MEMORANDUM
of the "WHAT NEXT" Round Table, JINR, Dubna March 3rd-5th 2014 concerning
Pilot EU-Russia MegaNetwork Seeds

Introduction

The Opening Session of the Round Table "WHAT NEXT", scientifically devoted to debate the future of Theoretical and Experimental Physics after the discovery of the BEH boson, had an institutional character with the participation of the Deputy Minister of Education and Science of the Russian Federation L. M. Ogorodova, of the Science and Technology Counselor of the EU delegation in Moscow, R. Burger, of the First Counselor of the Italian Embassy in Moscow, A. Pinna, of the Scientific Counselor of the latter Embassy, P. Frè, of several members of the JINR Directorate, including the Director of JINR V.A. Matveev.

In the perspective of the EU-Year of Science and of the launching of the European Frame Programme HORIZON 2020, contemporarily with the new measures taken by the Government of the Russian Federation to develop Science and Innovation, it was discussed WHAT NEXT in the EU – Russia collaboration.

The main theme was precisely related with the concrete perspectives of participation of Russian Institutions and Scientists to Networks and Projects of HORIZON 2020.

In order to contribute some ideas towards the concrete constructions of EU-Russia Network Projects able to compete effectively in the HORIZON 2020 selection calls, the organizers of the WHAT NEXT Round Table presented some *Pilot Network Seeds* that were firstly discussed in the Opening Institutional Session and then, in view of the recommendations developed there, were further extensively discussed by all the scientists taking part in Round Table. From such discussions emerged the proposal of two EU-Russia Mega-Network Projects that might possibly get on the move towards construction with the promotion of Round Table participants.

The common feature of these two *Pilot Network Seeds* is their concrete basis in expertise and in results provided by JINR existing collaborations with Italian Scientific Groups, Italy being the co-organizer of the WHAT NEXT Round Table, essentially allied, however, with solid perspectives of enlargement to several Russian Institutions and the Institutes of South Africa on one side and to institutions of other European Countries on the other side. In this respect, particularly relevant was the contribution of suggestions and advice from the coordinators and participants of former EU Research Networks present at the Round Table, specifically Prof. I. Antoniadis (CERN and Ecole Politechnique, Paris), Prof. A. Van

Proeyen (KU Leuven, Belgium), Prof. Alexander Sevrin (Vrije Universitit Bruxel, Belgium)

Furthermore the common feature of the proposed *Seeds* is that such enlargements are naturally based on existing contacts, on good traditions of successful collaborations and on a solid scientific basis.

Finally issues of innovation and interdisciplinarity are the main focus of these Network Projects.

The participants to the Round Table "What Next" have therefore agreed to summarize the Pilot Network Seed proposal as it is described below in the present document.

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Pilot Network Seed 1:

FUNDAMENTAL PHYSICS,

TECHNOLOGY DEVELOPMENT and TRANSFER

SUBNETWORK 1A

Cosmology and Particle Physics Theory after the Discovery of the BEH boson

This is the Seed of a Network Project in Theoretical, Experimental and Observational Physics that should address the very hot topic of reconciling the outstanding results on the history of the Early Universe obtained by the European Satellite Experiment PLANCK with the scenarios of Fundamental Physical Laws that are compatible with what we are now learning about the Higgs sector, after the detection of the BEH boson. Obviously the theoretical part of this project should be seen as an allied effort in the promotion of new experiments, both in Space and on the Earth, that can involve once more EU-Russia cooperation as, for instance, the GAMMA 400 experiment, which is to be jointly conducted by the Russian Academy of Sciences, the INFN, ASI and Roscosmos and other partners. At the same time the Observational Part of the Network connected with Optical Astronomy might involve links with ESO and the major ESO Project, namely EELT. In this respect industrial collaborations are also easily at hand. For instance there already exists a frame agreement between the Italian group EIE and the Russian State Corporation LZOS for collaboration in the construction of mirrors and mechanical components of largescale telescopes. In the field of electronics for Space Experiments agreements, for instance, between Roscosmos and ASI have already generated successful Technology Transfer to industry. Much more can be envisaged by an adequate Steering Committee of the Network.

The Theoretical part of Network envisaged here might involve the following countries and Universities/Laboratories:

1) Belgium (Vrije Universiteit Brussel, Universite Libre de Bruxelles, KU Leuven)
2) Netherlands (Amsterdam University, Utrecht University, Groningen University, Leiden University)
3) France (Ecole Normale Superieure, Ecole Polytechnique)
4) United Kingdom (Imperial College)
5) Italy (Torino University, Scuola Normale Superiore di Pisa, Università di Pisa, Università di Milano Bicocca, Laboratori Nazionali di Frascati, Università di Napoli, SIGRAV)
6) Germany (Ludwig Maximilian University Munchen, Max Planck Institute Munchen and Potsdam, Hamburg University, Hannover University)
7) Spain (Barselona University, Oviedo University, Valencia University)
8) South Africa (University of Cape Town)
9) Russia (INR RAS, Landau ITP RAS, NRC "Kurchatov Institute" (ITEP, IHEP), LPI RAS, SMI RAS, MSU, SAI MSU, MEPhI, NSU)
10) Joint Institute for Nuclear Research (JINR)
11) European Organization for Nuclear Research (CERN)

For the Experimental and Observational Part several of the same institutions in Italy, Germany and Russia might also be involved (for instance the University of Naples plays an important role in connection with EELT and the EIE LZOS agreement). Others might be identified by the Steering Committee of the Network.

SUBNETWORK 1B:

Heavy Ion and Polarized Particle Collision Physics and the Development of superconducting technologies, Electronic Technologies and Information Technologies

This is the seed of a Subnetwork that should aim at the Development of Heavy Ion and Spin Physics and in parallel at the Technology Transfer to industrial compartments of those innovative techniques that are related with the construction of Heavy Ion and Polarized Particle accelerators and their use both in Fundamental Research and in Applied Science. Pivot points in such a project are to be JINR with its NICA project and the allied/concurrent centre GSI/FAIR in Germany at Darmstadt. INFN in Italy can also enter the game in a substantial way in the frame of its traditional collaboration with JINR. Several Universities in Member States of EU that are also Member States of JINR can be involved and a significantly and ramified Network can be established. As for the IT sector inside this Project, preliminary contacts and frame agreements between the Politecnico di Torino and both MIREA and the Russian Academy of Sciences together can provide a starting

basis to be extended at JINR and the NRC “Kurchatov Institute” and South Africa Institutions.

SUBNETWORK 1C

Neutrino Physics and Astrophysics

This is the Seed of a Subnetwork on the important, rapidly developing and interdisciplinary field in elementary particle physics, cosmology and astrophysics. The main goals are to figure out neutrino properties (masses, Majorana or Dirac structure, CP-violation, electromagnetic interactions, existence or absence of new types of neutrinos) and discover astrophysical sources of neutrinos of various energies and thus solve the century long problem of the nature of cosmic accelerators. These challenging goals call for the development of novel technologies which will inevitably find numerous applications, immediate examples being the neutrino monitoring of nuclear reactors and detailed, real time study of the ecology of seas and lake Baikal.

Europe, Russia, South Africa and JINR have strong experience, rich traditions and great achievements in the field of neutrino physics and astrophysics. The collaboration between them is steadily increasing. In 2013, JINR became an associate member of ApPEC (Astroparticle Physics European Consortium). Also in 2013, German and Russian groups got a joint ASPERA-RFBR grant on low-energy neutrino detection. Concrete examples of collaborations between Russia/JINR and EU institutions include experiments GERDA (neutrinoless double beta decay search in Gran-Sasso, Italy), OPERA (neutrino oscillations in Gran-Sasso, Italy), Edelweiss/EURECA (direct dark matter search in Modane, France), HESS (South Africa), etc.

Presently, JINR and Russian physicists are in the final stage of preparatory phase for Gigaton Volume Detector (GVD) at Baikal lake, and EU scientists are preparing for KM3-NET underwater facility. These activities lead to the creation of the Global Neutrino Network (GNN), which joins the Northern Hemisphere projects (KM3-NET and Baikal-GVD) and IceCube into unique Global Neutrino Observatory. Under development is the new JINR-Russian research infrastructure for world-level neutrino investigations at the Kalinin Nuclear Power Plant.

The Countries and Institutions involved in this part of the Network might be the following ones:

1) Italy (Gran-Sasso Laboratory, Universities and INFN sections in Roma, Milano, Torino, etc.)
2) France (Modane Laboratory, IN2P3, Universities of Paris, etc.)
3) Germany (Univ. Munich, Tuebingen, Heidelberg, Hamburg, Julich, MPI, etc)
4) Poland (Krakow University, etc)
5) Slovakia (University of Bratislava**,** Kositce, etc)
6) Czech Republik (Charles University, Prague, etc)
7) South Africa (University of Cape Town)
8) Russia (INR RAS, MSU, NRC “Kurchatov Institute” (ITEP, IHEP), PNPI, MEPhI, etc.)
9) Joint Institute for Nuclear Research (JINR)
10) European Organization for Nuclear Research (CERN)

COORDINATION of the Mega-Network "FUNDAMENTAL PHYSICS, TECHNOLOGY DEVELOPMENT and TRANSFER"

It might be quite convenient if the central coordinator of such a Network were located in Belgium, which is the home country of the Nobel Laureate F. Englert. Previous experience in the organization of European Networks in Theoretical Physics, strong links among the participant scientists could now further benefit from the important contributions of Russian and South African institutions and scientists of great talent and fame.

Pilot Network Seed 2:

MOLECULAR BIOLOGY,

MEDICINE, RADIATION and SPACE

This is the Seed of a vast Network that, in an intertwined fashion, might address many different questions, ranging from fundamental issues in Molecular Genetics concerning genetic material and metabolic cycles, to research issues in Cellular Biology concerning Oncology, continuing with technological problems of Hadron Therapy and of both Radiotherapy and Diagnostics. The application of various types of radiation in Neurophysiological Researches fits into this Network which might have also a full-fledged Clinical Part, mainly concerned with Oncology and based on parallel experimentation in several clinical centers of Europe and Russia.

The main seeds of this proposed Network are in the extremely successful collaborations between the Radiation Laboratory of JINR with Italian Institutions and of the IMBP (Institute of Biomedical Problems) of RAS with other Italian partners, for instance within the framework of the MARS 500 experiment. A further basis is provided by the fruitful interactions between the Institute of Proteins of Pushino and the Laboratories of SISSA in Trieste. Moreover a new front has been recently opened with deepening contacts with the Pirogov Medical University and the Rumyantsev Clinic in Moscow.

The Countries and Institutions involved in this Network might be the following ones:

1) Italy (University of Rome Sapienza, University of Tuscia, University of Torino, University of Udine, Istituto Tumori di Napoli, Istituto delle Proteine del CNR di Napoli, SISSA di Trieste)
2) The Netherlands (University of Utrecht, University of Amsterdam, Radboud University, Maastricht University)
3) Germany (University of Kiel and other partners to be found)

4) Slovakia (University of Bratislava)
5) UK (Imperial College and other partners to be found)
6) Russia (IBMP, Pirogov Medical University, Rumyantsev Oncological Pediatrical Clinic, Semenov Institute of Biochemistry, Institute of Protein Pushino, State Technical Chemical University Ivanovo, NRC "Kurchatov Institute")
7) JINR

COORDINATION of the Mega-Network "MOLECULAR BIOLOGY, MEDICINE, RADIATION and SPACE"

The Central Coordinator of this Network might be Prof. Francesco Saverio Ambesi of Udine University who has already very much effectively collaborated with the Laboratory of Radiobiology of JINR and has already agreed to take this duty if requested. It is worth mentioning that the particular theme of Ambesi's collaboration with JINR was the testing in vivo of the radiation-protective protein rMnSOD ("recombinant human Manganese SuperOxide") discovered and patented by Italian Researchers. Its uses in Manned Space Flights as well as in Terrestrial Oncological Radio-Therapy are potentially enormous and there are even perspective uses for Cosmetical Products. This is just to note that the perspectives of industry involvement in such a Network are wide. Pharmaceutical Industry *in primis*, but also others related with Biotechnologies, Clinical Equipment and further on.

Additions and Further Suggestions from the Participants

Contribution from Prof. Stefano Bellucci (Laboratori Nazionali di Frascati)

Here is what the team at INFN-LNF can do in connection with the Pilot Network Seed 1.

Radiation shielding. Using fabricated thermally stable phosphate composites filled with different boron compounds and carbon nanotubes (CNT) for producing conductive ceramic providing the neutron shielding along withwell-known functional, technical and electromagnetic abilities. The use of this new multifunctional neutron shielding material can be of great advantage, since in an environment with high radiation level one can coat steel pipes with boron compounds included in thermally stable phosphate composites.

Shielding against electromagnetic interference effect (EMI). At a certain distance from the reactor the control electronic equipment will be protected by ultra-light materials with controlled electromagnetic properties based on nanocarbons, including single- and multi- walled carbon nanotubes, nanotube bundles, carbon onions, graphene flakes, etc., providing efficient shielding of electromagnetic radiation in a wide spectral range.

Development of XRD detector for space missions, based on field emission by carbon nanostructured electrodes.

Development of innovative organic thin film transistors (OTFTs) with carbon-based electrodes (either carbon nanotubes and/or graphene), the accomplishment of their proof-of-concept, modeling, characterization and optimization, yielding the technological solution for the industrial fabrication of such transistors.

High photoconductive oxide films functionalized with GeSi nanoparticles at surface for environmental applications.

Nanocarbon Interconnects for CMOS compatibility and Real-world Testing. The key concept of the activity in this area is that the improvement of the nanocarbon technology, namely the growth of graphene and nanoplatelets at temperatures compatible with integrated circuit technologies, will lead to creation of novel interconnects in advanced VLSI.

Development of Biosensors using Carbon Nanotubes/Graphene. The main direction of the antiterrorist defence is the prevention and/or the early exposure of terroristic attacks. In case of using the biological warfare such as living agents or toxins DNA – biosensors yield one of the most effective tools for early diagnostics. The main goal of our activity in this field is the realization of a reliable, sensitive, selective and noise protected prototype of a DNA biosensor.

Study of the behaviour of nanomaterials and biomedical systems from their initial contact to the stages when measurable effects can be observed in biological structures and organisms. The key concept of our actrivity consists in the realization of an integrated multidisciplinary experimental and theoretical approach to discovering physico-chemical mechanisms at micro- and nano-levels responsible for the impact of a wide range of nanomaterials on the living systems under real conditions of practical relevance.

Determining the fundamentals of the interaction between the gravitational field and living organisms. This can yield useful hints for exobiology. Investigating the dose dependence and the time range of reversibility of effects induced by microgravity on living structures. Possible use of antioxidating substances (e.g. procyanidines, melatonine), in order to contrast the effects induced by microgravity. Possible experimental activity at the International Space Station, using bioreactors suitable for space study.

Crystals for particle accelerators:

1. proton beam extraction and collimation by bent crystals and VEER
2. production of new photon sources by crystal undulators using a positron beam
3. study of coherent effects of matter interaction with radiation (CEMIR)
4. realization of targets for Laser (like FLAME at LNF or ELI facility) for acceleration of hadron beams.

Contribution from Prof. Anatoly Petrukhin (MEPhI)

One can add to Pilot Network Seed 1 the following: “Further important investigation direction is the theoretical and experimental study of hadronic matter at very high energies more than 1 TeV/nucleon in the center of mass system both in collider and cosmic ray experiments” (INFN, Sezione di Firenze & Pavia, Torino University, JINR, LPI RAS, MEPhI)

The present Memorandum was elaborated by the Memorandum Editorial Committee formed by

1) Prof. Vladimir D. Kekelidze (JINR) cochairman
2) Prof. Pietro G. Frè (University of Torino and Embassy of Italy in Moscow) cochairman
3) Prof. Jean Cleymans (University of Cape Town, South Africa)
4) Prof. Antoine Van Proeyen (KU Leuven, Belgium)

The present text was approved by the participants and it was signed on their behalf by the Memorandum Editorial Committee:

Prof. V.D. Kekelidze ..... Dubna March 5th 2014

Prof. P. G. Frè ..... Dubna March 5th 2014

Prof. J. Cleymans ..... Dubna March 5th 2014

Prof. A. Van Proeyen ..... Dubna March 5th 2014

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