PAC on PARTICLE PHYSICS

33rd meeting, June 22-23, 2010

Recommandations and work towards the optimisation of the research programme

Egle Tomasi-Gustafsson

Scientific Council, Dubna, 23/IX/2010

Alexey N. Sissakian

14 October 1944 - 01 May 2010

The members of the
PAC for Particle Physics commemorated
the Director of the Joint Institute
for Nuclear Research, Alexei Sissakian,
with a minute of silent appreciation.

….

Since the establishment of the PAC for Particle Physics in 1994 up to 2006,
…. as Vice-Director of JINR A. Sissakian coordinated the activity of this PAC

…..

The members of the PAC deeply regret the sad loss of Academician A. Sissakian.

II. Recommendations on the progress towards realization of the Nuclotron-M/NICA projects

G. Trubnikov

- The PAC appreciates the significant progress in upgrading the VBLHEP accelerator complex and the rigorous implementation of the work schedule for the Nuclotron-M and NICA projects.
- notes the successful spring run of the Nuclotron-M
- congratulates the Directorate and the staff for the achieved goals.
- welcomes the protocols and agreements with
  - CERN,
  - the Budker Institute of Nuclear Physics, and
  - GSI

  concerning collaboration on the NICA project.

Position	Required	Achiev. by 2007	Status by 06'2009	%
Ion source	124Xe44+ (2T)+new 6T	56Fe28+	84Kr28+ & 124Xe44+	95
Linac	Vacuum+optimization New modulator and DT	No No	Ready Under manufacturing	90 30
RF system	Noise reduction Automatization Adiabatic capture Feedback with beam	1 no no No	1/15 partially yes In progress	95 70 80 30
Ring vacuum, Torr	5*10^-10	5*10^-7	2*10^-9	100
Field (energy)	2T (6 AGeV)	1T (2.2 AGeV)	1.4 (3.8 AGeV)	80
Intensity	10^11 (d), 10^8 (i)	2*10^10 (d)	$5*10^{10}$ (d), $5*10^{7}$ (Li)	70
Power supply	Serial connection of magnets, new EES, MF control	old (< 1Tesla) || connection 1 Gs prescision	Serial connection ESS - 90% ready 0.1 Gs	70 90 99
New quench protection system	200 sensors	200 old	New prototype tested 30 - for run	40
Slow extraction system (efficiency)	Extraction at 6 AGeV	Max energy 2.2 AGeV (95%)	HV PS for 6 AGeV ready (95%)	85
Control, diagnostics	Beam losses <10%	70-80% losses	30-40% losses	70
Cryogenics	Safety + stability	Worked-out	Ready	99
Run stability	6 months/year	3 runs x 1month	2 runs x 1month	80

NICA main objectives in 2010:

Task	Collaborators	Status (June 2010)
1. Elaboration of Collider TDR (to be finished end of 2010)	BINP, FNAL, CERN, GSI	In progress
2. Technical project of civil engineering of the collider layout (we expect GlavGosExpertise in the beginning of 2011)	GSPI	In progress
3. Heavy Ion LINAC TDR	IHEP (Protvino), BINP	Negotiation
4. Prototypes of the dipole/quadrupole magnets for NICA Booster and Collider	Machinery plant "ATOM"	In progress
5. Booster RF system	BINP, Novosibirsk	Contract
6. New cryo-magnetic factory (manufacturing, assembling, cryo and vacuum tests) for SC magnets for NICA and FAIR	Industrial companies GSI/FAIR	Civil works in progress
7. MAC meeting	04-05 October'10	

II. Recommendations on the progress towards realization of the Nuclotron-M/NICA projects *(suite)*

- The PAC concurs with the Nuclotron-M/NICA MAC about essential advancement in the Technical Design Report for the NICA collider and looks forward to being presented a proposal for the next step of realization of the Nuclotron-M/NICA project at its future meeting.
- The PAC encourages the JINR management to publish an international call for experiments at the Nuclotron-M as soon as reliable performance figures can be presented qualifying for an outstanding physics programme.

visit to the Nuclotron-M

III. Recommendations on the progress towards the NICA White Paper

A. Sorin

- The PAC takes note of the report by A. Sorin on the ongoing preparation of the white paper for the NICA programme on the mixed phase and spin physics. The PAC notes the progress achieved in this direction and *recommends continuation of the work to elaborate a competitive research programme* in view of its complementarity with studies planned at CERN, RHIC, and FAIR.

Editorial board:

- **D. Blaschke**
- **D. Kharzeev**
- **A. Sissakian**
- **A. Sorin**
- **O. Teryaev**
- **V. Toneev**
- **I. Tserruya**

NICA

Draft v 3.01
June 17, 2010

SEARCHING for a QCD MIXED PHASE at the NUCLOTRON-BASED ION COLLIDER FACILITY (NICA White Paper)

http://theor.jinr.ru/twiki-cgi/view/NICA/WebHome

New Contributions to the NICA White Paper Draft v 3.03 (last update: June 20, 2010) http://theor.jinr.ru/twiki-cgi/view/NICA/WebHome

1) Peter Senger (GSI): Nuclear matter physics at NICA
2) S.M. Troshin (Protvino): Directed flow as signal of liquid state of transient matter
3) Kenji Fukushima (YITP Kyoto): Transitional change to baryon-rich QCD matter at NICA energy
4) Masayuki Asakawa (U Osaka): Importance of third moments of conserved charges
5) Yuri Ivanov (Kurchatov I Moscow and GSI): Baryon stopping in Heavy-Ion Collisions at E=2...160 GeV/nucleon
6) Giorgio Torrieri (FIAS & Columbia U): Statistical hadronization phenomenology in a low-energy collider
7) Giorgio Torrieri (FIAS & Columbia U): Flow scaling in a low-energy collider: when does the perfect fluid turn on?
8) Takeshi Kodama (U Rio de Janeiro): Fluctuations and non-equilibrium processes in collective flow
9) Marcus Bleicher & Jan Steinheimer (FIAS): MEMO production at high baryon densities
10) Oleg Rogachevsky, A.S. & Oleg Teryaev (JINR): Chiral vortaic effect and neutron asymmetries at NICA
11) D.E. Donets et al. (JINR): Development of highly charged ion sources for NICA injector and its possible application for nanofabrication and in medicine

Round Table Discussions on NICA@JINR

Round Table Discussion I
Searching for the mixed phase of strongly interacting matter at the JINR Nuclotron
July 7 - 9, 2005
http://theor.jinr.ru/meetings/2005/roundtable/

Round Table Discussion II
Searching for the mixed phase of strongly interacting matter at the JINR Nuclotron: Nuclotron facility development
JINR, Dubna, October 6 - 7, 2006
http://theor.jinr.ru/meetings/2006/roundtable/

Round Table Discussion III
Searching for the mixed phase of strongly interacting QCD matter at the NICA: Physics at NICA
JINR (Dubna), November 5 - 6, 2008
http://theor.jinr.ru/meetings/2008/roundtable/

Round Table Discussion IV
Searching for the mixed phase of strongly interacting QCD matter at the NICA: Physics at NICA (White Paper)
JINR (Dubna), September 9 - 12, 2009
http://theor.jinr.ru/meetings/2009/roundtable/

IV. Recommendations for activities at JINR related to the ILC

G. Shirkov

- The PAC takes note of the report by G. Shirkov on the progress for ongoing developments at JINR related to the ILC and recommends further participation in this work.

Annual report

V. Recommendations for new projects (I)

- The PAC takes note of the proposal for JINR's participation in the CBM project, presented by *A. Malakhov and P. Senger*, and recommends its approval until *the end of 2015*. It encourages the JINR group to select and focus on specific R&D applications to be developed in close connection with MPD.

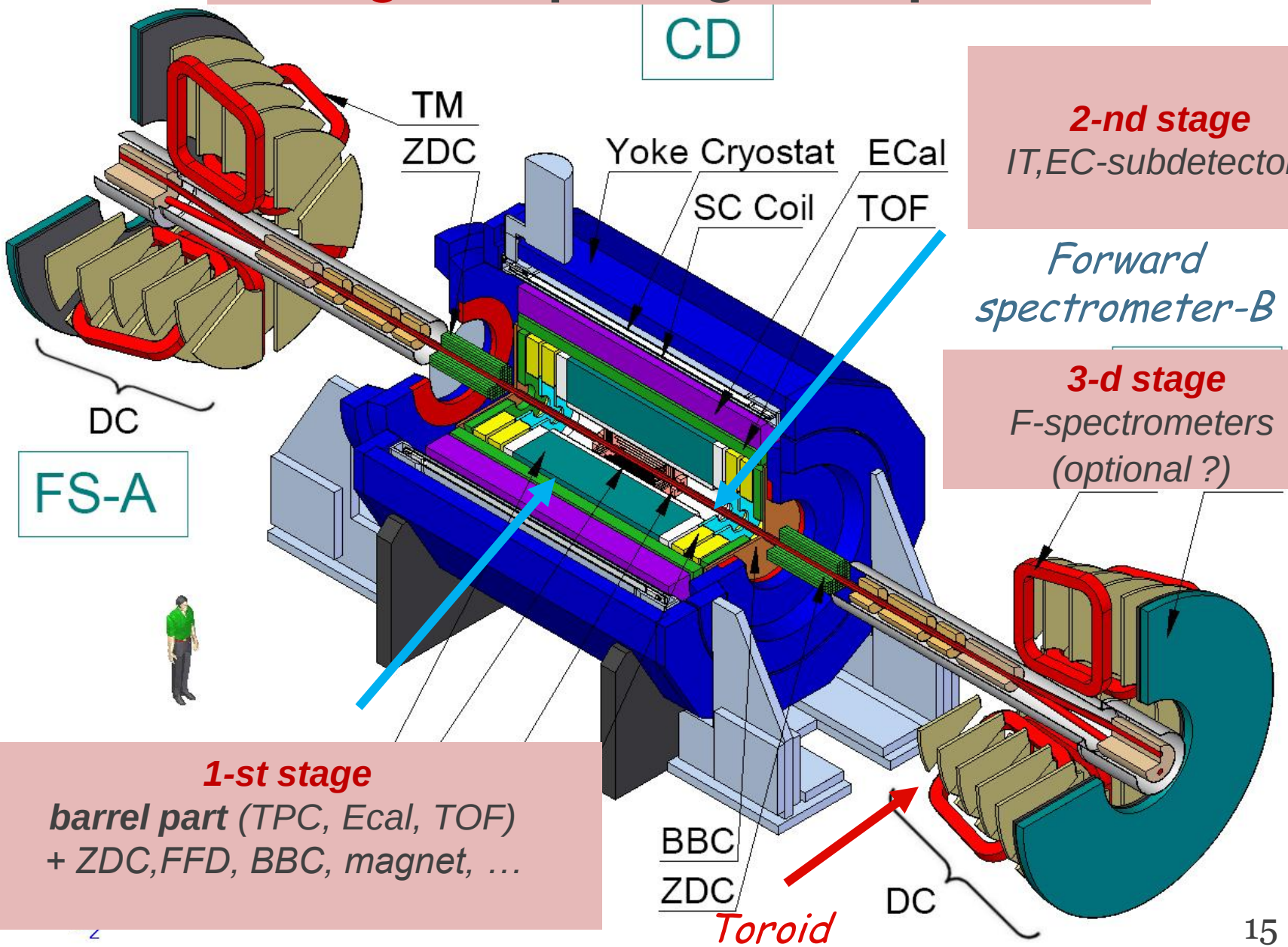
JINR participation in CBM

- Study of multiparticle dynamics in heavy ion collisions at CBM
- Design of dipole magnet
- Development of the Silicon Tracking System
- Development of fast and high granularity gaseous detectors for TRD
- Development and design of a straw tube tracker prototype
- Development of methods and algorithms for global tracking

V. Recommendations for new projects (II)

- The PAC takes note of the proposal of the project "MultiPurpose Detector to study properties of hot and dense baryonic matter at the NICA collider (MPD)", presented by *V. Kekelidze*, and recommends its approval until the end of 2015. The PAC notes the importance of the proposed scientific programme, the progress in the organization of the international collaboration, and the great interest from a wide scientific community. The PAC is pleased to see the first version of a comprehensive CDR.

3 stages of putting into operation



2-nd stage
IT,EC-subdetectors

Forward spectrometer-B

3-d stage
F-spectrometers (optional ?)

1-st stage
barrel part *(TPC, Ecal, TOF)*
+ ZDC,FFD, BBC, magnet, …

Timetable MPD

	Stage / Year	2009	2010	2011	2012	2013	2014	2015	2016
1	MPD Conceptual Design Report								
2	MPD TDR								
3	**R&D program**								
	TPC								
	TOF								
	ZDC								
	Si inner tracker								
	EMC								
	Straw Tracker								
	DAQ								
4	**Production and tests (the 1st stage detectors)**								
	Superconducting Magnet of MPD								
	TPC								
	EMC								
	ZDC								
	TOF barrel								
	Slow Control								
	DAQ								
	Installation& Commissioning								
	Si inner tracker								
5	**Production and tests (the 2nd stage detectors)**								
	TOF(EndCap)								
	Straw Tracker								
	DAQ								
	Slow Control								
	Installation								
6	**Production and tests (the 3rd stage, Forward Spectrometer)**								
	Toroidal Magnet construction								
	Coordinate detectors production								
	Coordinate detector testing								
	Installation& Commissioning								

V. Recommendations for new projects (III)

- *The PAC will closely follow the progress on these projects through regular reports and if necessary by appointing external referees.*

- The PAC takes note of the proposal of the TRANSMUTATION project, presented by *S. Tyutyunnikov*, and recommends its approval until the end of 2013. The PAC notes the practical importance of the proposed studies.

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VI. Recommendations on the reports of the JINR groups about first scientific results in LHC experiments

The PAC takes note of the reports by JINR groups on the first scientific results in the ALICE, ATLAS, and CMS experiments, presented by *A. Vodopyanov, V. Bednyakov and S. Shmatov* respectively, and highly appreciates the obtained results. The PAC looks forward at its future meetings to regular presentations of JINR's participation in data analysis focusing on JINR physicists' contributions and activities.

VII. Recommendations on activities previously approved for completion in 2010 and proposed for continuation

- "Mathematical Support of Experimental and Theoretical Studies Conducted by JINR",

  Gh. Adam, -> end 2013.
- "Information, Computer and Network Support of JINR's Activity", *V. Ivanov*, end of 2013. The PAC sees the need for an important increase in the computing power of JINR. It recommends that LIT, with the support of the JINR management, prepare a proposal for a High Power Computing Centre at JINR which would provide the JINR scientists with adequate computational capacity in the future.
- The PAC takes note of the report on JINR's participation in the BES-III project, presented by *A. Zhemchugov*, highly appreciates the received results and the importance of this work, and recommends continuation of this activity until the end of 2013.

VIII. Poster presentations by young scientists in the field of particle physics research

- The PAC notes with interest the poster presentations in particle physics presented by young scientists from VBLHEP and BLTP and recommends that this form of presentations be included in the agenda of its future meetings. *The PAC encourages the publication in the journal "Physics of Elementary Particles and Atomic Nuclei, Letters"* of the reports delivered at this session as poster presentations.

IX. Scientific reports

- The PAC notes with interest the reports "Observation of a first tau neutrino candidate event in the OPERA experiment in the CNGS beam", presented by *Yu. Gornushkin*, "Spin Structure of the Nucleon", presented by *G. Mallot*, "NA61/SHINE at the CERN SPS", presented by *M. Gadzicki,* and thanks the speakers.

Next meeting: 25-26 january 2011


Thank you for attention
Благодарю вас за внимание

OBJECTIVES

The project objectives are:

1. To study the possibilities and specific features of using hard neutron spectrum of deeply subcritical quasi-infinite uranium target irradiated by 1-10 GeV protons and deuterons for implementation of a new scheme of electro-nuclear method for energy production and transmutation of long-lived radioactive wastes – nuclear relativistic technology (RNT).

2. To improve existing theoretical models and verify computer codes for guaranteeing precise simulation of electro-nuclear systems for RNT experimental-industrial prototype design.

Average total Y and partial Y_{20} (for neutron energies higher than 20 MeV) neutron yields for long lead target (Ø 20 × 60 cm) irradiated by proton beams in comparison with calculated yields

E_p, GeV	Experiment (n/p)		MCNPX: INCL4+ABLA		MCNPX: BERTINI		Fluka 2008.3	
	Y	Y_{20}	Y	Y_{20}	Y	Y_{20}	Y	Y_{20}
0.994	24.1±2.9	2.1±0.4	23.7(2%)	1.62(2%)	24.1	1.45	24.4	1.40
C/E			**0,983**	**0,771**	**1,000**	**0,690**	**1,012**	**0,667**
2.0	44.4±5.3	4.7±0.8	46.1(2%)	3.29(3%)	49.7	3.02	48.7	3.21
C/E			**1,038**	**0,700**	**1,119**	**0,643**	**1,097**	**0,683**
2.55	63.5±7.6	5.8±1.9	50.5(1%)	3.99(1%)	62.5	3.88	60.1	4.10
C/E			**0,795**	**0,688**	**0,984**	**0,669**	**0,946**	**0,707**
3.17	71.6±8.6	6.8±1.2	57.9(1%)	4.66(1%)	76.3	4.89	72.14	5.03
C/E			**0,809**	**0,685**	**1,066**	**0,719**	**1,008**	**0,740**
3.65	80.6±9.7	8.5±1.5	62.6(1%)	5.14(1%)	86.8	5.5	80.2	5.67
C/E			**0,777**	**0,605**	**1,077**	**0,647**	**0,995**	**0,667**

PROGRAM

A set of integral macro- and micro-experiments in combination with necessary theoretical calculations will be carried out during the project realization.

The reliability and completeness of experimental data are provided by application of independent mutually verifying systems for measurement of physical processes in a quasi-infinite uranium target under the action of relativistic protons and deuterons.

The project schedule includes experiments in the framework of the physical program at the facilities are: “Energy+Transmutation” and “Gamma-3”. It is planned to develop and test measurement systems for experiments with the new uranium target in parallel with these experiments.

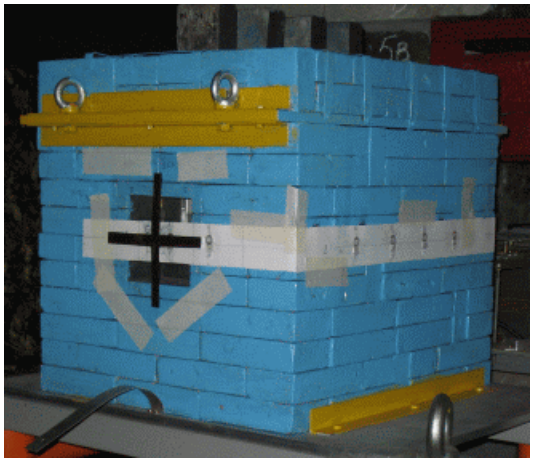
The main experiments of the project are planned to be performed on the basis of the new flexible target diagnostic complex “YOZHIK” which represents a quasi-infinite target from metallic uranium equipped by measurement channels whose position and design should provide optimal execution of the research program.

“E + T RAW” (“Energy plus Transmutation of Radioactive Wastes”)

Experimental Setup

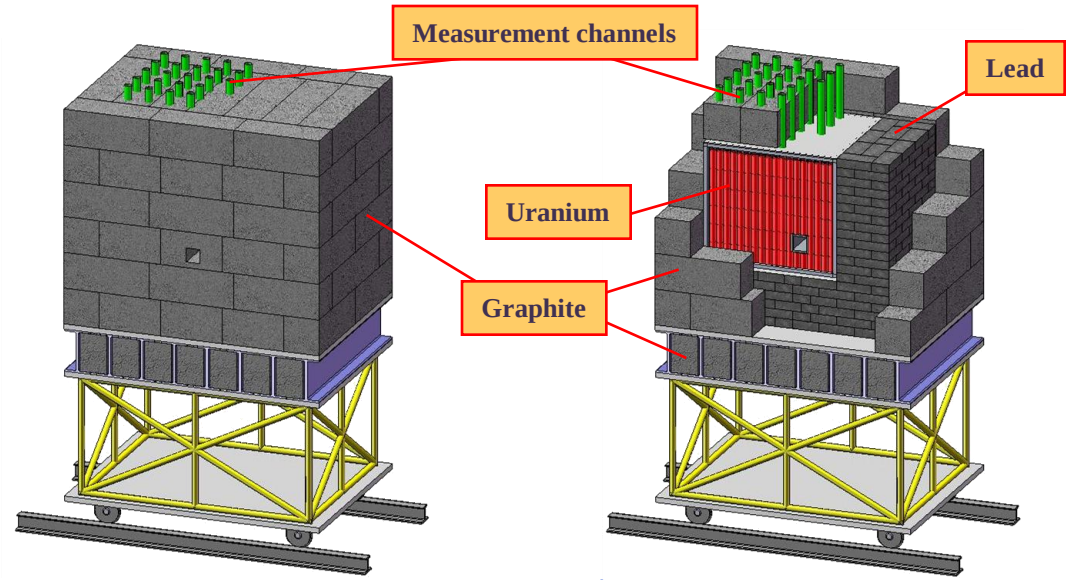
«Energy +Transmutation »

«Energy +Transmutation » (Quinta)

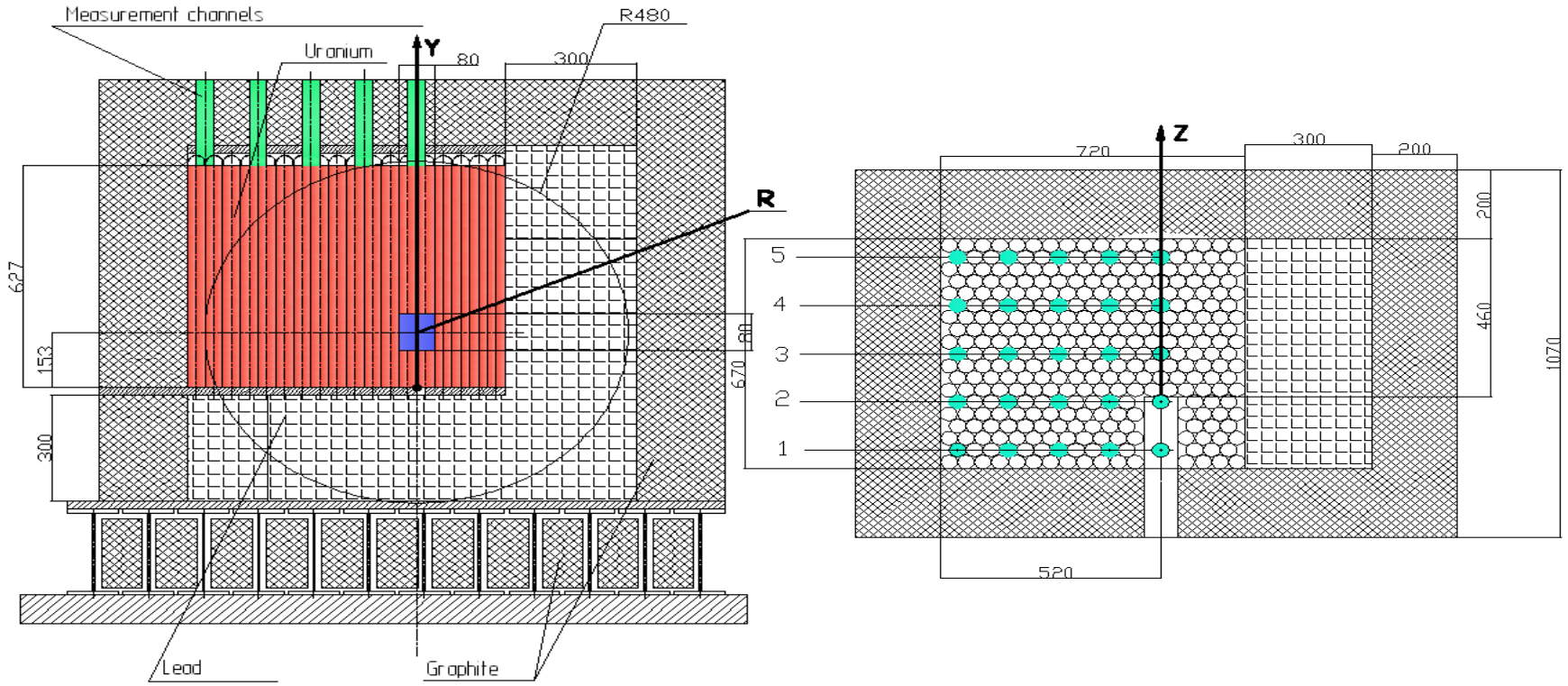


«Gamma-3»

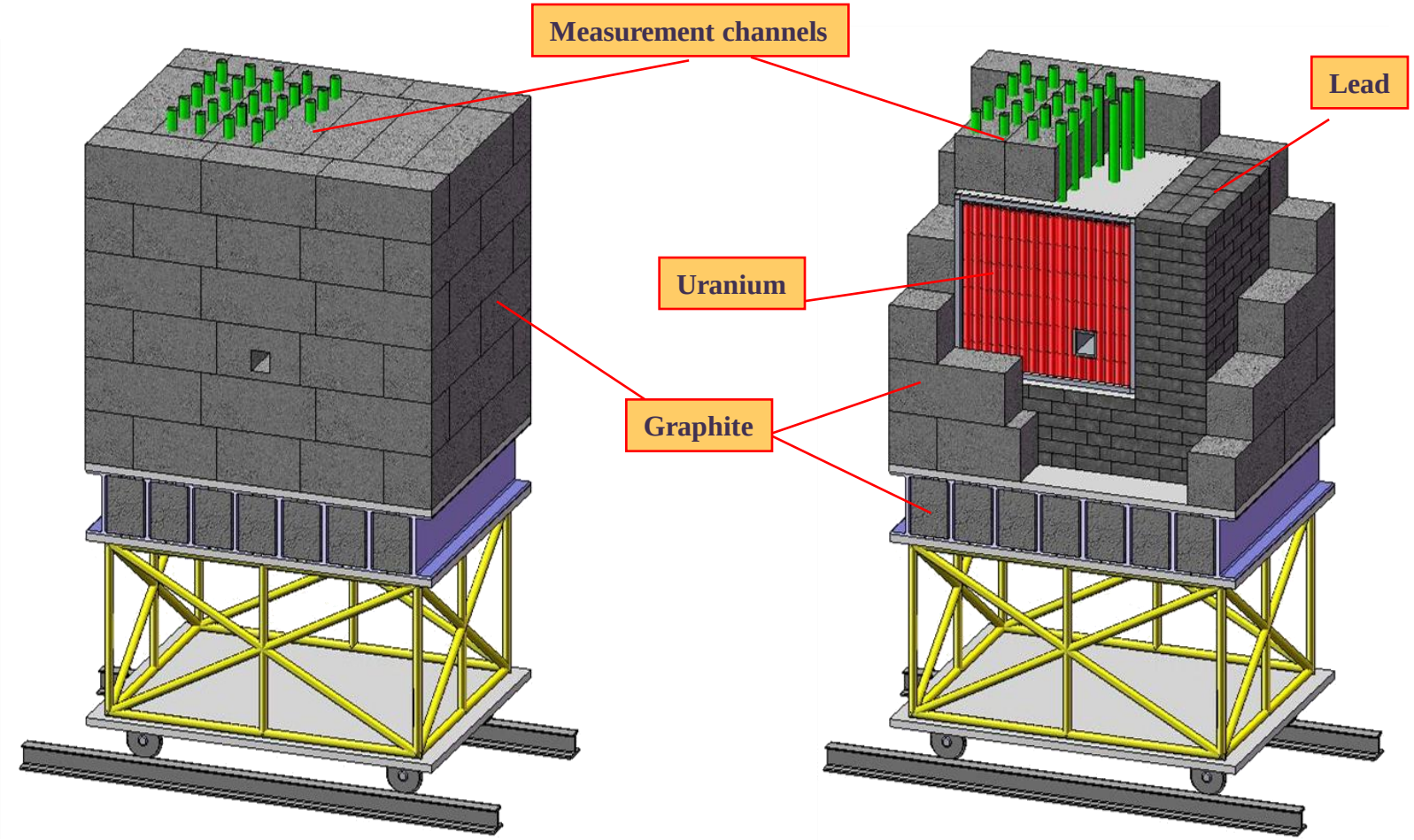
«YOZHIK-U»



The main experiments of the project are planned to be performed on the basis of the new flexible target diagnostic complex “YOZHIK” which represents a quasi-infinite target from metallic uranium equipped by measurement channels whose position and design should provide optimal execution of the research program.



New flexible target diagnostic complex “YOZHIK”



Direction 1 ("Integrals")

The first direction includes the set of integral experiments with the targets «YOZHIK-U», proton energies from 1 to 10 GeV and deuteron energies from 1 to 5 GeV/nucleon.

These experiments include:

1. study of neutron spectra at various points in the target volume in the presence and absence of graphite reflector (below, different target configurations);
2. study of spatial distributions of fission rates and transmutation cross sections of actinide fission fragments at different target configurations for determination of optimal transmutation regimes;
3. study of spatial distributions of radiative capture (n, γ) and (n,xn) reactions in samples from long-lived isotopes of spent fuel placed in measurement channels for different neutron spectra;
4. measurement of heat release distribution in the target volume depending on the target configuration and different enrichment by easily fissionable isotopes;
5. study of spatial distributions of parity between ^{239}Pu isotope accumulation and fission for determination of the value and time of achieving equilibrium concentration of this isotope for different target configurations;
6. obtaining power amplification coefficients depending on the characteristics of the neutron spectrum inside the target determined by its configuration and beam particle type and energy;
7. study of prompt and delayed neutron spectra and multiplicity depending on the target configuration, particle type and energy;
8. improvement and optimization of on-line and off-line methods for monitoring intensity, geometric characteristics, and Nuclotron beam position on the target;
9. study of desactivation rates for targets irradiated with different doses.

These studies will be accompanied by numerical and theoretical simulation in combination with activities in Direction 3 described below.

Direction 2 (“Constants”)

Carrying out a complex of constant measurements with thin samples, proton energies from 0,6 to 10 GeV and deuteron energies from 1 to 5 GeV/nucleon.

It is planned to perform the series of experiments for obtaining data on energy dependence of fission cross sections of the required set of target nuclei by relativistic protons and deuterons; delayed neutron yields, and fission products.

For reliable simulation of electronuclear systems it is necessary to know the characteristics of corresponding reactions in both thin and thick ($\geq$2000g/sm^2) targets .

Particularly, dielectric track detectors will be used to measure the cross-sections of fission reactions induced by primary and secondary particles.

This method is practically the only one that provides measurement of fission cross-sections for intensive primary and secondary particles fluxes. Track detectors with different registration thresholds provide distinguishing fission fragments from protons and neutrons, the mass spectrum of fission fragments can be also studied.

All data obtained within the second direction “Constants” should be converted into the complete nuclear data files according to the existing standards adapted for basic computer codes.

Direction 3 (“Simulation”)

Improvement of physical models, constant base, and computer programs by taking into account neutron multiplicity in extended fissionable media, especially in the energy range above 10 MeV.

The task of obtaining neutron-physical characteristics of the electro-nuclear method under study applies to two physics areas: interaction of high energy beams with condensed matter and reactor physics.

An appropriate account of high energy fission channels is of great importance for calculating neutron fields and heat release in such systems, because the results obtained using existing numerical models differ greatly (several times) from very limited experimental data obtained with small targets, and for quasi-infinite fissionable matter the expected deviation is more pronounced.

The complex of theoretical and numerical activities in the field of phenomenology of multiple particle production in a quasi-infinite fissionable target irradiated by a high energy beam will be performed in the framework of the third direction (“Simulation”).

The theoretical activity and simulations performed to support preliminary planning of experiments in the framework of the project and subsequent processing of results of measurements will make a reliable basis for creation and development of models, methods, and algorithms. The activity in this direction should provide reliability of simulation support for designing future prototypes of experimental-industrial RNT-setups after the proof of principle of the proposed electronuclear scheme.

Direction 4 ("Materials")

Investigation of relativistic beam impact on structural and fuel materials.

Within this direction we plan to carry out measurements of integral gas (^{3,4}He) production rates in interaction of relativistic beams and fast neutrons with the structural elements and the fuel. Radiation damage depending on the energy and type of primary particles will also be studied.

The activities within this direction are performed in parallel with the activities within the first and second directions. For this activity is necessary to provide minimal possible Nuclotron beam size in front of the target.

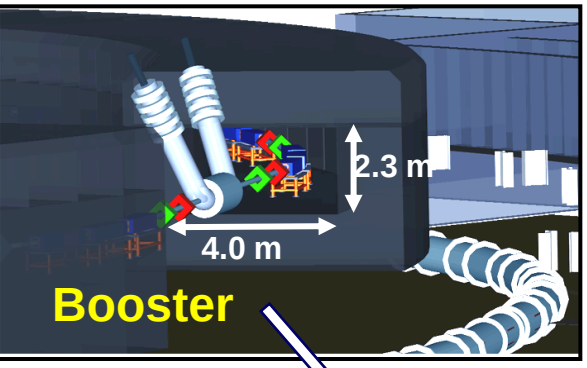
ORGANIZATIONAL AND TECHNICAL ASPECTS

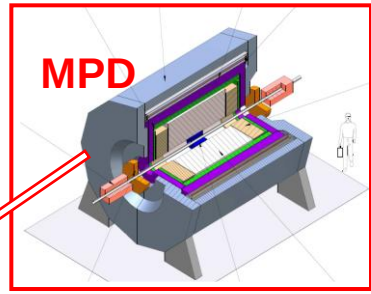
The project “E&T – RAW” will be performed in the framework of a large scientific and technical cooperation including: JINR (LHEP, DLNP, FLNP et al.), Center of Physical and Technical Projects “Atomenergomash” (Moscow), State Research Center Institute of Physics and Power Engineering (Obninsk), JINPR-Sosny NASB, IF NASB, and participants of “Energy plus Transmutation” and “GAMMA-3” collaboration.

Positive experience of joint activities, including long-term fruitful experiments at JINR, as well as successful experience of performing a complex of experimental studies initiated by Center of Physical and Technical Projects «Atomenergomash» at JINR and Petersburg Nuclear Physics Institute RAS in 2008-2009 and the GAMMA-3 / E+T Collaboration ensure successful realization of the proposed research program.

It is very important that JINR possesses unique capabilities for performing planned experiments, namely, operating relativistic particle accelerator Nuclotron, required amount of fissionable materials, developed measurement methods, as well as the basic international team of highly qualified scientists and technicians.

NICA status
(leader prof. I. Meshkov)





Collider
C = 400 m

KRION-6T &
HILac

Ion source &
"Old" linac

Nuclotron beam
transfer line

Nuclotron beam
lines & fixed target
experiments
(to be optimized)

Spin Physics
Detector (SPD)

Synchrophasotron
yoke

Beam transfer lines
& New research area

Nuclotron