MINUTES

of the Brazil-JINR Forum

"Frontiers in Elementary Particle, Nuclear and Condensed Matter Physics"

held on 15-19 June 2015 at the Joint Institute for Nuclear Research

in Dubna, Russian Federation

New challenges in physics demand competence and financial resources. The adequate infrastructure necessary for a fast development in research is expensive and sometimes hard to be attained. The establishment of international collaborations has shown to be a possible fast track for successful progress in science.

More than 60 leading researchers from JINR Member States and 18 Brazilian scientists participated in the Forum aimed at strengthening the existing scientific contacts and establishing new ones between main scientific research centers of Brazil and the Joint Institute for Nuclear Research. The mission of the Forum was to find new focal areas of cooperation and promote its new forms.

JINR is a large multidisciplinary scientific research institute holding a unique set of experimental facilities and executing its program on the basis of a broad international cooperation including 150 institutes and universities of the Russian Federation. Thus JINR could serve as a "bridge" facilitating a mutually beneficial cooperation of Russian and Brazilian scientists.

During plenary sessions of the forum, 19 review talks were given. The talks exposed the wide spectrum of scientific directions and the structure of fundamental research in Brazil and JINR. The plenary sessions were supplemented by excursions to JINR experimental facilities (VBLHEP, FLNR, FLNP, DLNP). Besides the local workshops some JINR laboratories (BLTP, FLNP, DLNP) were organized where the leading JINR and Brazil scientists gave 53 talks. At the final plenary session, the round table discussion was organized.

At the forum, various Brazilian universities and institutes were represented. They were:

University of São Paulo - USP (San Paulo, SP),

University of Campinas – UNICAMP (Campinas, SP),

Federal University of ABC – UFABC (Santo Andre, SP),

São Paulo State University – UNESP (São Paulo, SP)

Technological Institute of Aeronautics – ITA (São Jose dos Campos, SP)

Federal University Fluminense –UFF (Niteroi, RJ)

Federal University of Rio de Janeiro –UFRJ (Rio de Janeiro, RJ)

Federal University of Juiz de Fora – UFJF (Juiz de Fora, MG

Federal University of Santa Catarina – UFSC (Florianopolis, SC),

Federal University of Espírito Santo - UFES (Vitória, ES),

International Institute of Physics - UFRN (Natal, RN),

Center for Development of Nuclear Technology – CDTN (Belo Horizonte, MG)

Centro Brasileiro de Pesquisas Físicas – CBPF (Rio de Janeiro, RJ)

The participants have identified many areas of a common interest, which can be mastered using the JINR research facilities on a mutually beneficial basis. Some examples are the following ones:

1. Theoretical physics. The Bogoliubov Laboratory of Theoretical Physics (BLTP) is the world's largest community of theorists carrying research in various areas in a close contact with the JINR experimental laboratories. This allows a room for interdisciplinary investigations and direct interaction between theorists and experimenters. The main lines of research at BLTP are quantum field theory, elementary particle physics, relativistic heavy ion physics, low-energy nuclear physics, condensed matter and modern mathematical physics. The laboratory has a unique scientific potential and accumulates invaluable experience and traditions in these fields.

BLTP already has a long-term collaboration with different experimental and theoretical groups from Brazil. Common studies can be performed, for instance, in the fields of hadron physics, nanophysics, ultra-cold gases, strongly-correlated Fermi-systems, quantum fields in curved space and Casimir effect, gravitation and cosmology.

2. Nuclear reactions and spectroscopy. The Flerov Laboratory of Nuclear Reactions (FLNR) offers ion beams in a wide range of energies and atomic charges of accelerated particles through three research cyclotrons. FLNR is also implementing an ambitious plan for increasing its experimental capabilities – the new cyclotron complex "superheavy element factory" will be commissioned soon and the existing experimental area will be significantly enlarged. The participation of Brazil researchers in formation of research programs and theoretical support would be of particular value in areas of the dynamics of fusion and fission processes, nuclear structure, and in the synthesis and spectroscopy of transfermium elements. Scientists from both countries could participate in the development of relevant nuclear instrumentation. Also, FLNR has a large up-to-date experience in building heavy-ion cyclotrons for research and industry, which may offer a number of opportunities for engineers and researchers and for transfer of technology. The Brazilian physicists could share their experience in nuclear dating and other fields where they have a significant progress.

3. Neutrino physics. The Dzhelepov Laboratory of Nuclear Problems (DLNP) performs the study of neutrino properties and weak interactions. Of the highest importance is its development of a modern neutrino research infrastructure for experiments at the Kalinin Nuclear Power Plant (KNPP), where very promising searches for neutrino magnetic

moment, sterile neutrinos, coherent scattering and direct measurements of antineutrino flux from KNPP are under way. Also, creation and exploration of the Baikal Gigaton Volume Detector is the most important task of DLNP for the nearest future. The particular topics of interest are: neutrino-oscillations, neutrinoless double beta decay search, Study of the solar neutrinos and "rare" processes, Search for charged-lepton-flavor-violation in $\mu \rightarrow e\gamma$ decay and in $\mu \rightarrow e$ conversion in nuclei, direct and indirect dark matter search, Cosmic rays study. At DLNP successfully works medical technical complex (MTC) which performed proton therapy for more than 1000 patients. New detectors for particle physics and applied research such as precise e.m. calorimeters, laser inclinometer, MicroMegas etc. are creating in the DLNP.

4. Neutron applications. The Frank Laboratory of Neutron Physics (FLNP) the IBR-2 pulsed fast reactor delivering one of the higher neutron flux among the world's neutron sources. Brazilian scientists are welcome to apply for projects for joint investigations at IBR-2 reactor. The complementarity between neutron and ion based methods for investigation of nanostructures can also be an item of cooperation. FLNP has considerable strength in areas such as neutron spectrometers (1D and 2D neutron position sensitive detectors, sample environment devices, data acquisition systems, etc.) and for development of advanced cold neutron sources. Development of experimental equipment for extraterrestrial exploration can be also an item of mutual interest. Another possibility is the development of cooperation of neutron activation analysis for environmental studies.

5. High energy physics. The Veksler and Baldin Laboratory of High Energy Physics (VBLHEP) has a modern accelerator facility based on the Nuclotron – the superconducting accelerator capable of accelerating particles from protons up to heavy ions and polarized deuteron beams in a wide energy range. Implementation of the NICA project (Nuclotron-based Ion Collider fAcility) – the JINR flagship mega-science project – offers cooperation in the development of advanced detector systems and the numerous opportunities for training of hi-tech engineers and sharing of technology in detector development and signal processing, in cryogenic, high-frequency, vacuum systems, etc. VBLHEP invites Brazilian scientists to participate in the experimental study of the properties of dense and hot baryonic matter at the experimental set-up BM@N (Baryonic Matter @ Nuclotron) and further at the MPD (multipurpose detectors) and SPD (spin physics detector) at NICA collider rings.

6. Information technology. The Laboratory of Information Technologies (LIT) provides development of network, information, grid, computing infrastructure and methods of computational mathematics and computational physics for the research activity of JINR and its Member States on the basis of present-day information and high-performance programming technologies. LIT develops numerical methods, algorithms, and software, computationally adapted to multicore and hybrid architectures, methods of symbolic-numerical modeling of quantum systems and quantum informational processes, and mathematical processing and analysis of experimental data.

7. Radio-Biology. Using the JINR facilities, the Laboratory of Radiation Biology performs research in the fields of molecular radiobiology, radiation mutagenesis and radiation physiology. The main effort is oriented on molecular damage induction and repair in the DNA structure in human cells for radiation with different linear energy transfer (LET) and studies of gene and structural mutation induction in microorganisms and mammalian cells by accelerated heavy ions. The studies of chromosome aberration yield in human cells and kinetics of DNA damage repair for different doses of accelerated heavy ions are carried out as well as research of chromosomal instability in mutant mammalian cells after exposure to radiations of different LET. The interest is also in the research on biological effects of heavy ions on the retina and the visual pigment rhodopsin. In the initial stage are the studies of the effects of accelerated charged particles on the level of neurotransmitters in different brain structures. The LRB group of mathematical modeling develops theoretical models of inducible mutagenesis in microorganisms and mechanisms of the DNA break induction and repair. A new field of research has been created in the LRB – astrobiology, with the direction on the study of meteorite-catalyzed synthesis of pre-biotic compounds from formamide under proton radiation and the study of biofossils and organic compounds in meteorites and ancient terrestrial rocks.

8. Education. The University Center of JINR offers its educational facilities as a basis for executing the research part of qualification work in the Laboratories of JINR, as well as student practicum and internships. In particular, there are opportunities for PhD students, postdocs and MSc students in cooperation with Russian universities. JINR can act as a nodal hub for such cooperation with Brazil.

Conclusions

The participants of the Forum are convinced that the further development of the cooperation is supported by a solid basis. The JINR scientists and their Brazilian colleagues cooperate already within different research themes, among which *Theoretical Physics, Elementary Particle Physics , Relativistic Nuclear Physics, Networking, Computing and Computational Physics*

JINR is open for Brazilian experts to study all the spectrum of the opportunities for cooperation. The institute has a wide topical plan of research and a large number of research instruments. The number of research organizations and universities in Brazil which could be interested in cooperation with JINR is also large. To make the scientific cooperation with JINR most efficient, an informal Brazil-JINR Joint Coordination Committee (JCC) could be established. The Brazilian members of JCC would look for approval of Brazil-JINR cooperation activity by the Brazilian Physical Society and subsequently of the Brazilian Ministry of Science, Technology and Innovation.

We propose the following action plan for the next future, which can be facilitated by the above mentioned JCC:

- Establishing the communication channel by assigning the liaison officers

- Invitation of Brazilian observers to the meetings of JINR Program Committees and Scientific Council

- Invitation of Brazilian PhD students to JINR scientific Schools and co-supervising their qualification works

- Extending the Summer students programme (students.jinr.ru) to Brazilians

- Initiating the bilateral agreements between JINR and Brazilian research centers and universities for specifying joint research activities and facilitating networking

- Exchange of the information on Scientific conferences in JINR and Brazil, support of participation in these conferences, invitation of JINR lecturers to Brazilian Scientific Schools,

- Priority support of already existing collaborations between JINR and Brazil.

- Fostering exchange of the official delegations

- Attracting CNPq/CAPES and regional Brazilian sponsoring bodies for funding existing and emerging joint research activities

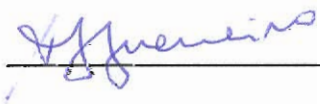
- Organizing dissemination of the information about the JINR in Brazil.

- Promoting JINR and its flagship project NICA as the possible centers of joint activity to the BRICS structures

- Using the occasion of the forthcoming 60-year anniversary of JINR and the other platforms for promoting Brazil-JINR cooperation

All these measures can result on a long and successful history of scientific communication of JINR with Brazil. During the Forum, the participants were acquainted with the structure of JINR and its organization. They also concluded that a promising way to perform the above mentioned cooperation would be an associate membership of Brazil to JINR.

Dubna, Russia
June 19, 2015



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