JINR

FLNP
User Guide

JINR, Joliot-Curie 6,
141980 Dubna, Moscow region, Russia
2016

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flnph.jinr.ru, ibr-2.jinr.ru

Dubna and Joint Institut for Nuclear Research

Dubna is a science town standing 130 km north from Moscow on the banks of the Volga River.

Since 2005 special economic zone "Dubna", aimed at modern technologies development, is under construction on the territory of the town. The International University of Nature, Society and Man of Dubna, Choir Studios, symphony orchestra and numerous sport complexes of the town make Dubna one of the educational and cultural centers of the Russian Federation.

The **Joint Institute for Nuclear Research (JINR)** is a world-known centre where fundamental research is successfully integrated with the development of new technologies, application of the latest techniques and university education. JINR is a genuine international institution comprising 18 member states and 7 associated member states. The main fields of the JINR activity are theoretical and experimental studies in elementary particle physics, nuclear physics, condensed matter physics, and radiobiology.

The name "Dubnium" was assigned to element 105 of the Periodic Table in recognition of the achievements of the JINR staff of researchers and their contribution to modern physics and chemistry.

Physical start-up of the modernized IBR-2 reactor: loading of first fuel assembly into the active zone

1977 Reactor commissioning without liquid sodium coolant

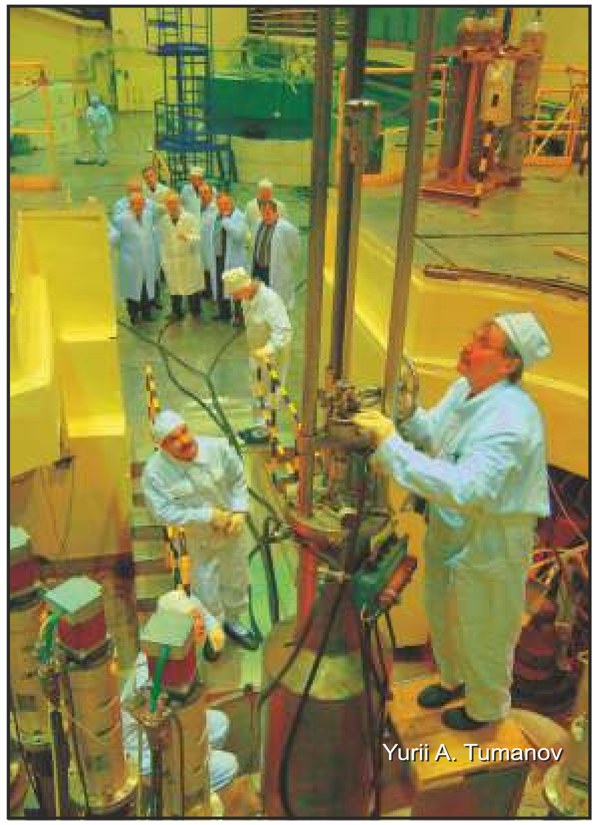
1981 Reactor commissioning with liquid sodium coolant, first power

1982 Reactor start-up, first experiments

1984 – 2006 Regular operation for physical experiments

2007 – 2010 Modernization

2010 Start-up of the modernized reactor



Main parameters

Parameter	IBR-2
Mean power, MW	2
Peak Power, MW	1850
Fuel	PuO_2
Number of fuel elements	69
Maximal burn up, %	9
Repetition rate, Hz	5; 10
Pulse width for fast neutrons, μs	~200
Rotation speed, rpm	
main reflector (MMR)	600
auxiliary reflector (AMR)	300
MMR and AMR material	Nickel+steel
Moveable reflector service life, hours	55000
Background, %	7
Number of satellites at 5 Hz	1
Thermal neutron flux from the surface of moderator:	
time average	10^{13} n/cm^2/s
burst maximum	10^{16} n/cm^2/s

Dear Users,

The **Frank Laboratory of Neutron Physics (FLNP)** is one of the seven JINR Laboratories. The scientific activity of the Laboratory focuses on two fields of science, namely nuclear physics and condensed matter research with neutrons. The first involves investigations of the neutron as an elementary particle and studies of compound states in neutron induced reactions, neutron activation analysis and applied research. The second includes compelling research programs focused on such areas of scientific interest as physics of nanosystems, structure and dynamics of functional materials, complex liquids and polymers, molecular biology and pharmacology, structure of rocks and minerals, engineering diagnostics, etc.

The greater part of all investigations is carried out in close collaboration with the JINR member states, as well as with international associates. FLNP is proud to have active cooperation agreements with almost 200 scientific institutes and universities of 40 countries from all over the globe. This statistics imply that our user program is designed for and open to both internal and external users worldwide. What is more, the international status of JINR allows users from the JINR member states to access the user program at privileged conditions. Before the IBR-2 reactor was upgraded, more than 250 experiments were realized year by year. Among these about 75% were proposed by users of the JINR member states and other countries. An enormous increase of operational abilities followed the upgrade of the IBR-2 reactor and at present the Laboratory owns one of the most intense pulsed neutron sources in the world.

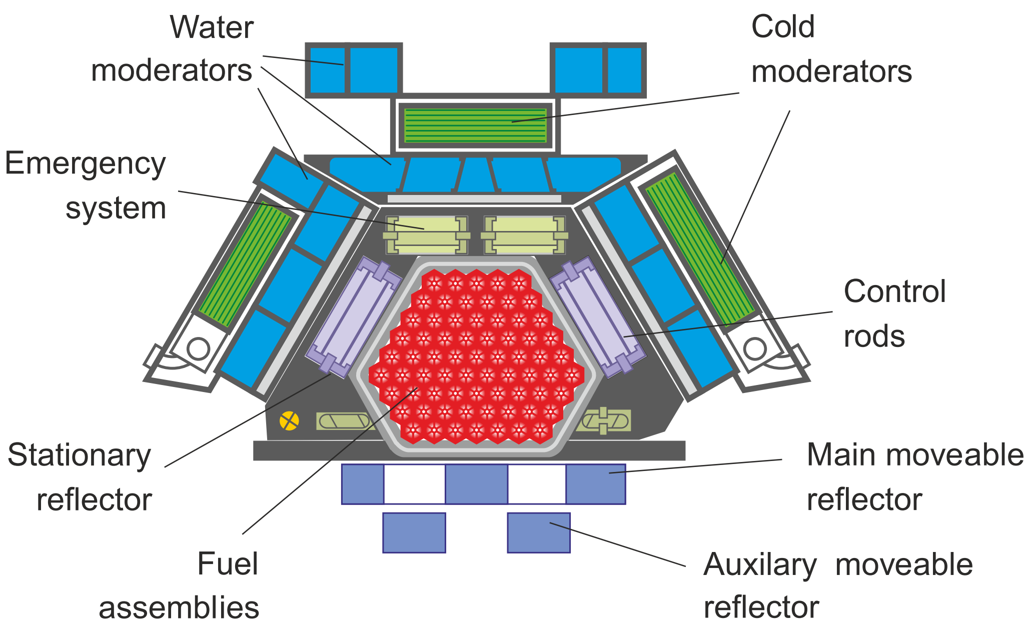
IBR-2 is a fast pulsed reactor with mechanical modulation of reactivity with a movable reflector. This unique machine has a mean power of 2 MW. In burst, its power is thousand times higher as it generates a thermal neutron flux of 10^{16} n/cm^2/s from the moderator surface. A set of 13 high-performance instruments, that are constantly being upgraded, are available for your experiments at the FLNP site, other two completely new instruments being presently under construction. A team of qualified and dedicated staff comprised by scientists, engineers and technicians is ready to assist you throughout the experiments at each instrument.

If you are a physicist, a chemist, a materials scientist, a biologist or a geologist, the FLNP scientific team is ready to provide you with qualified support concerning the application of neutron scattering techniques. Please, contact the IBR-2 User Club by telephone or via e-mail to discuss the research opportunities we are ready to provide you with and to get a qualified advice on submitting proposals.

Welcome to the IBR-2 User Club!

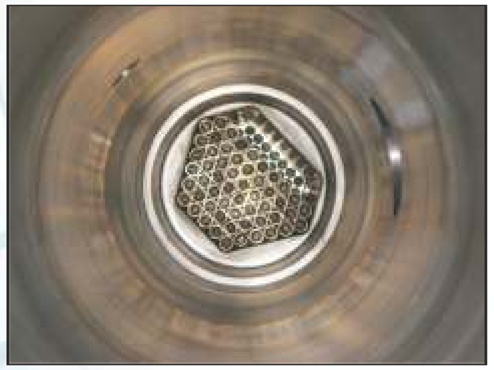
Sincerely,
Valery Shvetsov
Director of the Frank Laboratory
of Neutron Physics

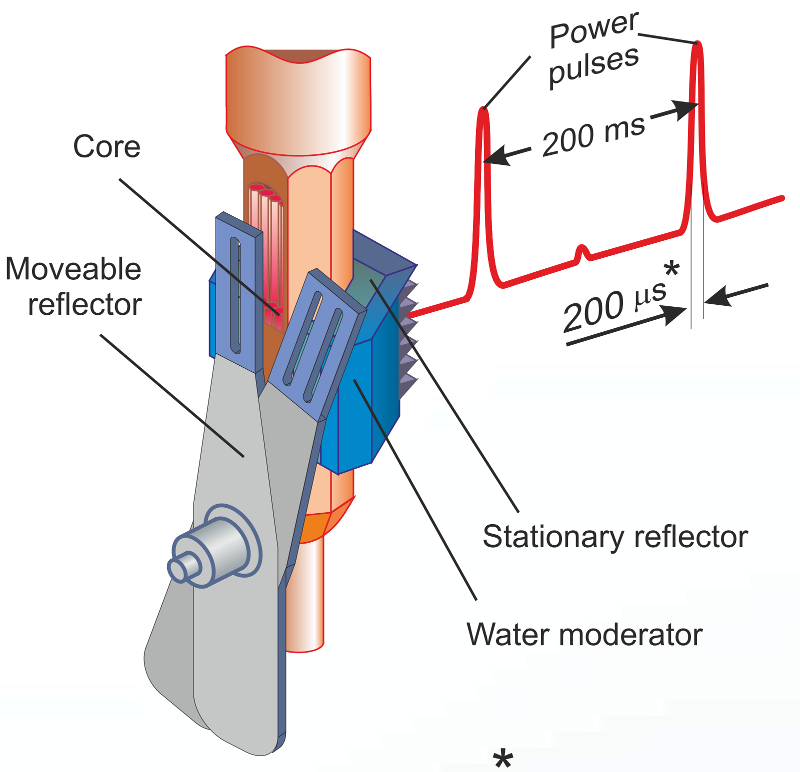
The modernized IBR-2 reactor core scheme



The modernized IBR-2 reactor operation scheme

Active zone of the reactor





* *at mean power 2 MW*

IBR-2 Experimental Hall

Neutron instrumentation at IBR-2

Diffraction:
HRFD, DN-2, DN-12, DN-6, SKAT, EPSILON, FSD

Small-angle scattering:
YuMO

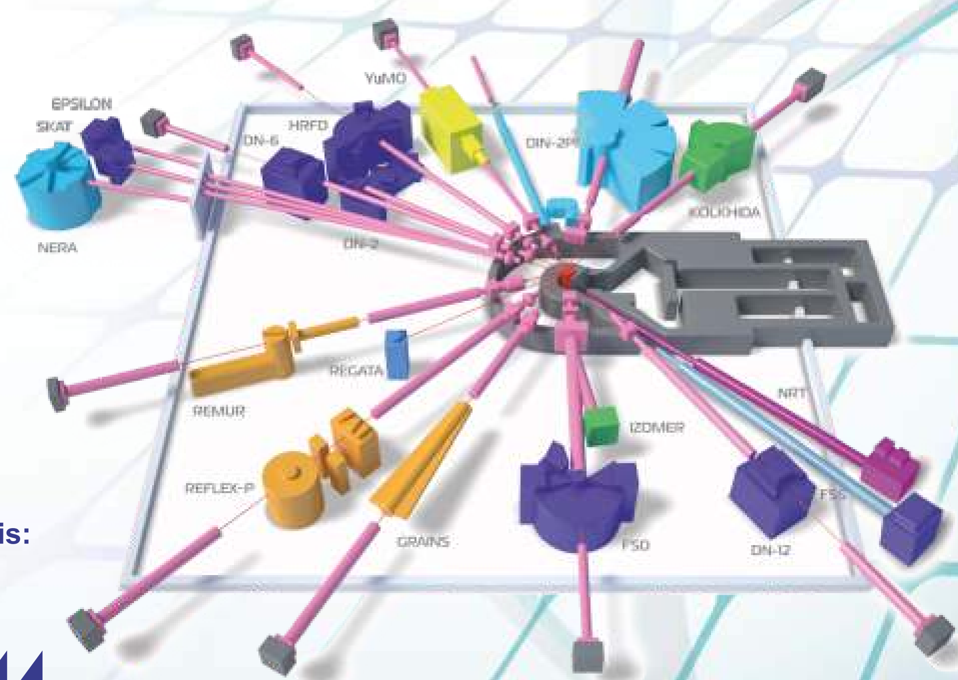
Reflectometry:
REMUR, REFLEX, GRAINS

Inelastic scattering:
DIN-2PI, NERA

Nuclear Physics:
ISOMER, KOLHIDA

Neutron Activation Analysis:
REGATA

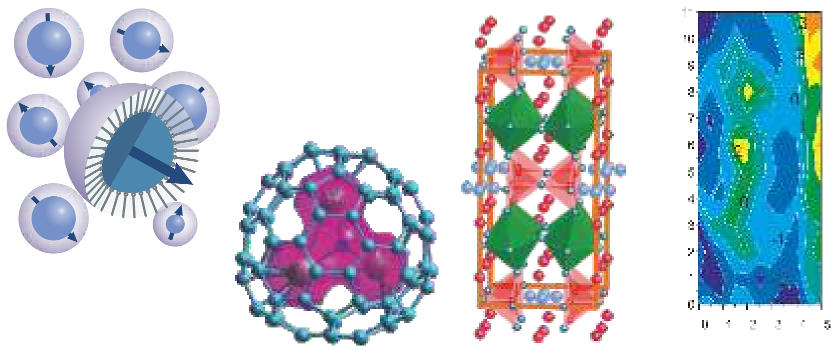
Irradiation Facility

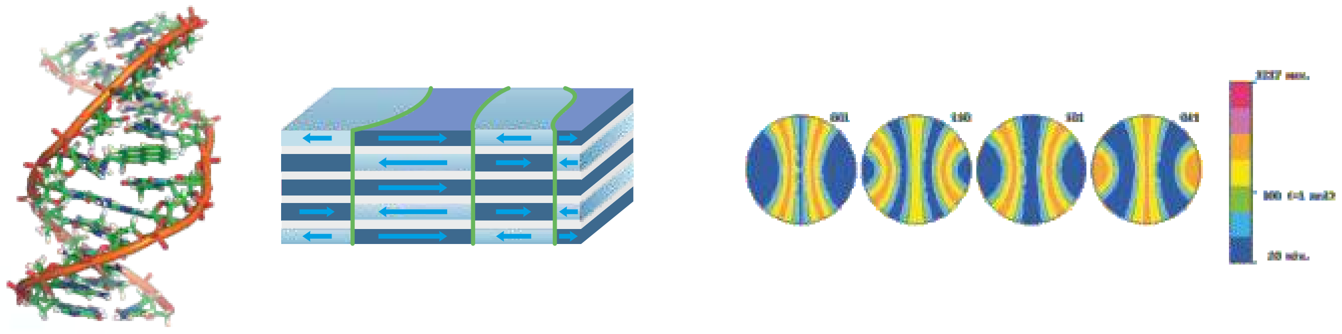


ibr-2.jinr.ru

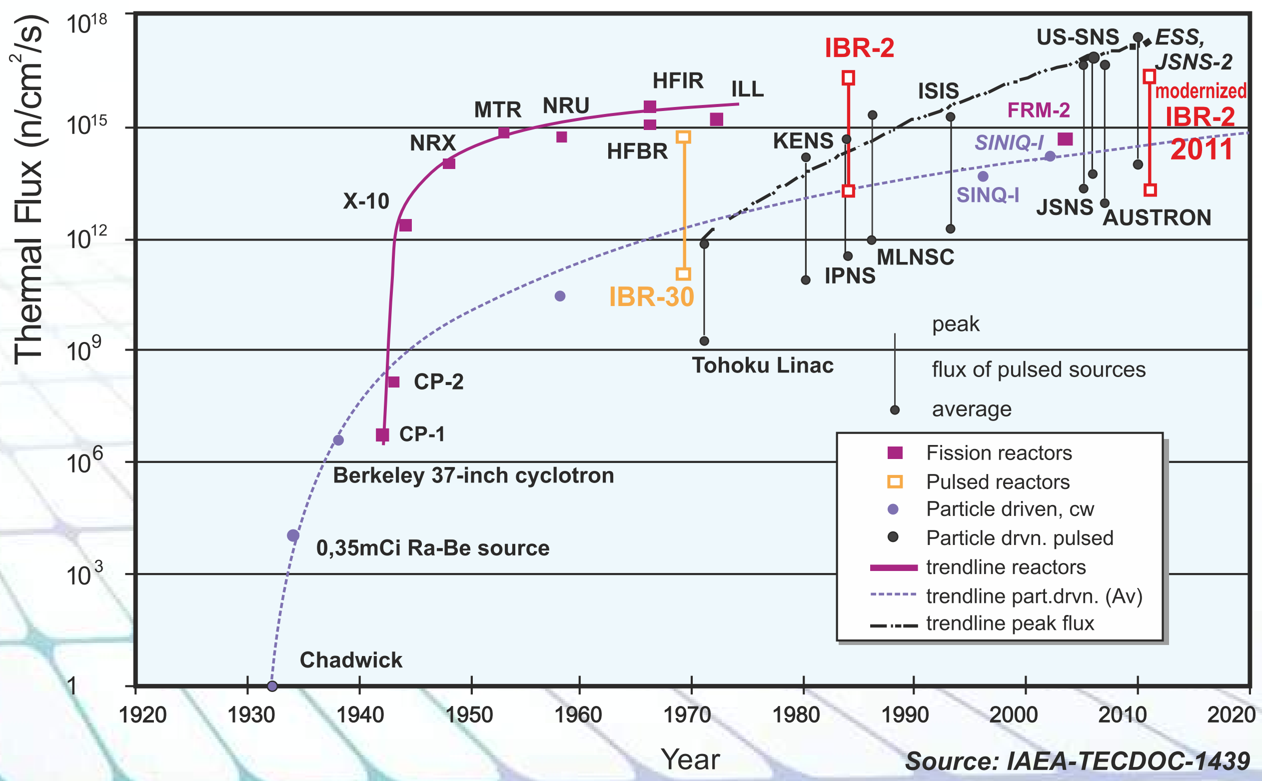
Neutron investigations at IBR-2

- Physics of Nanosystems
- Structure and Dynamics of Functional Materials
- Complex Liquids and Polymers
- Molecular Biology and Pharmacology
- Structure of rocks and minerals
- Engineering Diagnostics





World's Neutron Sources



Overview

The User Guide is designed to provide potential IBR-2 users with useful information on how to get prepared for a scientific visit to FLNP JINR. It covers the following points:

- How to become an IBR-2 user
- What to consider before the visit
- How to get the JINR Visa support
- How to get to FLNP JINR
- Detailed reimbursement regulations
- FLNP JINR policy on publications and experimental reports
- JINR safety regulations

Head of the FLNP User Program
Dorota Chudoba
e-mail: scientific_secretary@nf.jinr.ru
phone: +7 (496) 216-50-96

What is the IBR-2 User Club?

The IBR-2 User Club is a user-friendly website essentially designed to provide the FLNP scientific visitors with online access to related administrative tools and all necessary information.

After having registered as Club members, users are identified to their accounts with a personal ID each time they log in to the User Club website. Thus, users obtain access to information of concern such as FLNP site maps, experimental reports of other users, etc.

Some Club members may be granted privileged access to other tools, according to their responsibilities and status.

The IBR-2 User Club is intended to help users with:

- submitting proposals
- entering or updating personal dat
- uploading experimental reports
- keeping in touch with Secretary of the User Office

To become an IBR-2 user one should:

- **register** to the IBR-2 online User Club (***ibr-2.jinr.ru***)
- **submit** scientific project when the call for proposals is announced and wait for the decision of the Committee
- if the application for beam time is accepted, **follow** the instructions at the IBR-2 User Club website to get the Russian Visa and all necessary information regarding the forthcoming visit
- **perform** the experiment at FLNP JINR, Dubna
- **upload** scientific report via the IBR-2 User Club website

We would appreciate any feedback on the work of our website – its functionality and interactiveness – to help us make improvements.

You can also share your overall impressions of hotel accommodation and other aspects of your stay in Dubna. We are open to any suggestions.

Before your visit

Consider the following before your visit:

- **Registration** – register on the IBR-2 User Club website (http://ibr-2.jinr.ru, user_office@nf.jinr.ru) and submit your proposal.
- **Visas** – contact the User Office (flnpvisit@jinr.ru) in advance and get a free of charge Russian visa.
- **Health insurance** – Make sure that you have accident and sickness insurance.
- **Local contact** – Discuss the details of the experiment (sample environment equipment, sample containers, etc) with your Local Contact.
- **Arrival** – We advise you to use the Sheremetyevo airport in Moscow which conveniently runs a regular train to the Belorussky railway station.
- **Accommodation** – The IBR-2 users are accommodated in the hotel “Dubna” upon request. Information on the room availability and confirmation of your request will be sent by e-mail.
- **Site access** – The IBR-2 users are allowed to enter the JINR site only after a personal identification procedure. Make sure you have your passport with you.

  In order to obtain an access permit, you must have the following documents:
  1. For users whose occupation involves exposure to radiation
  - certificate of radiation exposure
  2. For users whose occupation does not involve exposure to radiation
  - medical certificate confirming that you are suitable for work involving ionizing radiation
  - certificate stating that your occupation does not involve exposure to radiation.

  Please note that you will not be granted access to the IBR-2 experimental halls unless you have the above-mentioned certificates.
- **Reimbursement** – Get acquainted with the reimbursement regulations for the IBR-2 Users.

(Get more information in further chapters)

Visa support

If you need a Russian visa you should fill in the form via the IBR_2 User Club at least three months prior to arrival.
Please note that JINR cannot arrange visa support documents for you at short notice.

View of the hotel “Dubna”

1st step - Moscow

- By plane (Moscow airports: Sheremetyevo, Domodedovo, Vnukovo)
- By train (Moscow railway stations: Kievskiy Vokzal, Belaruskiy Vokzal, Saviolovskiy Vokzal, Leningradsky Vokzal, Yaroslavsky Vokzal, Kazansky Vokzal, Paveletsky Vokzal).

2nd step - Dubna

- By car (provided by JINR)
- By train (Moscow Sovyolovskyi railway station - Dubna. Please note that there are two railway stations in Dubna, (Bolshaya Volga and Dubna). The last station listed is the terminal station and the one you need).
- By bus (Moscow Sovyolovskyi bus station - Dubna. Bus station Katelnaya is the one you need).

  Both the bus and the train stations are about a 10-minute walk from the hotel “Dubna” (Vekslera St., 8)

Both the bus and the train stations are situated in about 10 minutes walk from Dubna Hotel. Please check the User Club website to get the bus and the train timetables, maps and other related information.

On arrival

When you arrive to Dubna, check in at the hotel first.

Accommodation

Visitors who are invited to assist in the experiments get accommodation in the hotel “Dubna” (Vekslera St., 8), which is about a 20-25 minute walk from FLNP JINR.

Please note that all hotel reservations are made by the FLNP officials only. For further details please contact the User Office (flnpvisit@jinr.ru) or visit the IBR-2 User Club website (***ibr-2.jinr.ru***).

Costs

For users eligible for reimbursement

The FNLP reimbursement covers the following expenses only: room price (note that the type of the room depends upon availability) and the price of breakfast in the hotel. Extra nights are not included in the agreement and are to be paid by guests.

For users not eligible for reimbursement.

In this case the guests are to pay for accom-modation themselves by cash or a credit card at the hotel reception.

Hotel Dubna provides a 24-hour reception service.

- Phone: +7 (496) 216-21-25
- Fax: +7 (496) 216-58-90

Food on site

You can have lunch in the JINR canteen located in a 5 minute walk from the FLNP main entrance. The canteen is open Monday to Friday from 11.00 a.m. to 3.30 p.m.

Library

The JINR Scientific Library is open Monday to Friday from 9.00 a.m. to 5.00 p.m.

On departure

Samples used in experiments at the IBR-2 reactor are to be checked by the JINR Radiation Safety Department before they are taken off the site.
Please return your film dosimeter to the User Office and the pass to the security personnel.

Site access

The FLNP JINR site is a restricted area shared with FLNR, LIT, BLTP, DLNP, LRB and UC. To gain access you need to get a pass at the Pass Department (Bjuro Propuskov). For this purpose you will need to bring your Passport and show it to the security personnel at the site entrance upon their request.

Please note the following:

- The pass is valid for entering JINR only.
- The pass should be kept at the Pass Department in case of business trips and other long-termed absences of the pass holder.
- It is forbidden to give the pass to third persons for use.
- You should immediately inform the Pass Department in case of loss of the pass.
- You should return the pass to the Pass Department in case of expired validity or in case you do not need it any longer.
- In your bag you are allowed to carry documents and books required for your work only.
- You are supposed to let the security personnel inspect your bag upon their request.
- It is forbidden to bring any kind of photographic or filming equipment, portable telephones with digital camera features, recorders, laptops, domestic equipment as well as alcohol-containing beverages.

View of the IBR-2

Publication policy

We would like to draw your attention to the authorship rules set for papers resulting from experiments performed at the IBR-2 reactor. If the results of your experiment are to be published, the FLNP staff members participating in the experiment should be given proper credit and the IBR-2 facilities, where the experiment was performed, should be properly mentioned. FLNP considers it natural for Local Contacts who have made a significant contribution to the concept, design, execution, analysis or interpretation of users' experiments to be offered the opportunity to be listed as authors in related publications. Otherwise the authors should acknowledge the FLNP scientists for their affiliation with the IBR-2 experiment at the end of the paper.

As it is specified in the Application form, you should agree with your Local Contact on the terms of his/her involvement in the performance of your experiment and in the process of data analysis in advance.

We would be grateful for taking notice of this point and for your cooperation.

Experimental report policy

Following the recommendation of the FLNP JINR Scientific Council, Experimental reports are now mandatory for all experiments within 3 months after the experiment has been performed. If the experimental report was not registered in the IBR-2 user database until the moment of application for continuation, the proposal can be rejected.

The template for Experimental report can be found on the IBR-2 User Club website.

Safety regulations

All of the IBR-2 reactor users must comply with the Russian, the local administrative and the JINR safety regulations. Any ancillary equipment supplied by the user must conform to appropriate regulations. Experimental conditions involving special safety requirements (the use of radioactive isotopes, chemically or biologically hazardous materials, etc.) should be clearly stated in the proposal.

Please familiarize yourself with the JINR safety regulations on IBR-2 User Club website and upload the following documents:

- a copy of medical certificate confirming that your health status allows you to work under radiation conditions,
- a copy of the document indicating the dose you have received during the past year if proper,
- a copy of a signed declaration **confirming the following:**
  - I am insured against the risk of sickness and industrial accidents.
  - The experimental conditions and the samples to be used are as quoted in the original proposal.
  - I will publish my results giving proper credit to the FLNP staff members and properly mentioning the JINR facilities.
  - I will respect the JINR safety regulations.
  - I have informed my radiation safety officer that during the experiment being performed at the IBR-2 reactor I can be exposed to ionizing radiation.
  - If I have an implanted cardiostimulator or if I am pregnant, I will consult a healthcare specialist before starting to work at the experimental facilities.

DIN-2PI - Time-of-flight Spectrometer of Direct Geometry

General view of the instrument

Main parameters

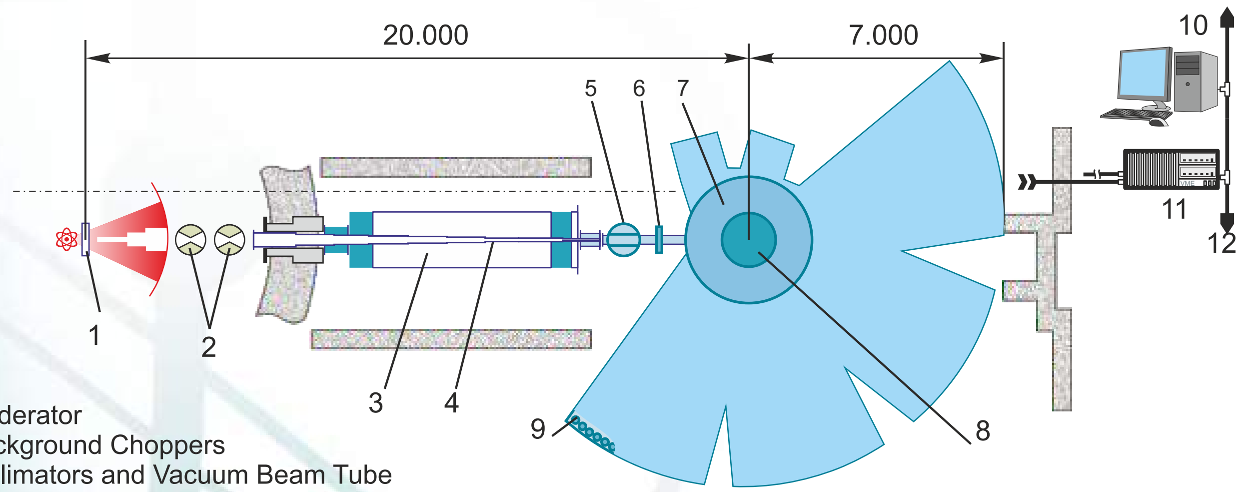
Responsible:
E.A. Goremychkin
e-mail: goremychkin@jinr.ru

Distance from the moderator to the sample, m	20.023
Distance from the sample to the detector, m	7.0
Scattering angles	5° - 135°
Dimensions of the beam on the sample, mm^2	160 x 120
Neutron flux at the sample for E_0=10 meV, $cm^{-2}s^{-1}$	$1.5 \cdot 10^3$
The range of primary energies, meV	1 - 30
The energy resolution $\Delta E_0/E_0$, %	4 - 10
The ratio of effect / background in the elastic peak for a standard vanadium sample, E_0 = 50 meV	2000

Sample environment equipment

Thermostat TS-3000		Cryostat Max ORANGE	
Max temp Tmax, K	3000	Min temp Tmin, K	1.5
Temperature measurements:			
- Thermocouples W5 / W26Re, K	Up to 2473		
- Infrared pyrometer DP1522, K	over 2200		
Heater type	tungstic		
Accuracy of temp. on the sample, ΔT/T	0,01		
The vacuum in the chamber of the sample, Torr	10^{-6}		
Sample size: diameter / height, mm	80/80	Sample size: diameter / height, mm	100/150
Neutron scattering angles, °	0 - 150		
Transmission for neutrons (E0 = 25 meV)	0.8	Resistance thermometers	RhFe, SiD

Principal scheme of the instrument



1. Moderator
2. Background Choppers
3. Collimators and Vacuum Beam Tube
4. Supermirror Neutron Concentrator
5. Curved-Slit Chopper
6. Monitor
7. Evacuated Sample Chamber
8. Sample Table
9. He^3-counters
10. VME control and operative visualization/analysis
11. VME Station (OS/9) Data Acquisition
12. EtherNet Data Transfer

NERA Inverted Geometry Time-of-flight Spectrometer

General view of the instrument

Main parameters

Responsible:
E.A. Goremychkin
e-mail: goremychkin@jinr.ru

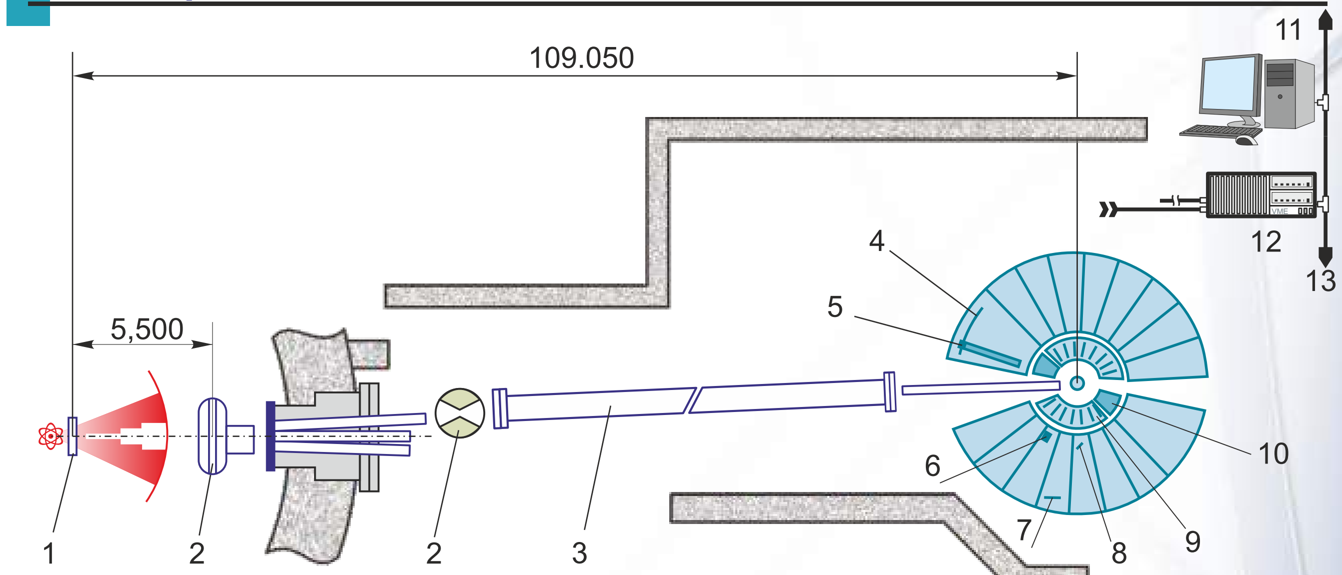
Co-responsible:
D. Chudoba
e-mail: dmn@nf.jinr.ru

Neutron guide	Ni, mirror, vacuum
Guide aperture	50x160 mm^2
Thermal neutron flux at sample position	4.6×10^6 $n/cm^2/s$
Wavelength range	0.4 - 7.0 Å
Scattering angles range	10°-170°
Energy transfer range (INS)	ω=0-130 meV
Moderator - sample distance	109.5 m
Sample - detector distance	0.815 m (INS with Be-filter)
	1.015 m (INS with single crystal)
	1.415 m (neutron diffraction)
Resolution	
Inelastic scattering	Δω/ω=2-4%
Neutron diffraction	Δd/d=0.4% for λ >1Å

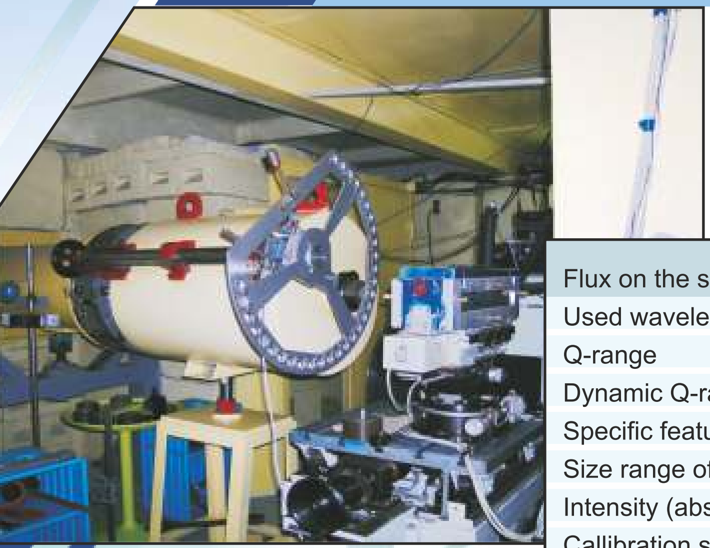
Sample environment equipment

- Closed-cycle helium refrigerators (4-300 K).
- A high-pressure cell up to 10 kbar.

Principal scheme of the instrument



1 Moderator
2 Background Choppers
3 Ni Guide Tube
4 Detector for High Intensity Diffraction
5 Detector for High Resolution Diffraction
6 He^3 Detectors (INS and QNS)
7 Single Crystal QNS Analyzer
8 Pyrolytic Graphite INS Analyzer
9 Be-Filters
10 Collimators
11 VME control and operative visualization/analysis
12 VME Station (OS/9)Data Acquisition
13 EtherNet Data Transfer



General view of the instrument

Main parameters

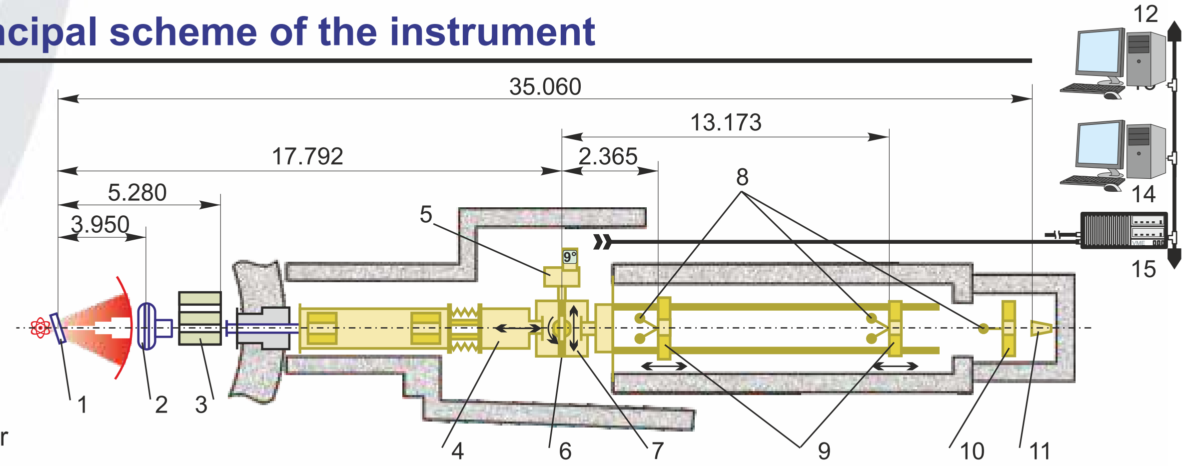
Responsible:
A.I. Kuklin
e-mail: kuklin@nf.jinr.ru

Co-responsible:
D.V. Soloviov e-mail: DSolovjov@nf.jinr.ru
O.I. Ivankov e-mail: ivankov@jinr.ru

Flux on the sample (thermal neutrons)	10^7 - 4×10^7 n/(s cm^2)
Used wavelength #	0.5Å to 8Å #
Q-range	7×10^{-3} - 0.5Å^{-1}
Dynamic Q-range	q_{max}/q_{min} up to 100
Specific features	Two detectors system , central hole detectors
Size range of object *	500 - 10Å*
Intensity (absolute units - minimal levels)	0.01 cm^{-1}
Callibration standard	Vanadium during the experiment
Size of beam on the sample @	8 - 22 mm^2 @
Collimation system	Axial
Detectors	He^3-fulfiled, home made preparation, 8 independent wires
Detector (direct beam)	^{6}Li-convertor (home made preparation)
Condition of sample	In special box in air
Q-resolution	low, 5-20%
Temperature range ^	-50°C – +130°C ^ (Lauda)
Temperature range **	700°C ** (Evrotherm)
Number of computer controlled samples ***	14 ***
Background level	0.03 - 0.2 cm^{-1}
Mean time of measurements for one sample +	1 h +
Frequency of pulse repetition	5 Hz
Electronic system	VME
The instrument control software complex	SONIX
Controlling parameters	Starts (time of experiments), power, vandium standard position, samples position, samples box temperature, vacuum in detectors tube
Data treatment	SAS, Fitter

- without the cold moderator
@- could be easily changed to decreasing
* - only for estimation (Radii of giration from 200 Å - to 10 Å - Angstroem)
^ - in basic configuration of instrument
** - in special box, using nonstandard devices
\+ - for estimation only
***- simultaneously in standard cassette with Hellma

Principal scheme of the instrument



1 Moderator
2 Chopper
3 First Variable Aperture Collimator
4 Second Variable Aperture Collimator
5 Thermostat LAUDA
6 Cartridge for Samples
7 Computer-Controlled Table
8 Scattering Standard
9 Ring Detectors
10 PSD
11 Direct Beam Detector
12 EtherNet Data Transfer
13 Remote terminal
14 VME control and operative visualization/analysis
15 Data Acquisition

General view of the instrument

Main parameters

Responsible:
A.I. Petrenko
e-mail: petrenko@nf.jinr.ru

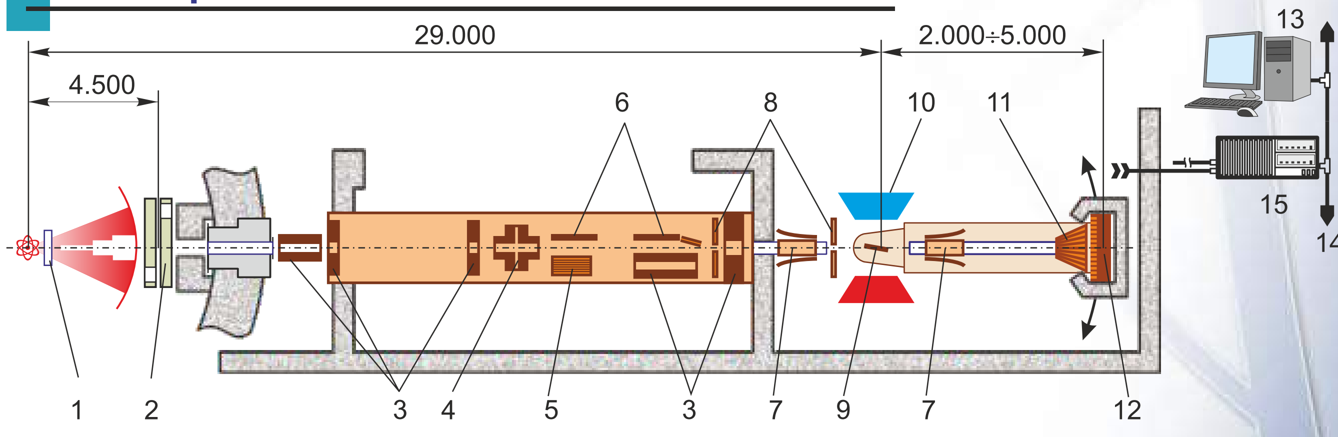
Co-responsible:
V.D. Zhaketov
e-mail: zhaketov@nf.jinr.ru

Reflectometer	
Sample plane	vertical
Scattering plane	horizontal
Neutron wavelength	0.9 - 10 Å
Wavelength resolution	$\delta\lambda$ = 0.011 Å
Scattering angle range	1 - 100 mrad
Sample-detector distance	4.9 m
Detector spatial resolution	1.5 mm
Flux at sample for two polarization modes:	$3\cdot10^4$ n/(s·cm^2)
two polarizers PR1 + Pr2	10^4 n/(s·cm^2)
second polarizer PR2	$3\cdot10^4$ n/(s·cm^2)
Small-angle mode	
Neutron wavelength	1.5 - 10 Å
Flux at sample with polarizer PM	10^5 n/(s·cm^2)
Sample-detector distance	1.5 - 7.5 m
Momentum transfer	Q = 6 × 10^{-3} ÷ 0.7 Å^{-1}

Sample environment equipment

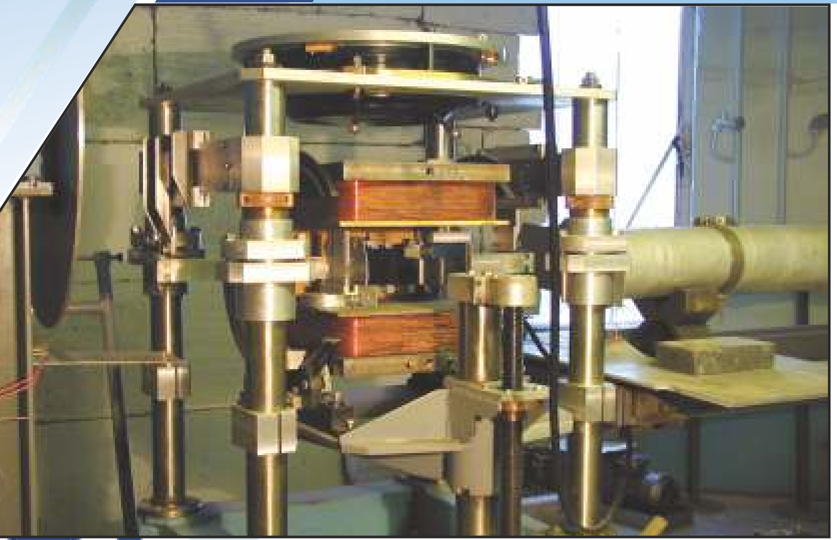
- Three-circle goniometer with an electromagnet generating external magnetic field in the range 0-20 kOe. It is possible to change the field direction with respect to the sample plane in the range of ± 90°. A set of removable poles with cross sections: 40 × 20 mm^2, 110 × 70 mm^2 and 60 × 40 mm^2.
- The maximum magnetic field with a pole gap of 15 mm is 20 kOe for small poles with cross section of 40 × 20 mm^2 and 10 kOe for large poles of 110 × 70 mm^2.
- Cryostat with a vertical magnetic field of up to 3 Tesla and T = 1.6 - 600 K.
- The maximum sample size is 40 × 40 mm^2.

Principal scheme of the instrument



1 Moderator
2 Double Disk Background Chopper
3 Collimators
4 Cross-type Collimator
5 Small-Angle Scattering Mode Polarizer
6 Adjustable Platforms
7 Spin-Flipper
8 Variable Diaphragms
9 Sample Position
10 Electromagnet
11 Fan Polarization Analyzer
12 Position-Sensitive Detector
13 Control and operative visualization/analysis
14 Data Acquisition
15 Data Transfer

Reflectometer of Polarized Neutrons REFLEX-P



General view of the instrument

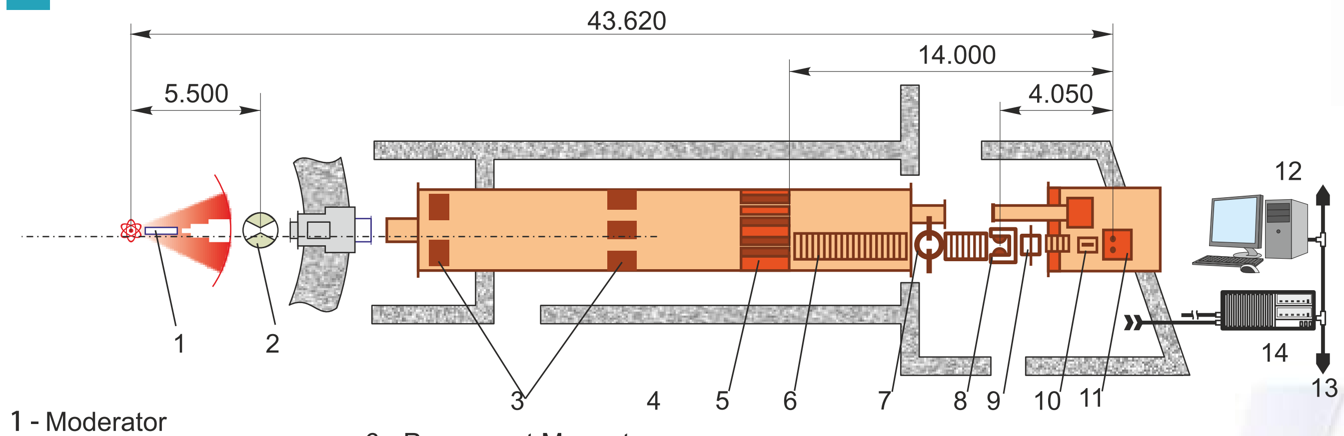
Responsible:
V.I. Bondarchuk
e-mail: bodnarch@nf.jinr.ru

Co-responsible:
A.V. Nagorny
e-mail: avnagorny@jinr.ru

Main parameters

The source of thermal neutrons	a) comb water moderator (T=320 K)
	b) water pre-moderator (T = 320K)
The maximum wavelength range	0.5 Å < λ < 10 Å
Q - range	$0.003 < Q < 0.2$ Å^{-1}
	2 mm (width) x 60 mm (height)
Size of beam cross-section at the sample position	
Valid slip angles of Q	1 < Q < 20 mrad
The angular resolution $\Delta\Theta/\Theta$	~2% (the horizontal beam divergence $\Delta\Theta \sim 1.5 \times 10^{-4}$ rad)
The neutron flux at the sample	~ 10^5 n/cm^2/s
Polarizer	Mirror neutron guide 1.6 m based on FeCo/TiGd films
Spin-flipper	Adiabatic spin-flipper by D.A. Korneev
Minimum sample size	20 mm x 20 mm
Maximum sample size	80 mm x 200 mm
Magnetic field at the sample	2 revolving around the beam axis electromagnets with fields:
	a) up to 2 kerst b) up to 10 kerst
Detector	Single detector of two types:
	a) He^3 - counter SNM-31
	b) scintillation counter on the ZnS-based ceramics
The minimum attainable experimental value of reflectivity coefficient R_{min}	~ 10^{-7}
The temperature of the sample	a) cryo-refridgerator (T > 10 K)
	b) furnace (T < 900 K)
Magnetometer	Hall magnetometer to measure the 3-projections of the magnetic field

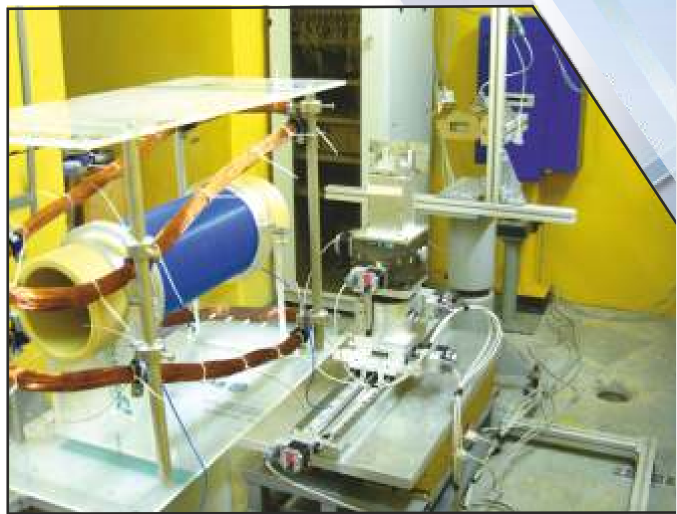
Principal scheme of the instrument



1 - Moderator
2 - Background Chopper
3 - Collimators
4 - Vacuum Tube
5 - Polarizer
6 - Permanent Magnets
7 - p-Flipper
8 - Electromagnet
9 - p or p/2 -flipper
10 - Analyzer
11 - Detectors
12 - Control and operative visualization / analysis
13 - Data Acquisition
14 - Data Transfer

GRAINS – Multi-functional Neutron Reflectometer with Horizontal Sample Plane

General view of the instrument



Main parameters

Neutron flux at the sample	2×10^6 cm^{-2}
Wavelength range	0.05 - 1 nm
Angle range	3 -15 mrad
Q - range	0.08 - 4 nm^{-1}
Q - resolution	< 5 %

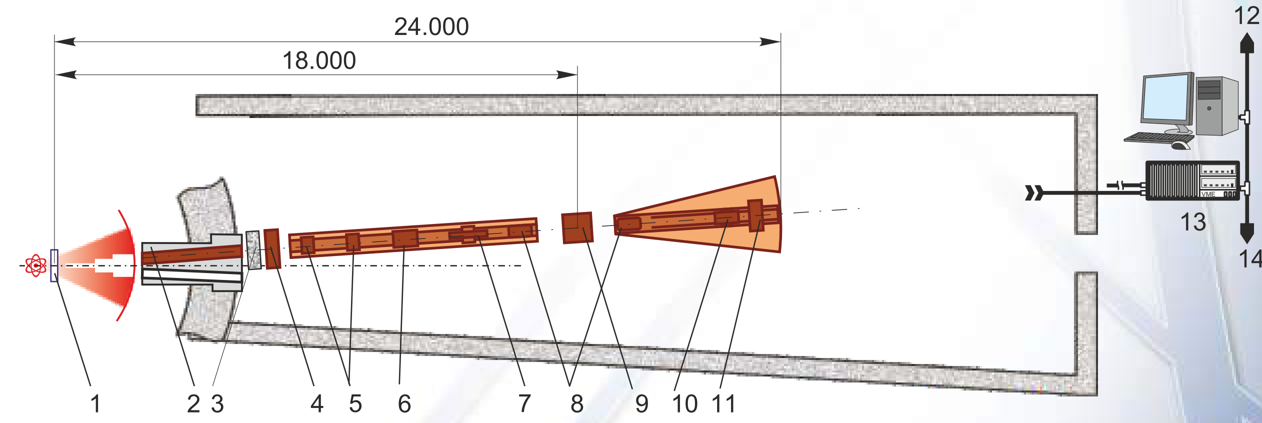
Responsible:
A.V. Tomchuk
e-mail: tomchuk@nf.jinr.ru

Co-responsible:
V.I. Petrenko
e-mail: vip@nf.jinr.ru

Sample environment equipment

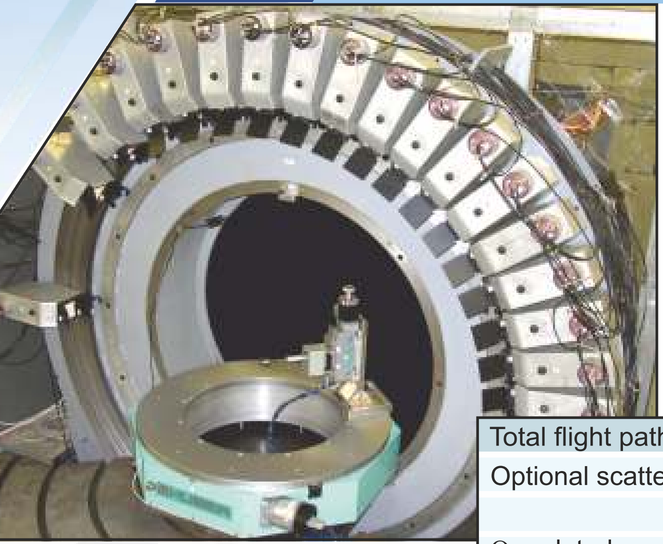
- Cell with silicon crystal for liquid samples
- Thermostat
- Antivibrational table

Principal scheme of the instrument



1 - moderator
2 - splitter
3 - shutter
4 - chopper
5 - slit apertures
6 - polarizer
7 - deflector
8 - spin-flipper
9 - sample holder
10 - analyzer
11 - 2D-PSD
12 - 14 - Data acquisition and storage

SKAT –Texture Diffractometer



General view of the instrument

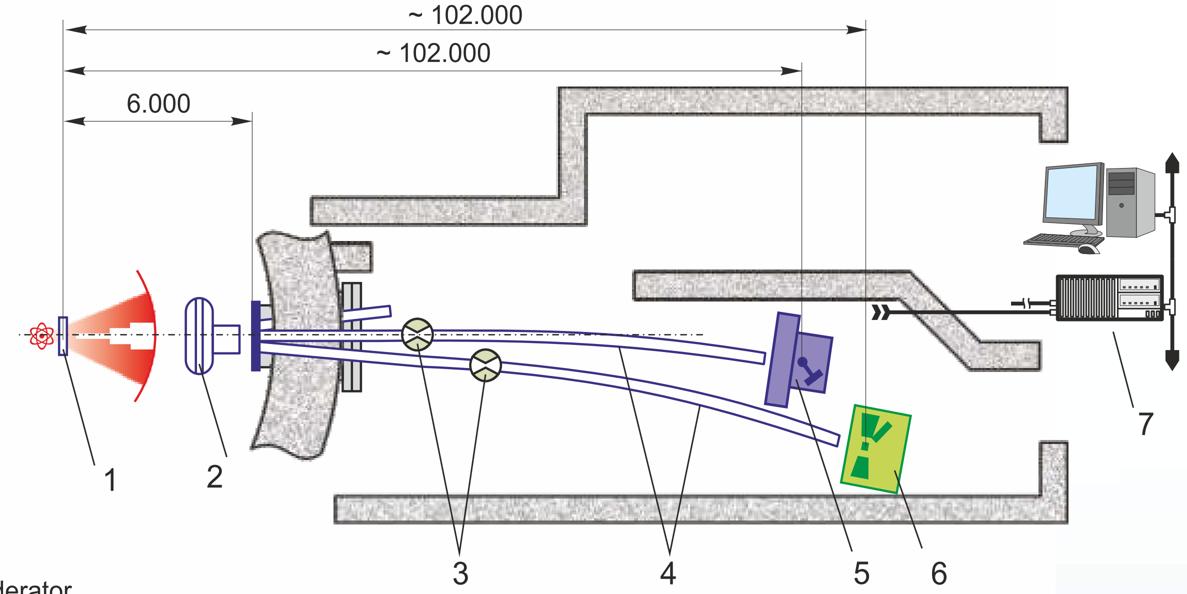
Responsible:
Ch. Scheffzuek
e-mail: christian.scheffzuek@kit.edu

Main parameters

Total flight path (moderator-detector):			~102 m
Optional scattering angles 2Θ			65° / 90° / 135°
λ_{max}			7.0 Å / 14.6 Å*
Θ– related parameters	2Θ = 65°	2Θ = 90°	2Θ = 135°
d_{max}	6.5 Å / 13.6 Å*	5.0 Å / 10.3 Å*	3.8 Å / 7.9 Å*
Best resolution Δd/d	$6.2x10^{-3}$	$5.0x10^{-3}$	$3.1x10^{-3}$
Secondary beam path	1.10 m	1.00 m	0.95 m
Neutron guide			Cross section: 50 mm (w)x 95 mm (h) Radius: 13400 m Coating: natural Ni (m = 1) Option: chopper covering every 2nd neutron pulse
Detectors			Set of 19 ^{3}He single tube detectors P = 4.5 bar ∅: 60 mm
Secondary collimation			Two sets of Gd-coated soller collimators Angular dispersion: 18' / 45' Cross section: $55x55 mm^2$
Sample positioning			3 axes goniometer

* applying the primary beam chopper

Sample environment equipment



1 Moderator
2 Background chopper
3 I-choppers
4 Bent neutron guides (evacuated)
5 Texture diffractometer SKAT
6 Strain/stress diffractometer EPSILON-MDS
7 PC based experiment control and data acquisition system

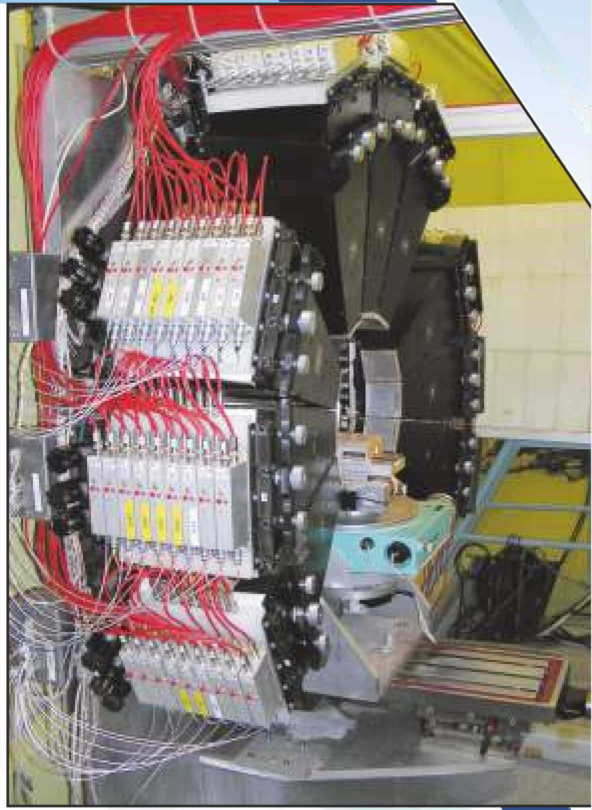
EPSILON-MDS-Strain/Stress Diffractometer

General view of the instrument

Main parameters

Responsible:
Ch. Scheffzuek
e-mail: christian.scheffzuek@kit.edu

Total flight path (moderator-detector):	~ 107 m
λ_{max}: with / without the beam chopper	7.1 Å / 14.4 Å
d_{max}: with / without the beam chopper	5.1 Å / 10.2 Å
Neutron guide:	beam cross section: 50 mm (w) x 95 mm (h) bending radius: 13400 m coating: natural Ni (m=1) option: chopper covering every 2nd neutron pulse
Detectors:	81x ^{3}He single tubes diameter: 10 mm; active length: 120 mm
Collimators:	nine radial collimators, foils GdO_2-coated
length:	500 mm
divergence of the foils:	20 min. of arc
2Θ-range:	82° ≤ 2Θ ≤ 98°
size of entrance window:	$50 x 50 mm^2$
size of exit window:	$200 x 200 mm^2$
Spectral resolution Δd/d:	$4\cdot10^{-3}$ at d ≥2Å
Goniometer:	4-axes goniometer
Φ-rotation:	0° to 360°
x-, y-translation:	120 mm
z-translation:	40 mm
accuracy:	0.0025° and 0.0025 mm, respectively
Uniaxial pressure device:	F= 100 kN (P= 150 MPa)
Sample dimensions:	Θ = 30 mm, l = 60 mm
Maximal sample volume:	$42 cm^3$
Thermal conditions:	stabilized: 1K



Sample environment equipment

- Uniaxial pressure device (150 MPa) for *in-situ* stress experiments
- Acoustic emission detection system
- Laser extensometer for macro-strain measurements: resolution: 0.5 µm

Principal scheme of the instrument

See the scheme on page 20

FSD - High Resolution Fourier Stress Diffractometer

General view of the instrument

Responsible:
I.V. Papushkin
e-mail: piv@nf.jinr.ru

Main parameters

Curved neutron guide	mirror, Ni-covered
length	19 m
Straight neutron guide	mirror, Ni-covered
length	5.01 m
Moderator - sample distance	28.14 m
Chopper - sample distance	5.55 m
Fourier - chopper (disk)	high-strength Al based alloy
outer diameter	540 mm
slit width	0.7 mm
number of slits	1024
maximal rotation speed	6000 rpm
maximal beam modulation frequency	100 kHz
Thermal neutron pulse width:	
low-resolution mode	320 μs
high-resolution mode	9.8 μs
High resolution detectors:	
BS¯	^{6}Li, time focusing
AstraLeft / AstraRight	ZnS, combined electronic & time focusing
+90 / -90	
0.63-6.71 / 0.63-6.71	
$4.6\cdot10^{-3}$ / $4.6\cdot10^{-3}$	
$4.0\cdot10^{-3}$ / $4.0\cdot10^{-3}$	
0.117 / 0.117	
Low-resolution detectors	^{3}He tubes
Wavelength interval	0.9 ÷ 8 Å
Flux at sample position:	
without Fourier chopper	1.8×10^{6} n/cm^2/sec
with Fourier chopper	3.7×10^{5} n/cm^2/sec

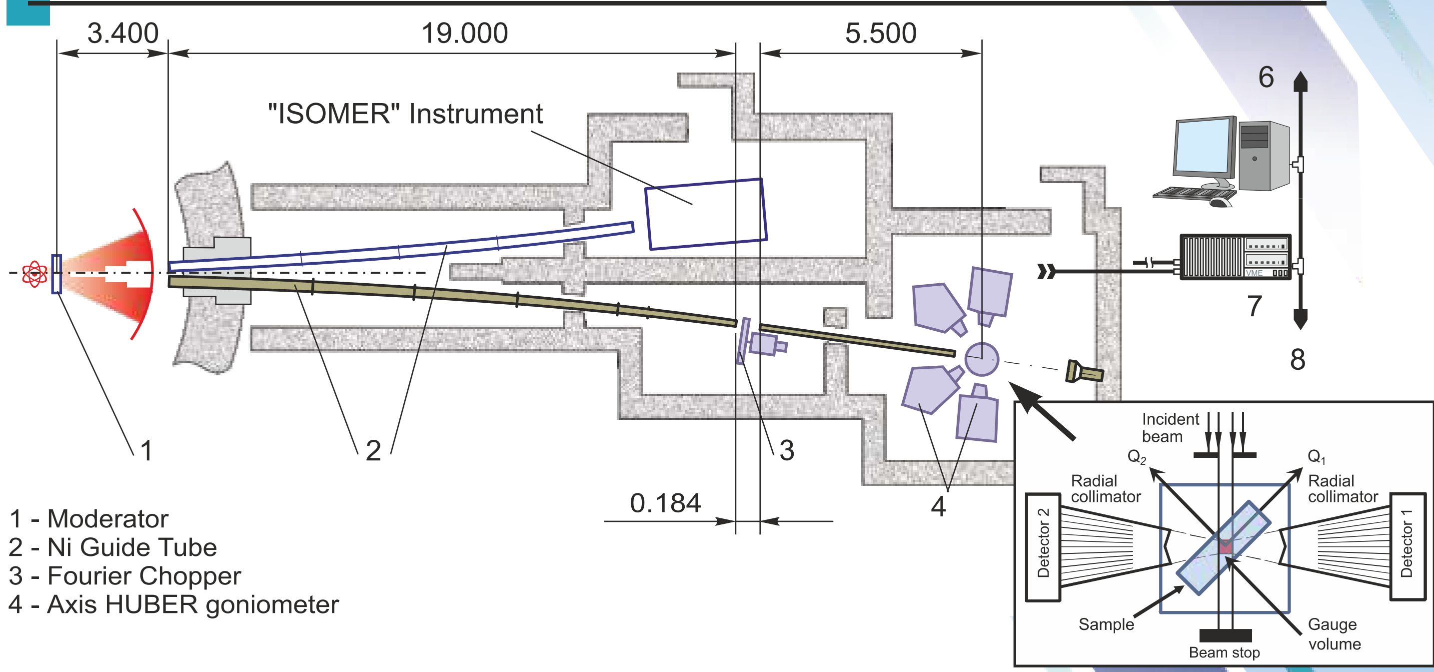
Sample environment equipment

- Four axis (X, Y, Z, Ω) HUBER goniometer (max. carrying capacity ~300 kg);
- Load testing machine (Fmax ~20 kN and Tmax ~800°C).
- Mirror furnace with halogen lamps (Tmax ~1000 °C);
- Wide-aperture radial collimators with spatial resolution of ~1.8 mm

Main parameters of high-resolution detectors on FSD

Detector Parameter	BS¯
Scattering angle 2θ,°	140.864
d_{hkl} -range, Å	0.51 - 5.39
Δd/d (d =1 Å)	3.4×10^{-3}
Δd/d (d =2 Å)	2.3×10^{-3}
Solid angle Ω, str.	0.054

Principal scheme of the instrument



1 - Moderator
2 - Ni Guide Tube
3 - Fourier Chopper
4 - Axis HUBER goniometer

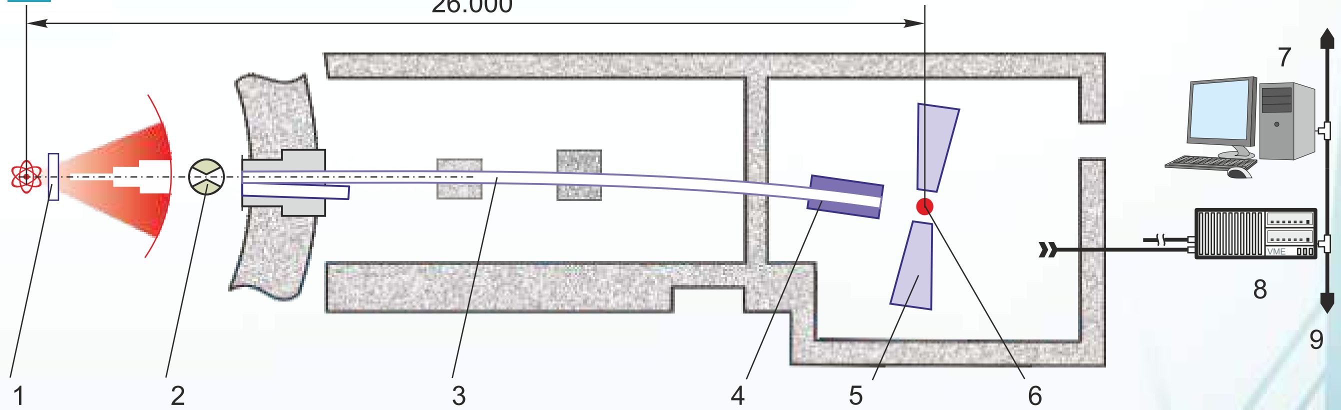
DN-6 – Neutron Diffractometer for Investigations of Micro-samples at High Pressure

Main parameters

Responsible:
E.V. Lukin
e-mail: lukin@nf.jinr.ru

Distance:	moderator-sample	29.6 m
	sample-detector	0.4
Ranges:	wavelengths	0.8 – 12 Å
	scattering angles	45° – 90°
	d-spacing	0.5 – 6 Å
Resolution (d/d , d=2 Å): at Θ=90		0.020
Solid angle of detector system		1 sr.
Typical sample volume		0.1 – 5 mm^3
Pressure range		
	with sapphire anvils	5 – 10 Gpa
	with diamond anvils	up to 25 Gpa
Temperature range		10 – 300 K

Principal scheme of the instrument



1 - Moderator
2 - Background Chopper
3 - Supermirror Guide Tube
4 - Shielding
5 - Ring Shaped Detectors
6 - Sample Position
7 - VME Control and Operative Visualization/Analysis
8 - Data Acquisition
9 - Data Transfer

HRFD - High Resolution Fourier Diffractometer

General view of the instrument

Main parameters

Responsible:
V.G. Simkin
e-mail: simkin@nf.jinr.ru

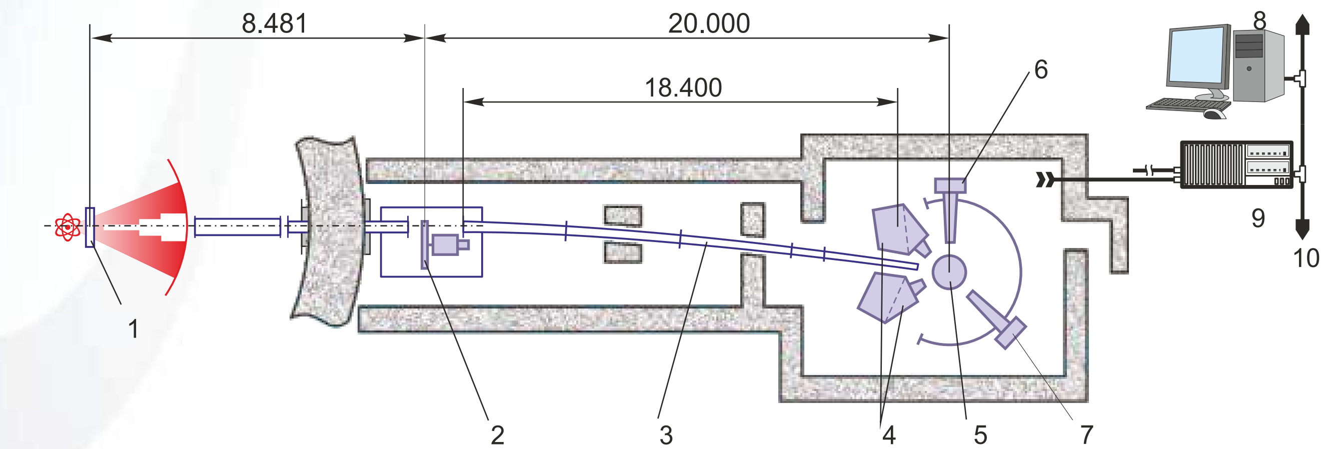
Co-responsible:
I.A. Bobrikov
e-mail: bobrikov@nf.jinr.ru

Neutron beam cross-section at sample position	10 x 100 mm
Moderator - sample distance	~ 30 m
Chopper - sample distance	21134 mm
Fourier-chopper (disk-type)	Al-alloy
- outer diameter	540 mm
- slit width, number of slits	0.7 mm, 1024
- max speed of rotation	6000 rpm
- max modulation frequency	102.4 kHz
- effective pulse width	≈10 μs
Main detectors at 2θ = 90° and 2θ = 152°	^{6}Li, time-focusing
Detector for large d_{hkl}	^{3}He, PSD, Δx ≈ 1.8 mm, 2θ ≈30°
Aperture of the main detectors:	0.08 sr (2θ = 152°),
Wavelength range	0.04 sr (2θ = 90°)
d_{hkl} range:	0.9 - 8 Å
- high resolution	0.7 - 4 Å
- medium resolution	2 - 16 Å
Neutron flux at sample position	10^7 n/cm^2/s
Standard sample volume	~ 2 cm^3
Resolution (Δd/d) for 2θ = 152°, d = 2 Å	~ 0.0007

Sample environment equipment

- Air lamp furnace (from room temperature (RT) up to 1500 °C)
- Air furnace (from RT up to 500 °C)
- Vacuum furnace (from RT up to 950 °C)
- Closed - cycle helium refrigerator (from RT up to 2.4 K)
- Closed - cycle helium refrigerator (from RT up to 8 K)
- Electromagnet (up to 0.95 T)
- Goniometer GKS-100
- Load testing machine Huber (up to 60 kN)

Principal scheme of the instrument



1 Moderator
2 Fourier Chopper
3 Guide Tube
4 Main Detector
5 Sample Position
6 90°-Detector
7 PSD Detector
8 VME Control and Operative Visualization/Analysis
9 VME Station (OS/9) Data Acquisition
10 EtherNet Data Transfer

RTD - Real-time Diffractometer

General view of the instrument

Main parameters

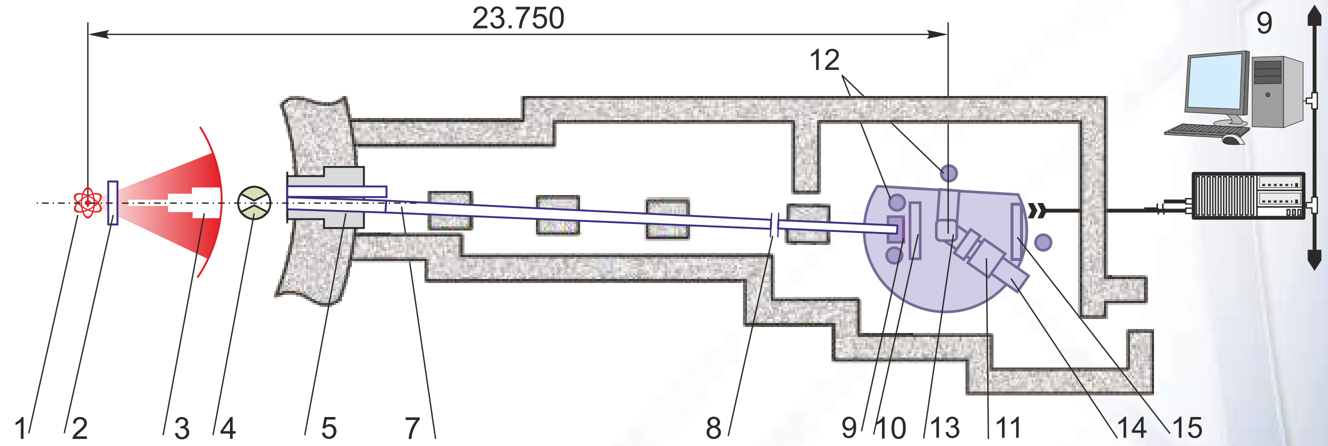
Responsible:
D. Neov
e-mail: dneov@nf.jinr.ru

Neutron guide	Ni, mirror
Guide aperture	15 mm × 180 mm
Moderator - sample distance	23.85 m
Detector - sample distance	0.15 - 2.0 m, changeable
Neutron flux at sample position	~ 5.10^6 n /cm^2/s
Range of wavelengths	1.2 - 20 Å
scattering angles	5 - 170°
d-spacing	0.6 - 60 Å
Resolution, Δd/d, Θ = 80°, d = 2 Å	1 %
Θ = 10°, d = 60 Å	10 %
Detector system	Position Sensitive Detector 225x225mm^2

Sample environment equipment

- Cryostat on the basis of closed-cycle helium refrigerator. Temperature range – from 10 K to 290 K.
- Water thermostat for investigations of biologic samples. Temperature range – from - 30°C to +100°C
- Vanadium furnace. Temperature range – from RT to 850 K.
- Muffle furnace for backscattering measurements at up to 1400K. Permanent magnet from 0.0 to 0.5T at RT (can be directed both vertically and horizontally).

Principal scheme of the instrument



1 Reactor core
2 Moderator
3 Schieber (primary beam shutter)
4 Chopper
5 Beam splitter
6 Biological shielding
7 Mirror neutron guide
8 Secondary beam shutter
9 Adjustable diaphragm
10 Backscattering ring detector
11 Position-sensitive detector
12 3 banks x 8 ^{3}He «point» detectors
13 Goniometer and sample position
14 PSD movable arm
15 Small angle ring detector (in production stage)

DN-12 - Neutron Diffractometer for Investigations of Micro-Samples at High Pressure

General view of the instrument

Main parameters

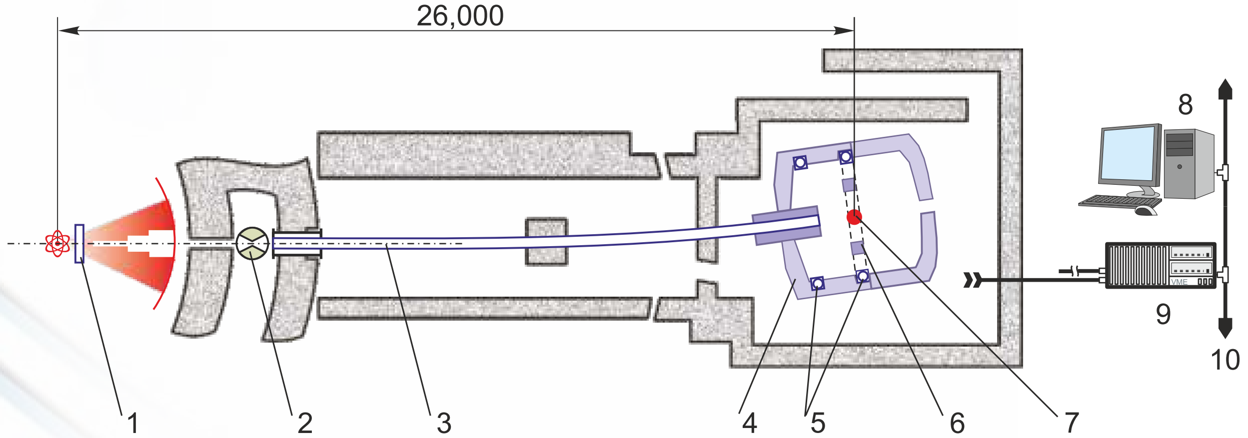
Responsible:
S.E. Kichanov
e-mail: ekich@nf.jinr.ru

Flux at sample position (average thermal power of the IBR-2 reactor 2 MW)	$2 \cdot 10^6$ n/см^2/с
Distance:	
moderator-sample	26.0 m
sample-detector	0.4 and 0.6 m
Ranges:	
wavelengths	0.8 - 10 Å
scattering angles	45° - 135°
d-spacing/span>	0.6 - 13 Å
Resolution (Δd/d , d = 2 Å):	
at 2Θ = 90°	0.022
at 2Θ = 135°	0.012
Solid angle of detector system	0.125 sr
Typical sample volume	0.5 - 3 mm^3
Pressure range	
with sapphire anvils	5 - 10 GPa
with diamond anvils	7 - 15 GPa
Temperature range	10 - 300 K

Sample environment equipment

- Cryostat on the basis of closed-cycle helium refrigerator: temperature range of 10 - 290 K;
- High-pressure cells based on the technology of sapphire and diamond anvils: high pressures up to 10 Gpa;
- Cooled beryllium filter permits measurements of inelastic incoherent neutron scattering (necessary for investigations of the dynamics of atoms in crystals).

Principal scheme of the instrument



1 - Moderator
2 - Background Chopper
3 - Supermirror Guide Tube
4 - Shielding
5 - Ring Shaped Detectors
6 - Be-Filter
7 - Sample Position
8 - VME Control and Operative Visualization/Analysis
9 - Data Acquisition
10 - Data Transfer

Reimbursement regulations for JINR reactor users

Neutron beams and instrument facilities are provided free of charge to proposers of accepted experiments under certain conditions detailed hereafter. Scientists affiliated to laboratories in JINR member states get financial support for the accommodation expenses and the per diem (20 USD/day) for a limited period. As a rule, only one scientist is reimbursed for each experiment. However, it is possible to provide reimbursement to two scientists if they come from different laboratories.

JINR Member Staters

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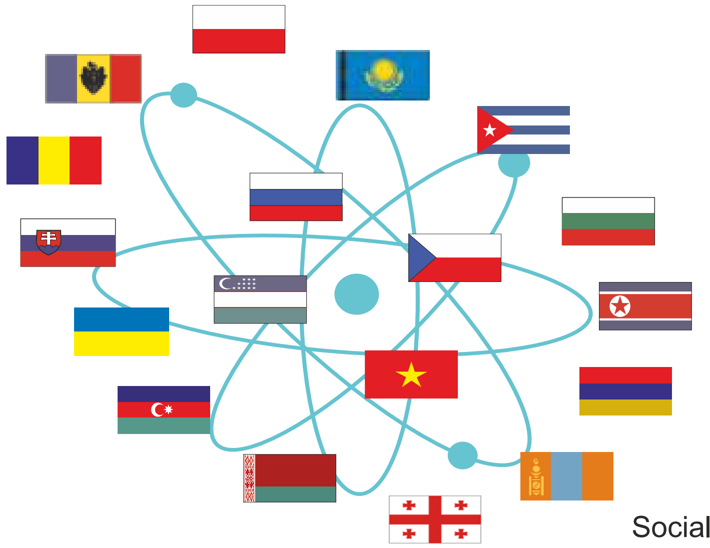

Republic of Moldova
Mongolia
Republic of Poland
Romania
Russian Federation
Slovak Republic
Ukraine
Republic of Uzbekistan
Socialist Republic of Vietnam

Please note that, in general, extended stays for data treatment are not reimbursed. In case **some extra days are required for installing special equipment** or preparing samples, reimbursement may be authorized if requested in advance. For any special requests please contact User Office before your arrival.

The following regulations apply to users eligible for reimbursement only:

- All users are accommodated in Dubna Hotel. The JINR reimbursement policy is applied to a fixed number of days agreed on in the invitation form, +1 additional day only. Other additional days are to be paid directly by the user.
- Dubna Hotel provides users with a prepaid breakfast. Apart from that, each user gets the per diem upon arrival (Administrative building №2, room №113).

Please note that FLNP do not reimburse travel expenses to JINR.

Dubna – town map

Frank Laboratory of Neutron Physics

Table of instruments

Instrument	Domain and object of research	Responsible	e-mail	page
DIN-2PI	A study of lattice dynamics of crystalline, amorphous materials and liquids	Dr. E.A. Goremychkin	goremychkin@jinr.ru	14
NERA	A study of lattice dynamics and structural parameters of molecular crystals, crystals with molecular ions, especially exhibiting polymorphism	Dr. E.A. Goremychkin Dr. D.Chudoba	goremychkin@jinr.ru dmn@nf.jinr.ru	15
YUMO	Determination of structural characteristics (size and shape of particles, agglomerates, pores, fractals) of nanostructured materials and nanosystems, including polymers, lipid membranes, proteins, solvents, etc	Dr. A.I. Kuklin Dr. D.V. Soloviov Dr. O.I. Ivankov	kuklin@nf.jinr.ru DSolovjov@nf.jinr.ru ivankov@jinr.ru	16
REMUR	Determination of magnetization profile of layered magnetic nanostructures, studies of proximity effects in nanosystems	Dr. A.V. Petrenko V.D. Zhaketov	petrenko@nf.jinr.ru zhaketov@nf.jinr.ru	17
REFLEX-P	Determination of structural characteristics of thin films and layered nanostructures	Dr. V.I. Bodnarchuk Dr. A.V. Nagorny	bodnarch@nf.jinr.ru avnagorny@jinr.ru	18
GRAINS	Studies of surface and interface phenomena in soft and liquid nanosystems (magnetic fluids, polymers, lipid membranes)	Dr. A.V. Tomchuk Dr. V.I. Petrenko	tomchuk@jinr.ru vip@nf.jinr.ru	19
SKAT	Studies of texture of geological samples (rocks, minerals)	Dr. Ch. Scheffzuek	christian.scheffzuek @kit.edu	20
EPSILON	In situ studies of macro- and micro-stresses in rocks	Dr. Ch. Scheffzuek	christian.scheffzuek @kit.edu	21
FSD	Determination of residual stresses in bulk materials and products	I.V. Papushkin	piv@nf.jinr.ru	22
DN-6	Determination of structural parameters of crystalline materials as function of external pressures	E.V. Lukin	luklin@nf.jinr.ru	23
HRFD	Determination of structural parameters of crystalline materials (lattice parameters, atomic coordinates and thermal factors) with high precision	V.G. Simkin Dr. I.A. Bobrikov	simkin@nf.jinr.ru bobrikov@nf.jinr.ru	24
RTD	Determination of structural parameters of crystalline materials and nanosystems (lipid membranes, etc), real-time studies of chemical and physical processes	Dr. D. Neov	dneov@abv.bg	25
DN-12	Determination of structural parameters of crystalline materials as function of external pressures	Dr. S.E. Kichanov	ekich@nf.jinr.ru	26

Dubna, LNP – site map

Dubna, JINR, LNP