue in the future. Unfortunately, despite the decisions of the Committee of Plenipotentiaries, many of the JINR Member States fail to fulfill their financial obligations toward the Institute. During the past several years, the Directorate had to make extraordinary efforts to secure adequate budgetary funding, but the actual implementation of budget was about 60-65% of the approved annual one (37.5 M$ per year). It is quite clear that such low level of financing urges the reforms in order to concentrate the financial and human resources only on the most important directions of JINR's activity. One of the timely and important steps toward this should be a reasonable solution to enhance centralization of the Institute management and reduce the excessive number of administrative functions and services in all the Laboratories.

The reforms are proposed to be done in two stages. The main tasks to be solved at the first stage are as follows:

- Centralized operation and management of the JINR basic facilities;
- Optimization and reduction of infrastructure;
- New staff policy.

The Directorate believes that a guaranteed stable operation of the JINR facilities should be achieved through a centralized management of the facilities and by a policy of tight economy of resources. Now we can mention with satisfaction that the reforms have already yielded the first positive results in this area.

The reform in the field of the overgrown infrastructure of JINR is directed to a maximum reduction of doubling services and transfer of a part of the buildings for rent, including by JINR self-supported divisions.

The proposed reforms envisage a general reduction of the Institute's personnel with a tempo not less than 25% during 3 years. The reduction is aimed at:

- a higher inflow of young scientists to JINR,
- an increase in salaries.

The reduction is regarded by the Directorate as a delicate question requiring measures for social protection of the dismissed personnel, and will be done in cooperation with the municipal authorities of the town Dubna.

The second stage of reforms will be connected with the field of scientific research.

2. JINR IS A MAJOR PARTNER OF WORLD'S HEP LABORATORIES.

2.1. JINR's international cooperation in high energy physics.

Broad international cooperation is one of the most important principles of the JINR activity. Almost all investigations are carried out in a close collaboration with JINR member-state scientific centres as well as international and national institutions and laboratories of the world. The most effective cooperation is realized with such institutes of Russia as IHEP (Protvino), Kurchatov Institute in Moscow, Institute of Nuclear Physics in Gatchina near St. Petersburg, ITEP (Moscow), INR (Troitsk), Lebedev Institute of Physics (Moscow), Moscow State University et al.

A fruitful scientific cooperation is being held with CERN, especially in the last years, as well as with many physics laboratories in USA, France, Germany, Italy, and other countries. Cooperation with Nuclear Scientific Centre of Peking University (China) is being developed, a Protocol on collaboration has been signed between JINR and the Institute of Modern Physics of Academia Sinica. The JINR Directorate is ready to maintain constant and long-term contacts with laboratories of other countries as well.

The Figure 2 shows a current status of JINR International Cooperation in HEP.

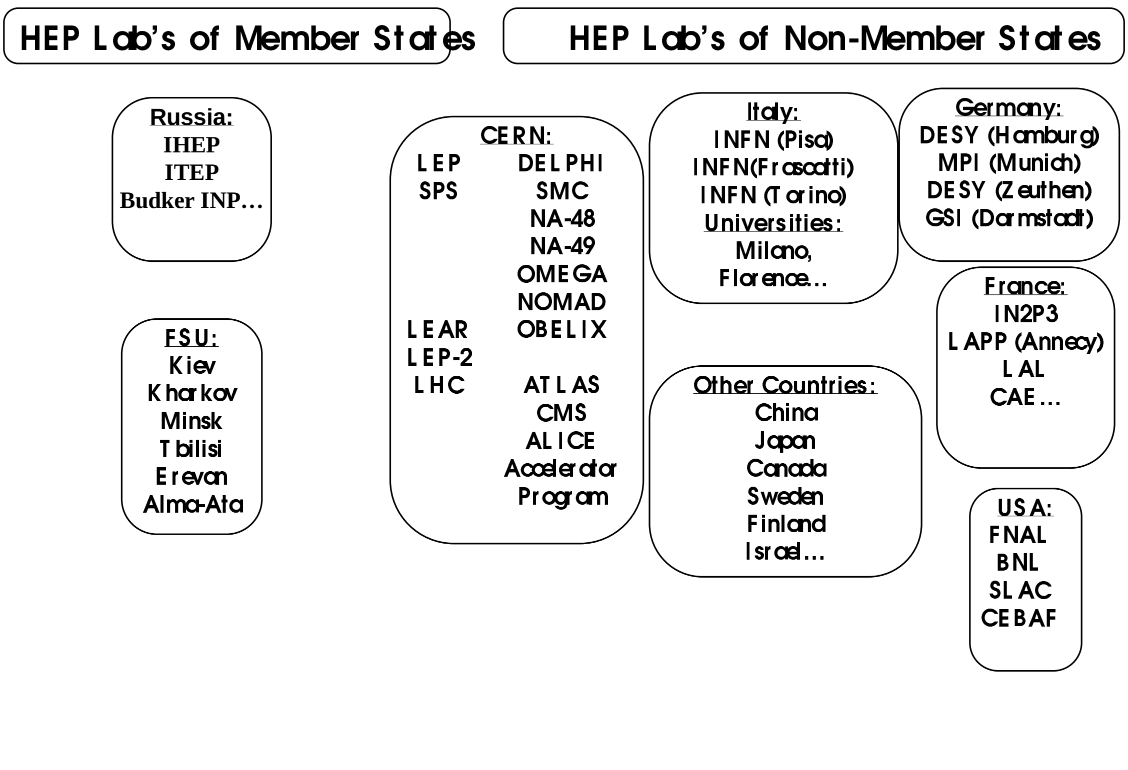


Figure 2. JINR International Cooperation in HEP.

2.2. Cooperation with CERN.

Dubna physicists are involved in a big part of the CERN experimental programme. The general Agreement between JINR and CERN was signed in 1992, but cooperation between two international organizations has a very long history.

The Table 2 shows the experimental projects in which Dubna research groups are involved at CERN.

Table 2
CERN Experiments where Dubna is involved

Project	Location	a) main goals b) JINR contribution
NA48	**SPS CERN**	a) Highest precision direct CP-violation searching in neutral kaons decays. b) Subsystems design & construction; data taking runs. Data analysis.
NA49	**SPS CERN**	a) Search for the predicted phase transition from hadrons to deconfined quarks and gluons in Pb+Pb-collisions at SPS. b) 900-channel time-of-flight detector for identification of $h^{\pm}$, $K^{\pm}$, p, $\bar{p}$, d and $\bar{d}$. Data analysis.
NOMAD	**SPS CERN**	a) Search for $\nu_{\mu}\rightarrow\nu_{\tau}$ and $\nu_{\mu}\rightarrow\nu_{e}$ oscillations. b) Data taking & analysis; new proposal preparation.
COMPASS	**SPS CERN**	a) Hadron structure and hadron spectrometry on high rate hadron and muon beams; q&g contribution to nucleon spin; polarization of nucleon sea q's etc. Glueballs Search for exotics. b) Hadron Calorimeter, Muon Detector, large area track chambers.
DIRAC	**PS CERN**	a) 5% accuracy test of low en. QCD by 10% precision ($\pi^{+}\pi^{-}$) atom life time measurement. b) JINR proposed experiment; Drift Chambers; secondary particles channel; trigger development; MC simulation & software. Data taking RUNs, data processing & analysis.
DELPHI	**LEP CERN**	a) Precision measurement of m (W), search for new particles, etc. b) Continue to maintain Hadron Calorimeter and Surround Muon Chambers; physics analysis.
ATLAS	**LHC CERN**	a) General purpose $p\bar{p}$-experiment. b) Subsystems: calorimeters; muon, transition radiate detection; radiate hardness tests; physics software & simulation; trigger and data acquisition.
CMS	**LHC CERN**	a) General purpose $p\bar{p}$-experiment. b) Subsystems: forward mu-station, hadron END CAP Calorimeter; e/m cal preshower; simulation. Heavy ion physics.
ALICE	**LHC CERN**	a) Heavy ions relativistic beams. Study of q-g plasma and phase transition. b) Warm dipole Magnet; large scale Pestov counters production. Detector assembly. Data taking runs. Data processing & analysis.
R&D for LHC Accelerator Complex Elements	**LHC CERN**	a) Development & construction of LHC beams formation & control system elements. b) Design & construction of transverse oscillation damping system. Simulation & prototypes study.

The Figure 3 gives a picture on the scale of Dubna contribution to some CERN Projects.

The very first MODULE 0 for the Atlas Hadron Barrel Tile Calorimeter was successfully assembled in Dubna on the 6 *meters* in diameter rotating table of the milling-boring shop-machine.

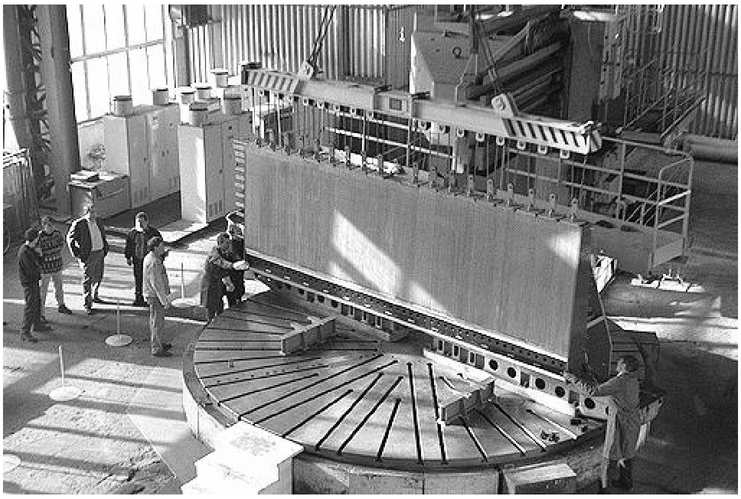


Figure 3. MODULE 0 in Dubna.

Russian, Slovakian, Belarus industries were involved in manufacturing of the module. JINR, IHEP, ANL, PISA, Barcelona, Prague contributed a lot to this activity.

2.3. Cooperation with IHEP (Protvino).

JINR scientists are carrying out experiments at IHEP's U-70 proton synchrotron with the help of such set-ups as Tagged Neutrinos, EXCHARM, HYPERON, Neutrino Detector, and others. The most essential features of our scientific programme on 70 *GeV* accelerator of Protvino are summarized in this Table.

Table 3
JINR's participation in research at U-70

EXCHARM	Search for exotic states with strange quarks, study of processes of production and decay of particles containing heavy quarks.
HYPERON	Investigations of rare K-meson decays.
NEUTRINO DETECTOR	Investigations of neutrino oscillations and neutrino-nucleon interactions.
TARGGED NEUTRINO COMPLEX	Verification of the universal features of weak interactions; search for rare decays in neutrino interactions; search for CP-violation in K-decays.
PROZA-DIBARION	Measurements of polarization parameters of πN and NN interactions.

3. JINR'S SCIENTIFIC POTENTIAL.

3.1. Technical possibilities of JINR Laboratories for HEP experiments.

Technical possibilities of JINR Laboratories for HEP experiments are as follows:

track and semiconductor detectors (Laboratory of Particle Physics), superconducting magnetic systems, polarized targets; cryogenic systems in Laboratory of High Energies; wire proportional chambers, pressurized drift tubes, electromagnetic and hadron calorimeters, radiation-proof big-sized scintillation counters in Lab. of Nuclear Problems, radiation tests by fast neutrons in Laboratory of Neutron Physics, etc.

3.2. Dubna accelerators and reactors.

The main fields of the Institute's investigations are theoretical physics, elementary particle physics, relativistic nuclear physics, physics of low and intermediate energies, heavy ion physics, nuclear physics with neutrons, condensed matter physics, radiobiology and nuclear medicine, experimental instruments and methods.

The major facilities of the Institute for experimental investigations are the nuclotron, synchrophasotron, phasotron, U-400 and U-400M cyclotrons, IBR-2 and IBR-30 neutron reactors.

The new superconducting accelerator Nuclotron was put into operation three years ago. It will enable to perform a wide programme of research in relativistic nuclear physics. The injection complex is being developed consisting of a buster, linac and ion sources. This complex will allow one to accelerate nuclei from hydrogen to uranium with the intensity from 10^{13} to 10^{8} particles per pulse respectively in the energy range of 6 7 *GeV* per nucleon. Polarized deutron beams are foreseen.

Research programme on NUCLOTRON is executing and I give one recent new result on the determination by studying of cumulative protons production with $\theta_{pp}=109^0$. Experiment was performed on internal deuteron 2 *GeV*/nucleon beam of NUCLOTRON with the carbon target on orbit. It was found that in the cumulative protons production the transversal dimension (r_0) of the interaction region for incoming deuterons is noticeably larger than for incoming protons (Figure 4).

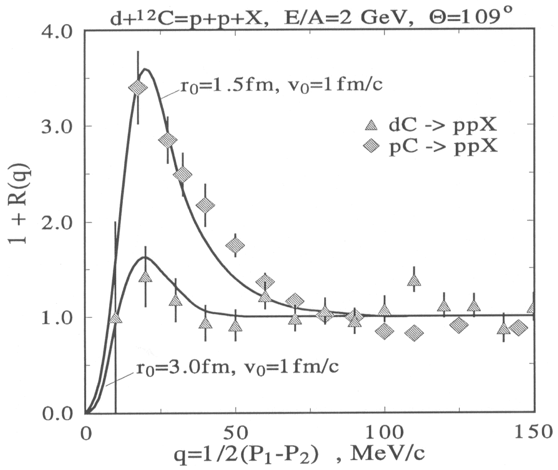
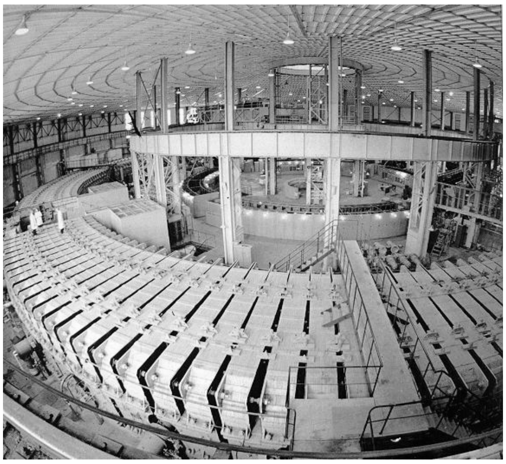


Figure 4. The Studying of Cumulative Protons Production on Nuclotron.

Synchrophasotron is an accelerator of 10 *GeV* protons put into operation in 1957. In the 70's the acceleration of nuclei heavier than hydrogen, that is deuterium, lithium, carbon, fluorine and magnium, was accomplished in the broad energy spectrum from a few hundred *MeV* to 4.5 *GeV* per nucleon. Average densities of beams range from 10^4 to 10^{11} ion/cm^2s depending on the atomic number of accelerated nuclei and experimental requirements (Figure 5).



Particles obtained	Number of particles per cycle	Energy of particles
protons	4×10^{12}	8-10 GeV
deutrons	1×10^{12}	
^{3}He	2×10^{10}	
^{4}He	5×10^{10}	
^{7}Li	2×10^{9}	
^{12}C	1×10^{9}	3.6 GeV/nucleon
^{16}O	5×10^{7}	
^{20}Ne	1×10^{4}	
^{24}Mg	5×10^{6}	
^{28}Si	3×10^{4}	
^{32}S	3×10^{3}	

Figure 5. Synchrophasotron — accelerator of polarized protons and deutrons.

Synchrophasotron beams attracts physicists from all the world. Wide international collaboration SPHERE has recently performed the study of the nuclear matter at short distances in experiments with polarized deuteron beams to separate contribution from S and D components in the deuteron wave function.

In order to clarify the reactions mechanism and the structure of non-nucleon degrees of freedom the new experiment with the polarized deuteron fragmentation into cumulative hadrons has been performed. The observed difference of MODEL — to — experiment data is especially large for K=0.2 *GeV/c* where it would be natural to expect the manifestation of non-nucleon degrees of freedom in the deuteron wave function (Figure 6):

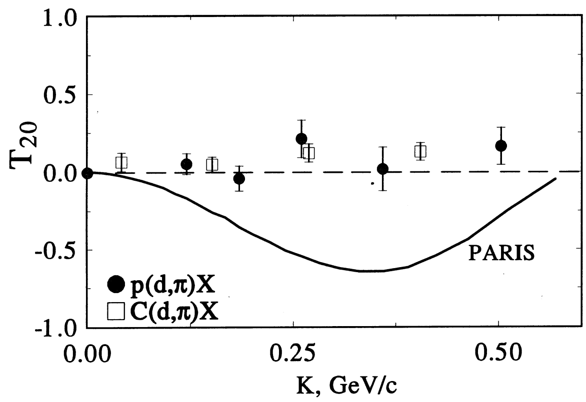


Figure 6. The Measurement of the Tensor Analyzing Power T_{20} in Inclusive Polarized Deuteron Fragmentation into Pion at Zero Angle.

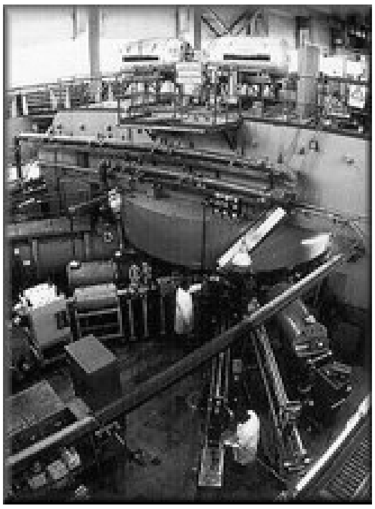
Phasotron is an accelerator of 680 *MeV* protons. It was put into operation in 1949, reconstructed in 1984 and represent the oldest basic facility of JINR. 10 beam channels are available at this machine which are used to carry out experiments with pions, muons, neutrons and protons. 5 secondary beams are designed to carry out medical investigations. The intensity of the extracted proton beam is 2 *mkA*. The research programme at the phasotron includes low energy proton-nuclei interactions, mu-catalysis physics. Radiochemistry and applied physics (including cancer therapy, proton, pion, meson beam, radioisotopes etc.) are currently the noticeable part of phasotron programme.

U-400 is a heavy ion isochronous cyclotron constructed in 1978. The range of accelerated nuclei is $(A/Z)=4$ — 20, energy is 650 $Z^2/AMeV$, beam intensity is 10^{12} — 10^{14} *ion/s*.

U-400M is an isochronous cyclotron put into operation in 1991-92 to accelerate heavy ions. It produces ion beams of atomic masses from 4 to 100 and maximum energy up to 25 *MeV/nucleon* and beam intensity from 10^{12} up to 10^{14} *ion/s*. It is designed to operate in the cyclotron U-400+U-400M complex and allows to accelerate ions from hydrogen up to uranium in the range of energy 120 — 20 *MeV* per nucleon respectively with the average beam intensity of 4 — 10^{13} — 10^{11} *ion/s*. The main areas of research include synthesis of new elements, investigation in the chemistry of new transferium elements, and studies of the radioactive decay of heavy nuclei far from beta-stability.

The Figure 7 shows the cyclotrons U-400 and U-400M.

U-400 **U-400M**



Cyclotron	Particles obtained	Energy of Particles	Beam Intensity ions/sec
U-400	ions B÷Zr	650 Z^2/AMeV	10^{12}—10^{14}
U-400M	ions B÷Zr	120—20 MeV per nucleon	4×10^{13}—10^{11}

Figure 7. Accelerators U-400 and U-400M.

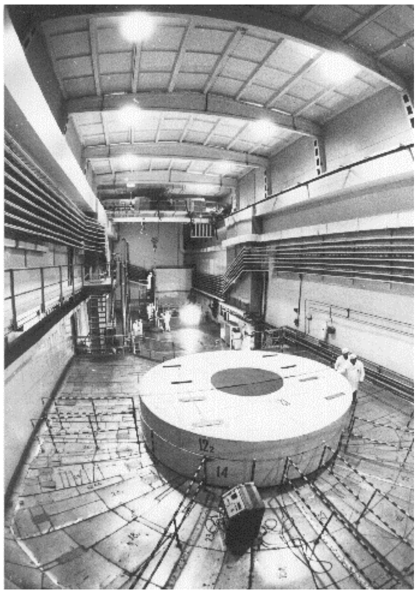
On the U-400M accelerator there was recently obtained quite a new result. In the study of the reaction of 2 neutrons transfer from ^{6}He to ^{4}He we have detected — for the first time — the di-neutron bounded state in the nuclei field. Secondary ^{6}He was registered in CMS angular interval of 10 — 160^0. The observed effect is the increase of ^{6}He yield at the angles $\Theta>100^0$

The experiment is expected to be continued with another configuration which provides a detection of low-energy ^{6}He in angular range more than 160 degrees.

Another very interesting achievement is that during 1998 experiment there was synthesized the most heavy — of known — nuclei $^{283}Z_{112}$ in the reaction chain U+^{48}Ca → (compound) → 3n + $^{283}Z_{112}$. The searches of 114th element of the Mendeleev periodic table are in progress. This element expectedly has a long time of life. Discovery of such an element would manifest the existence of the "island of stability".

IBR-2 is a pulsed reactor with average thermal power 2 *MW* and peak power in pulse 1500 *MW*. The wide programme of the condensed matter studies was performed on this reactor. Power pulses with a frequency of 5 *Hz* are generated by reactivity modulators (Fig. 8).

IBR-30+LUE-40 is a pulsed neutron source consisting of old pulsed reactor IBR-30 and electron 40 *MeV* linac LUE-40. The average heat power of the reactor is 10 *kW*, instant pulse power is 150 *MW*. It generates neutron pulses with frequency about or less than 100 *Hz* and duration of 4.5 μs. The total neutron yield is 5×10^{14} *n/s*, the flux of fast neutron at surface of active core is about 10^{12} n/cm^2s.



Reactor	Particles obtained	Thermal Power	Pulse Power	Frequency of Power Pulses
IBR-2	neutrons	2 MW	1500 MW	5 Hz
IBR-30+ LUE-40	neutrons γ-quanta	10 kW	150 MW	≤100 Hz

Figure 8. IBR-2 — pulsed reactor:

3.3. Dubna High Performance Computing Centre.

The very important element of the Dubna infrastructure is the Satellite Space Station. Through this station and Laboratory of Computing Techniques and Automation we develop of interfaces with international computer networks to provide a prompt contact between JINR and other research centres of the world community of scientists.

Regarding the computing facilities, at JINR there is a whole diversity of computational problems in various fields of physics, which need powerful computing resources. They involve problems of theoretical and mathematical physics, solid state physics problems, experimental data processing problems, especially in HEP. Following the world tendency in the field of computing for science and higher schools and the progressive requirements of users, the LCTA developed a conception of establishing a High Performance Computing Centre (HPCC) at JINR. It should be read as a balanced development of four main components of HPCC, namely:

- Telecommunication systems:
    - External communication channels (INTERNET);
    - High-speed JINR ATM Backbone;
- Systems for powerful computations and mass data processing:
    - General High-performance server;
    - Clusters of workstations of JINR laboratories and experiments;
    - Computing farms (PC-farms);
- Data storage system:
    - File servers system based on AFS;
    - Mass storage system;
    - Information servers and database servers;
- Software support systems:
    - Systems for application creation and maintenance;
    - Visualization systems.

4. DUBNA AS AN EDUCATIONAL CENTRE.

4.1. The University Centre of JINR.

JINR gradually changes from a purely scientific research institution to an international centre in which fundamental science, applied research, and engineering are closely connected with the university education process. In 1991, the University Centre (UC) of Moscow State University, Moscow Engineering Physics Institute, and Moscow Institute of Physics and Technology was established at JINR.

The UC students come from many institutes and universities of Russia, the former Soviet Union, and JINR Member States. Students of 4^{th} and 5^{th} years and graduates are invited to study at the UC for two years.

The students complete here their university education. Classes include not only ordinary courses in physics, but also intensive courses on subjects defined on the basis of JINR research.

Structurally, it takes the form of a new satellite "students" laboratory. Its prototype is the currently working University Centre. This new training function of JINR is supposed to be oriented to international demand.

The Centre offers the following full-time graduate programmes:
Nuclear Physics, Particle physics, Condensed Matter Physics.

In the above three fields, the UC also offers the full-time theoretical physics programmes on the basis of the Bogoliubov Laboratory of Theoretical Physics.

The UC offers also Technical Physics, and Radiobiology.

The full-time educational programme of the University Centre is two years long, though it has also become a practice to accept students for shorter periods, such as one or two-month intense courses on some selected topic. The working language for foreign students is English.

Post-graduate students are also admitted to attend lectures on selected topics and take part in scientific research at the JINR Laboratories.

Students have wide access to the Laboratories of JINR and can work with scientists and staff of the Institute, as well as to study under professors who are eminent in their fields.

Graduate and post-graduate studies at the UC are based immediately on JINR's research conducted at a wide variety of world-renown facilities, for example, heavy ion accelerator U-400, ion beam from the U-400M cyclotron, the nuclotron — a superconducting accelerator of relativistic nuclei, the IBR-30 neutron booster, and the IBR-2 pulsed reactor (which is especially fruitful in condensed matter research).

Special importance is attached to the language education. Russian and English are taught here as a second language.

The UC has a post-graduate training license from the State Committee of Higher Education of Russia. The post-graduate students are trained in the large scale of specialties:
Physics of nuclei and elementary particles, Theoretical physics, Charged particle beam physics and accelerator technique, Computational mathematics, Solid state physics, Physical experiment technique, High energy physics...

The International University of Nature, Society, Man (the University President is JINR Director V.G. Kadyshevsky, University Rector is O.L. Kuznetsov, President of the Russian Academy of the Natural Sciences) was opened in 1994 in Dubna. University works in the very tight cooperation with JINR University Centre.

4.2. International contacts of the UC.

International scientific educational contacts have become a regular and well-established UC's activity.

The UC has always kept high profile in the organization and conduction of international scientific schools and training courses. Here are some typical examples.

In 1995, the UC actively participated in the organization of two schools — on theoretical physics (jointly with the Laboratory of Theoretical Physics) and on neutron physics (jointly with the Laboratory of Neutron Physics). In September-October 1995, the International Nuclear Information System (INIS) courses of IAEA were conducted in Dubna, which was largely assisted by the UC. In 1996, the UC and Laboratory of Particle Physics organized jointly the Young Scientist School on Problems of the Charged Particle Acceleration. Within the frames of the cooperation between IAEA and JINR, the 9-week International Regional Post-Graduate Educational Course on Radiation Protection was held in 1996 on the basis of the UC. In 1998, the UC has conducted the International Summer School in memory of Bruno Pontecorvo.

The UC is a participant of the European Mobility Scheme for Physics Students (EMSPS). The European Physical Society has appointed the UC one of the Russian Federation coordinators in the EMSPS.

By the Partnership Agreement between JINR and European Physics Education Network (EUPEN), the UC is included in EUPEN's "Thematic Network" in Physics.

UC also maintains ongoing contacts with CERN in the training of students and young scientists.

A number of graduate students from Western Europe had their specialized practice at JINR's laboratories, which was coordinated and assisted by the UC.

UC also receives student groups from Europe coming here with visits of acquaintance.

5. PLANS FOR FUTURE.

JINR has the following projects for the development of new basic facilities:

IREN (Intense Resonance Neutron Source) is a project aimed at constructing a high-flux pulsed neutron source to carry out investigations with resonance neutrons.

The facility will comprise a modern 200 *MeV* electron linac and subcritical plutonium booster having neutron multiplication coefficient 30. The pulse rate is 150 *Hz*, duration 0.4 μs, total neutron yield ~10^{15} *n/s*. The research programme for the IREN includes investigation of P- and CP-violations in slow neutron interaction with nuclei and other fundamental nuclear physics topics. This project started of realization from 1994. It will be put into operation in 1999.

cτ-Factory is a project of a new accelerator complex to comprise an electron-positron collider with an energy of 1.7 — 3 *GeV* in each beam and an injection system.

The research programme for this complex will include the study of Tau-lepton and τ-neutrino physics, τ–charmonium spectroscopy, CP violation, charmed baryon physics and meson spectroscopy. The design of specialized synchrotron radiation source (8 — 10 *GeV*, NK-10) is under consideration.

Particularly we investigate the possibility of the creation the Synchrotron Radiation Source at JINR on the base of the NIKHEF (Amsterdam) AmPS machine.

Accumulated scientific experience, available high qualification “human resources” and our realistic estimates of our financial possibilities give the reasonably balanced vision of our nearest perspectives.

JINR’s plans for the nearest future:

- Development of methodical and computing possibilities for participation in experimental programmes of the world’s largest HEP laboratories (CERN, FNAL, IHEP and others).
- IREN construction.
- Development of the injector complex of the Nuclotron.
- Further development of the JINR University Centre.
- The use of JINR’s advanced infrastructure for holding international conferences, meetings and schools.

In conclusion of this part of my talk I would like to express the following opinion:

The combination of JINR’s attractive scientific programme, development of new technologies and our recent initiatives in the educational field make our Institute an interesting and promising partner.

6. THE STATUS OF HEP IN RUSSIA AND FSU-COUNTRIES.

Speaking of the programme in high energy physics in the territory of the former Soviet Union, one has to note the existence of serious economic difficulties. Yet we believe that they are temporary. This region has a rich background of applied and fundamental sciences. The world’s largest proton accelerator in operation in the late 60’s was in Protvino, Russia. The prestige of our HEP physicists in theoretical investigations, in accelerator and detector technologies was always very high.

Among the participants of European and world collaborations one can often see such research centres as

Institute for High Energy Physics (Protvino),
Institute of Theoretical and Experimental Physics (Moscow),
St. Petersburg Institute of Nuclear Physics (Gatchina),
Budker Institute for Nuclear Physics (Novosibirsk),
Institute for Nuclear Research (Troitsk, Moscow),
Moscow State University,
Lebedev Institute of Physics (Moscow),
Kurchatov Institute (Moscow),

Moscow Engineering Physics Institute,
Yerevan Institute of Physics and Yerevan University (Armenia),
Institute of Physics (Azerbaijan),
Belarus State University,
Institute for High Energy Physics (Alma-Ata, Kazakhstan),
Kharkov and Kiev institutes (Ukraine),
Institute of Nuclear Physics (Tashkent, Uzbekistan)
and others.

These Institutes actively participate in HEP research programmes at CERN, DESY, FNAL and some other world scientific centres.

The main accelerating facilities used for research in high energy physics in Russia are:

- the 76 *GeV* proton synchrotron (IHEP, Protvino, near Serpukhov),
- the 7×7 *GeV* positron-electron storage rings VEPP-4 (Institute for Nuclear Physics of the Siberian branch of the Russian Academy of Sciences, Novosibirsk),
- the synchrophasotron for acceleration of protons (10 *GeV*) and atomic nuclei, and Nuclotron (Joint Institute for Nuclear Research, Dubna),
- the proton synchrotron of the Institute for Theoretical and Experimental Physics (Moscow) accelerating protons up to 9.3 *GeV*,

and others.

Besides, a number of proton accelerators with energies up to hundreds of *MeV*, phasotron is also available operating in Russia at the Joint Institute for Nuclear Research (Dubna) and isochronous cyclotron — at St. Petersburg Institute of Nuclear Physics.

An intensive linear proton accelerator is also constructed at the Institute for Nuclear Research (Troitsk). The first stage of the accelerator has been completed.

In IHEP (Protvino, Director — A.A. Logunov) the works to build new accelerator U-600 are in progress.

Another direction of HEP research is connected with plans of the Institute for Nuclear Physics (Novosibirsk, Director — A.N. Skrinsky) to create colliding electron-positron beams on the basis of linear electron accelerators (VLEPP).

The international experience in dealing with heavy-current accelerators shows that a meson factory is a generator of high-intensity secondary beams of pions, muons, neutrons, neutrinos, polarized nucleons, hydrogen neutral atoms and is a unique tool for investigations in nuclear and elementary particle physics. That is why the construction of Moscow meson factory by the Institute for Nuclear Research (scientific leader — A.N.Tavkhelidze, director — V.A. Matveev) is another important direction for fundamental studies in physics in Russia.

In terms of its parameters, every large accelerator is a unique physical installation. The high cost and sophistication of experimental apparatus urges the necessity of a wide international scientific and technical cooperation. Such cooperation in operating huge accelerating machines makes it possible to develop faster and more efficiently complicated experimental facilities comprising numerous detectors, electronic equipment and control systems.

CONCLUSION.

This short review presents only some general information about our research centre in Dubna. However, I'd like to emphasize that over its 42 years of existence JINR has become a well-known international scientific centre, which incorporates the fundamental research of the structure of matter, development and application of high technologies, and university education in the relevant fields of knowledge. The scientific policy pursued by the JINR Directorate was developing in the context of the world scientific trends. At the same time last years were marked with a struggle for survival and preservation of the Institute as a unified scientific centre in the time of radical political changes and serious economic difficulties in Russia and some of the Member States. This struggle was very often waged under conditions close to the extreme ones. Nevertheless, due to the joint efforts, the Institute has survived and continues to contribute significantly to world science in the field of particle physics, nuclear physics, and condensed matter physics.

Successful implementation of new reforms should become an impulse for the dynamic development of this international scientific centre in the 21st century.

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