INTERNATIONAL INTERGOVERNMENTAL ORGANIZATION
МЕЖДУНАРОДНАЯ МЕЖПРАВИТЕЛЬСТВЕННАЯ ОРГАНИЗАЦИЯ

JOINT INSTITUTE FOR NUCLEAR RESEARCH
ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Joint Institute for Nuclear Research

SCIENCE BRINGING NATIONS TOGETHER

Strategic Long-Range Plan for JINR

Boris Sharkov

International Working Group has been established 2016 in order to organize the elaboration of the Strategic Long Range Plan (SLRP) of JINR

Members of SLRP WG

- **V.Matveev** (chair),
- B.Sharkov and N.Russakovitch (vice chairs),

- V.Aksenov, V.Bednyakov, L.Cifarelli, M.Dubnickova, S.Gales, M.Itkis, M.Jezabek, R.Jolos, D.Kazakov, V.Kekelidze, V.Korenkov, E.Krasavin, R.Lednicky, M. Lewitowicz, D.Nagy, Yu.Oganessian, E.Rabinovici, V.Rubakov, A.Sorin, M.Spiro, H.Stoecker, G.Trubnikov, I.Tserruya, G.Zinovjev.

Strategic Goal

Strategic goal is to develop JINR as a world-class scientific center, which takes a leading position in the field of high energy physics, nuclear physics of low energy and heavy ion physics, neutrino physics, condensed matter physics, radiation biology, high performance computing and innovative technologies.

Expected Result

SLRP will represent the outcome of detailed scrutiny by international leading experts and will help focus the views of the JINR scientific community on the most promising directions in the research fields of JINR and create the basis for governing bodies to provide adequate support.

Thematical sub-groups cover core research areas of the JINR scientific program

1. Particle and High-Energy Physics.
2. Relativistic Heavy-Ion and SPIN Physics.
3. Nuclear Physics.
4. Condensed Matter and Neutron Nuclear Physics.
5. Radio- and Astrobiology.
6. Information Technologies & High Performance. Computing

Members of the sub-groups – outstanding experts from JINR, member states and world science community

Possible Structure of a Laboratory's SLRP

A) Executive Summary

B) Introduction: What is and has been done in the Laboratory

a) Past and present Research Projects

b) National and International networking and context

c) .. Staff and Equipment today

C) Medium Range Projects

a) Project M1 – Motivation, international context , proposed research, needed resources (equipment, infrastructure, manpower)

b) Project M2 – Motivation, international context, proposed research, needed resources (equipment, infrastructure, manpower)

n) Project ..M..- Motivation, international context

D) Long Range Projects

a) Project L1 – Motivation, international context

n) Project ..L.. Motivation, international context

E) Summary with **time line** and international context

Sub-groups submitted the drafts of their contributions to the Editorial Board

and

prepared presentations for the SC session in September 2019.

Preparation of the Strategic plan
for long-term development of JINR

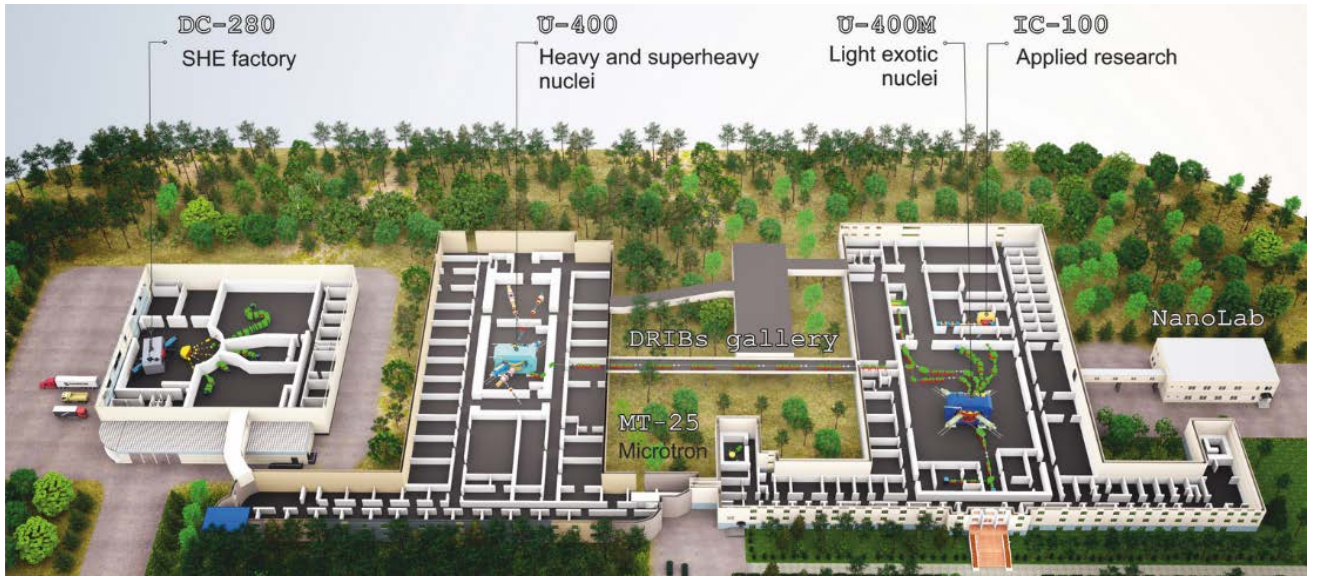
NUCLEAR PHYSICS AT LOW AND INTERMEDIATE ENERGIES

Alexander Karpov

JINR Scientific Council meeting, September 19-20, 2019

FLNR’s basic directions of research

FLEROV LABORATORY OF NUCLEAR REACTIONS



DRIBS-III ACCELERATOR COMPLEX

- Heavy and superheavy nuclei
- Light exotic nuclei
- Nuclear reaction studies
- Radiation effects and physical groundwork of nanotechnology
- Accelerator technologies

FLNR main tasks for 2017–2023

Commissioning and development of "SHE Factory" based on DC280 cyclotron:

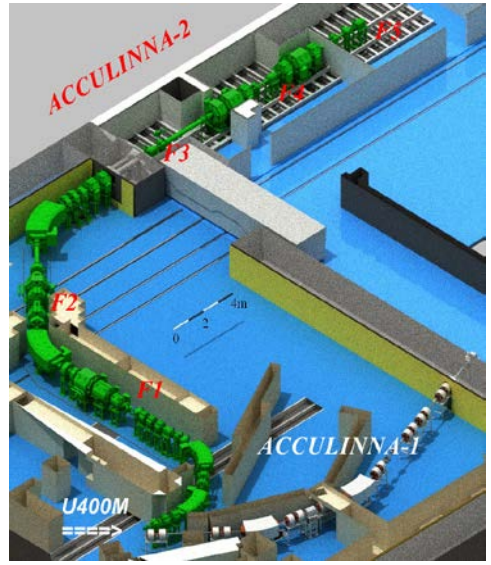
- *smoothly variable energy;*
- *beam intensity ~10 pμA for nuclei with A~50;*
- *new set-ups;*
- *infrastructure for accommodation of user setups.*

Modernization of the U400M cyclotron (2020-2021):

- *new main magnet coils, vacuum, diagnostics and radiation safety control systems;*
- *increasing beam intensities and energies.*

Reconstruction of the U400 to U400R cyclotron complex (2020-2023):

- *new experimental hall;*
- *accelerated ions from helium to uranium;*
- *smoothly variable energy within a wide range 0.8–25 MeV·A;*
- *decrease the cyclotron power consumption.*



Development of long-running experimental set-ups

Long-term future of the RIBs research at FLNR

- Substitution of the driving accelerator U-400M with a new one.
- Superconducting **LINAC-100** is under consideration.

Goals:

- **Beams**: up to Uranium
- **Energy**: ~100 MeV/nucleon
- **Intensities**: maximal possible **world best !**

A new project entitled “Construction of a prototype of the initial section of the high-current heavy-ion linear accelerator for the production of intense radioactive ion beams for basic research” was proposed and considered by **JINR PAC on Nuclear Physics**.

The project is a supplement to the physical program of the project “Development of the FLNR accelerator complex and experimental setups (DRIBs-III)” (theme: 03-0-1129-2017/21).

The works within this project should demonstrate the feasibility of the LINAC-100 plus new fragment separator facility and prepare the basic technical documentation (TDR).

Summary

- **Realization of the experimental program in the area of SHE research.**
- Continuation of experimental program on light exotic nuclei at the modernized **U-400M** cyclotron with the use of the ACCULINNA-2 fragment separator.
- Feasibility study for construction of a **new driving accelerator** for the radioactive beam research.

- Development of experimental set-ups @ the **SHE Factory**.
- Construction a specialized radiochemical complex of the 1st class.
- Development of ECR ion source on 28 GHz for acceleration of ions up to Uranium.
- Upgrade the U-400 (U-400R) accelerator, construction of the new experimental hall and equipping it with existing and new set-ups intended mainly for the study of nuclear reactions.

- The total available beam time of three FLNR's cyclotrons (DC-280, U-400R, and U-400M) is expected to be of about **18 000 hours annually**. This will allow us to formulate a **user policy** and open the FLNR facilities for external users.

Relativistic Heavy Ion and Spin Physics

Roumen Tsenov

Sub-group of the JINR Strategy Long Range Plan International Working Group

Results of our sub-group work

- **First priority in the next decade is the realization of the NICA scientific program** based on:

  - Heavy ion (up to Au^{+79}) collisions at center-of-mass energy in the range 2 – 11 AGeV;
  - Collisions of transversely and longitudinally polarized protons and deuterons at center-of-mass energy up to 27 GeV

Available at: *https://indico.jinr.ru/conferenceDisplay.py?confId=296*,

NICA scientific program

Investigation of hot and dense strongly int… matter, search for a mixed phase and critical … phase diagram in the poorly exp… baryon chemical potential.

…e nucleon spin structure … by performing experim… deuteron b… d

…not only to JINR and member st… to the international scientific community at …

In the next 25-30 years, the potential of the NICA accelerator complex should be fully exploited and further developed.

Upgrade of the Nuclotron beam extraction channels based on superconducting technology shall take place. It will be supplemented by construction of superconducting magnetic energy storage device (SMES).
R&D for upgrading of the magnetic system of the Nuclotron using high-temperature superconductor.

Future lines of development of the NICA accelerator complex

For > 2030 four directions have been identified that are scientifically promising, technically feasible, and can be seen as natural extensions of the planned NICA program:

- Upgrading of the NICA rings to obtain **asymmetric** heavy ion collisions and collisions of polarized protons with polarized deuterons and also pA and dA collisions.
- A feasibility and design study for an **electron accelerator of a few GeV** energy and, possibly, for a **high-energy photon beam**.
- A feasibility and design study for **search for the proton and deuteron electric dipole momenta (EDM)** with the NICA rings.

Involvement in external experiments

Traditionally, the HEP scientific program of JINR includes participation in experiments at accelerator centers around the world (**CERN, BNL, DESY, GSI**) that provide unique conditions to perform studies in the fields of high-energy heavy-ion physics and spin physics. **The key factor here is a mutual benefit from the exchange of new scientific information and know-how**. JINR participation will depend on the **discovery potential** of the experiments and **leading role** in them of the JINR researchers

The continuing participation in the experiments **NA61 and COMPASS at SPS, ALICE at LHC and STAR at RHIC** is of invaluable importance for preparation and realization of the physics program at the NICA complex. **Strategically important is the JINR participation in experiments at future electron-ion collider (EIC) facility to be built in US and in fixed-target experiments at FAIR-GSI.**

The JINR strategy for cooperative research at other accelerator centers should be linked closely to the **updated European Strategy for Particle Physics**, expected to be available in 2020.

2030

We have a strategy!

Strategic Plan of the long-term development of JINR

Particle Physics and Astrophysics

Dmitry V. Naumov (DLNP JINR)
On behalf of the committee

Baikal GVD – Flagship Experiment of JINR

- 3D Array of photo-sensors
  - Now: 0.25 km3
  - Phase I: 0.4 km3 (by 2021)
  - Phase II: 1.5 km3 (by 2027)
- Flagship Experiment of JINR
  - Hardware
  - Software
  - Everything
- JINR is the leading institute
- Aim to identify sources

Mid-term plan till 2030

- **ATLAS** - Phase 1 (100 kCHF) , Phase 2 (3,6 MCHF)
- **JUNO** -

JINR is THE Major Collaborator in JUNO

Total: 4.35M$

- DarkSide, Edelweiss } Dark matter
- NOvA: MO, CP-violation
- Kalinin PP: magnetic moment, coherent, sterile
- TAIGA: 100 TeV gamma
- GERDA, SuperNEMO: $0\nu\beta\beta$

Long-term plan after 2030

- NOvA → DUNE : Scintillation light RO in LAr TPC (now)
  Or
  → HyperK : Yet to be determined
- BAIKAL GVD
- JUNO
- ATLAS High Luminosity
- Bonus: Gravitational waves interferometers: LIGO/ VIRGO or interferometer @DUBNA

Attractiveness of JINR

- World class Neutrino Physics and expertise
- Top level in detection technologies
- New technologies (laser inclinometer, HPGe, ...)
- Mechanical workshop with modern machines (5D numerical machines available)
- Excellent engineers and modern equipped labs
- World class ultra cold technologies
- Unique world class home experiments:
  - BAIKAL GVD, Kalinin PP, TAIGA, ...
- Young, dynamic and open-minded team

Expert Group in the Radiobiology — Astrobiology

Strategic plan for the long-term development of JINR

The scientific program of the Laboratory of Radiation Biology for the period up to 2030

E.A. Nasonova

Dubna, September, 19, 2019

THE MAIN FIELDS OF RESEARCH

Molecular radiobiology

Radiation cytogenetics

Radiation Physiological studies on primates

top priority research!

Radiation Medicine

15-fold increase of proton beam efficiency by DNA synthesis inhibitors

Mathematical modeling of radiation-induced effects

Astrobiology

Radiation research

Radiation Protection **management and shielding at new nuclear facilities (incl. NICA)**

Main future topics identified

Infrastructure development

Purchasing of new modern equipment:

- **Flow cytometer sorter FACS AriaIII (~ 0.7 mln. $)**
- **System for scanning, processing and analysis of cytogenetic images (~ 0.2 mln. $)**
- **Station for automated cultivation and analysis of cell cultures IM-Q (~ 0.09 mln $)**
- **Real-time amplifier with the ability to set a temperature gradient (~ 0.03 mln $)**
- **Gel and chemodocumenting system with transilluminator (~ 0.015 mln $)**
- **Solid-state thermostat and reagents for genetic engineering (~ 0.013 mln $)**
- **Fluorescent tomography in vivo imaging system and hemoanalyser (~ 0.37 mln $)**
- **Upgrade of computing infrastructure (~ 0.54 mln $)**

Total: ~2 mln $

Sources of ionizing radiation

- **FLNR: U400M accelerator: light ions with an energy of up to 50 MeV / nucleon;**
- **VLHEP: Nuclotron accelerator: Carbon ions beams (E=500 MeV/nucleon), krypton ions (E=2.57 GeV / nucleon)**
- **DLNP: Medical technical complex: proton beams 170 MeV ans SOBP**

- **In future: Nuclotron (NICA): iron and other ions with an energy of ~ 500 MeV/u.**

WSG-5 on Condensed matter and neutron physics
for the Strategic Long-Term Plan of JINR

DNS-IV: a New Advanced Neutron Source at JINR

Alexander Ioffe

(chairman of the WSG-5)

Jülich Center for Neutron Science at Heinz Maier-Leibnitz Zentrum (Munich, Germany)
and
Frank Laboratory of Neutron Physics (JINR, Dubna)

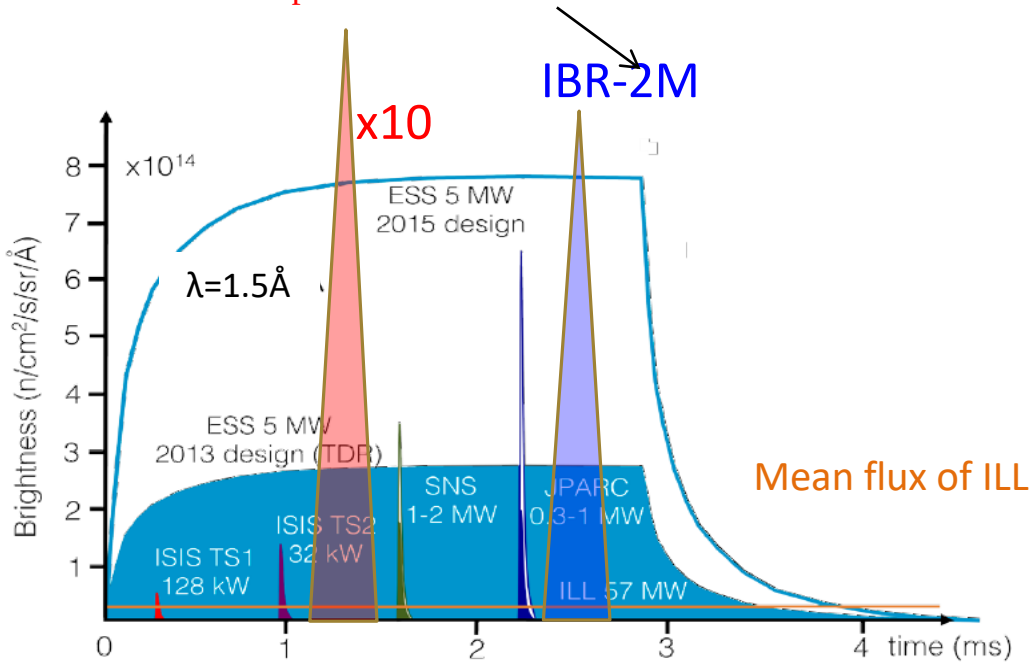
JINR Scientific Council Dubna 19.09.2019

New Dubna Neutron Source: DNS-IV

DNS-IV - not just another neutron source, but one of the best in the world!

- Long pulse neutron source, however shorter pulse than at ESS (0.3ms vs. 3ms)
- 10 times higher magnitude
- ESS long pulse is good for low resolution experiments
- High resolution requires pulse shaping => intensity losses

DNS-IV: $\Phi_{peak} \sim 10^{16}$

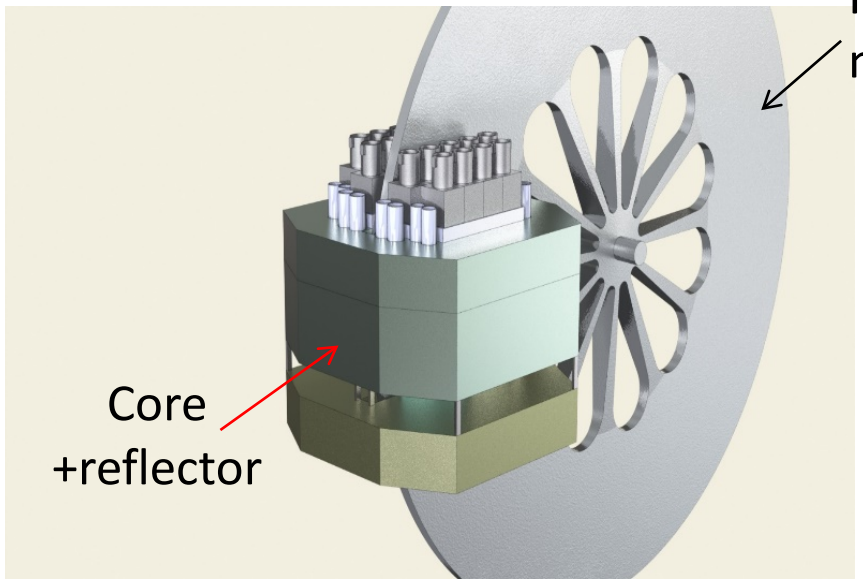


New Dubna source will provide shorter neutron pulses, however containing the same number of neutrons as at ESS.

=> it will be as good as ESS for low resolution experiments and better for high resolution experiments.

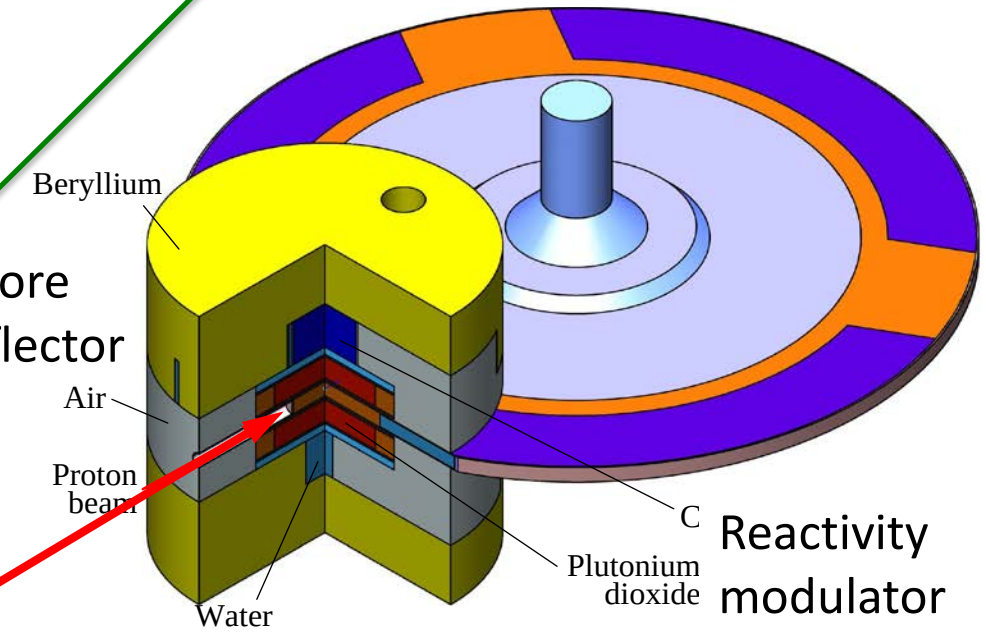
DNS-IV: two alternative concepts

1. Pulsed reactor IBR-3



E. Shabalin et al.

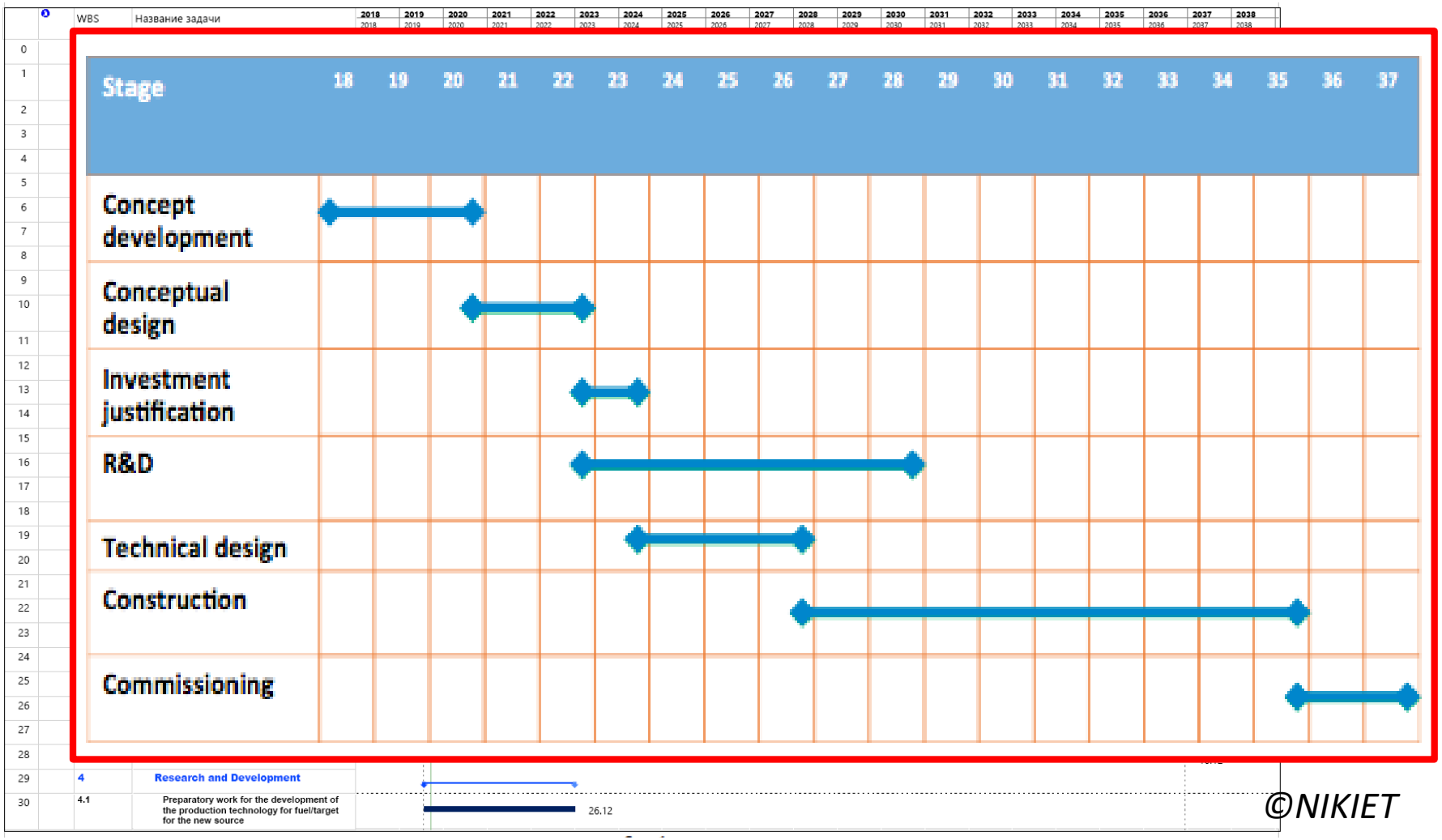
2. Accelerator-driven neutron source: spallation + multiplier



A. Vinogradov et al.

Time-line for DNS-IV

- **Both options are under the feasibility study in N.A. Dollezhal Research and Development Institute of Power Engineering (NIKIET), Moscow**



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Plans for 2023-2030

1. Development of the final concept of modern thermal and cold moderators

2. Design of modern neutron instruments

- Monte-Carlo simulations and optimization of neutron delivery system – maximal use of the emitted neutrons.
- Monte-Carlo simulations and optimization of neutron scattering instruments – maximal use of the delivered neutrons.
- Development of dedicated Monte-Carlo simulation procedures

3. Design of the high-efficient neutron delivery system

- Ballistic, elliptic and parabolic neutron guides

4. IBR-2 Instrumentation Development

- Construction, installation and commissioning of two inelastic neutron scattering spectrometers in inverted and direct geometry at the beamline #2;
- Upgrade of the all IBR-2 instruments;
- Design of the instruments for DNS-IV, testing the key technologies prototypes at the IBR-2;

INFORMATION TECHNOLOGIES

@

JINR DEVELOPMENT STRATEGY

Nikolay Voytishin

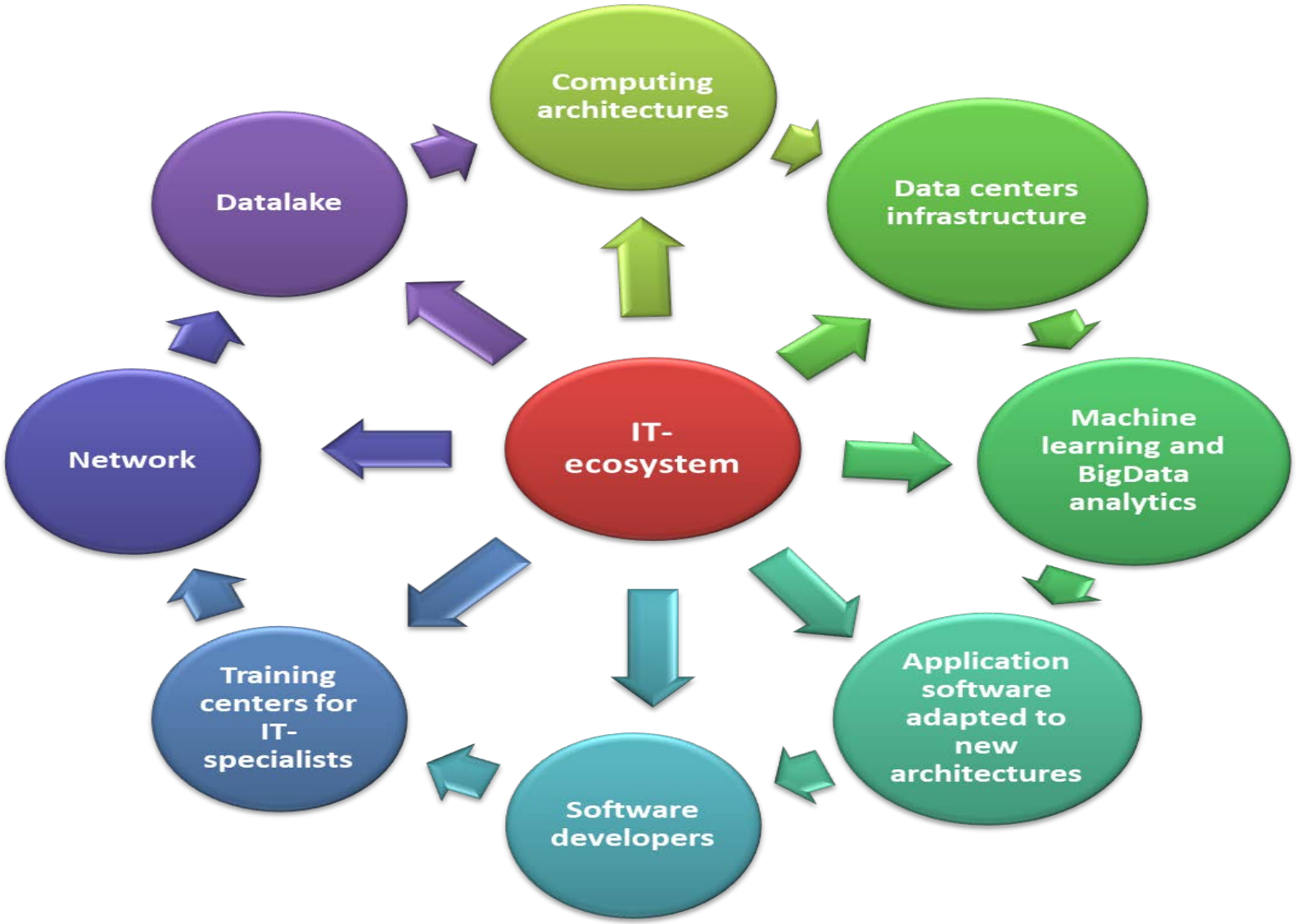
on behalf of the LIT strategy group

126th JINR Scientific Council

19.09.2019

Dubna

STRATEGIC LONG-TERM PLAN



AIM

Expandable worldwide dynamically evolving IT-ecosystem that combines a variety of technological solutions, state-of-art computing concepts and methodologies.

PURPOSES

Significantly reduce the time spent on the implementation of projects that require computing resources and IT expertise

BENEFICIARIES

JINR, its Member States and international collaborators

Scientific Council 19 -20 September 2019

<resolution>

- The SC recommends that the international WG ensures preparation of an integrated document based on materials presented by thematic subgroups describing the overall strategy with flagship projects and partnership priorities.

- The SC recommends to inform the CPP at its session in November 2019 about the progress in preparing the Strategic plan for long-term development of JINR.

WG Members Input

- Victor Matveev
- Itzhak Tserruya
- Valery Rubakov
- Horst Stoecker
- Grigory Trubnikov
- Sidney Gales
- Michel Spiro

- Structure – coherence/homogeneity
- Priorities
- Motivation, international context
- Uniqueness, leadership…
- Balance of research at home and outside
- Inter-laboratories co-operation
- Neutrino physics enhancement
- CMS, fixed target experiments enhancement
- **Time lines !!!**

Procedural timeline

- Status reports of the topical sub-groups. SC – September 2019
- International WG meeting –recommendations for sub-groups and for editorial board (EB) - September 2019
- Discussion in S-T-Committee of JINR, recommendations for EB – October 2019

- Status report in CPP – November 2019
- Integration and final text editing - November 2019 – January 2020
- Presentation in SC for approval - February 2020
- Approval by CPP - March 2020
- Printing of the SLRP book

Заключение

- **Благодарю руководителей и членов НТС**
- **Благодарю Рабочие Подгруппы и их координаторов, докладчиков…**
- **Представленные материалы, с разной степенью оптической резкости, позволяют Редакционной Группе очертить отчетливые контуры Стратегического Плана Долгосрочного Развития по каждому направлению…**
- **Просьба : завершить работу над текстами в кратчайший срок с учетом замечаний Ред. Гр. и членов международной РГ !**
- **Ред. Группа активно работает над подготовкой интегрального, сбалансированного текста …**
- **Этот материал – С. План Развития ОИЯИ - должен послужить основой разработки следующей 7-летки, а также основой для принятия Руководящими Органами Института мудрых решений, ведущих наш замечательный Институт**

  к новым научным достижениям, к мировому лидерству и к научной славе !

Comments, suggestions are welcome !

The current versions of working documents from the sub-groups are posted :
https://indico.jinr.ru/event/978/material/1/

SLRP is a forward look enabling JINR scientific community, in interaction with policy makers of JINR member States, to **develop long-term views** and **analyses of future research developments** with the aim of defining research agendas of JINR laboratories **in national and international context.**

Proposals for JINR Long-Range Strategy plan up to 2030

V.A. Matveev , 126th session of the Scientific Council

- **NICA – II (SpinPD, MPD-Upgr., NICA-HL, Innov.Centre)**
- **DRIBS-III (Dubna Radioactive Beam Complex for Super-Heavy Elements and Exotic Nuclei studies)**
- **SC HI LINAC-100 and DERICA Project (Dubna Electron Radioactive Ion Collider fAcility)**
- **Physics with the ultra cold neutrons at IBR-2M**
- **DubnaNS-IV: Super booster "NEPTUN" (Proton beam initiated Pulsed Np-237 Neutron Reactor)**
- **Baikal–GVD Neutrino Telescope Upgrade above 1 km^3**
- **BIG DATA @ IT Technologies Center, Supercomputer "Govorun" Upgrade**
- **Hadron Therapy research complex, Radiobiology Center**
- **Participation in the World Global Projects (HL-LHC, ILC, ClIC, Fcc, JUNO, etc)**

JINR – CERN strategic partnerships

- JINR actively participates in the LHC programmes including the ATLAS, CMS , ALICE and the Collider itself and planning to contribute to the LHC detectors upgrade.
- Besides, JINR participate in the four SPS projects:
- Compass-II (NA58) – nucleon spin structure, hadron spectroscopy (with interests to future SPD at NICA);
- NA61 – (intersects with BM@Nuclotrone and MPD);
- NA62 – CP-violation and rare decays;
- NA64 – search for the dark sector;
- Accelerator development: **HL-LHC CLIC**,**ILC LHeC**, **FCC**, Precise laser metrology (super sensitive inclinometr) ,
- Computing and Information Technologies, **WLCG, Tier-1,2**
- Neutrino platform, DUNE; other - nTOF, DIRAC,
- Education and Teachers programs etc.