The upgraded experimental setup Kolkhida designed to study interactions of polarized neutrons with polarized nuclei.

Berikov Daniyar
Junior researcher, JINR, FLNP

Table of contents

Introduction

Nuclear neutron precession

V.G. Barishevski, M.I. Podgorecki, Zh Eksp. Teor. Fiz., 47, 1964, 3(9) , p.1050, Sov. Phys. JETP, 20, 1965, p.704.

$$\omega = \frac{4\pi N\hbar}{m_n}\frac{I}{2I+1}(f^+ - f^-)P_N ,$$

The value of the effective magnetic field is:

$$H_{ef} = \frac{\omega}{\gamma_n}P_N ,$$

Introduction

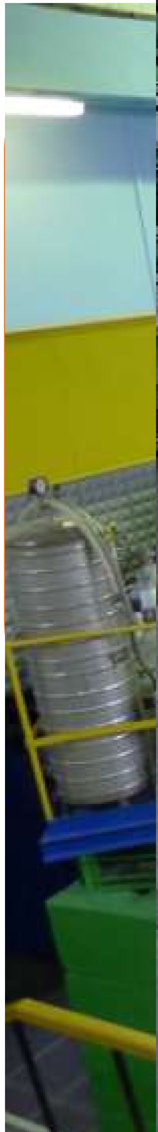
Our plan is to study the nuclear precession of neutron spin in a wide range of neutron energies

The projected studies on neutron nuclear precession will be performed in the neutron energy range from 0.062 eV to 2.3 eV.

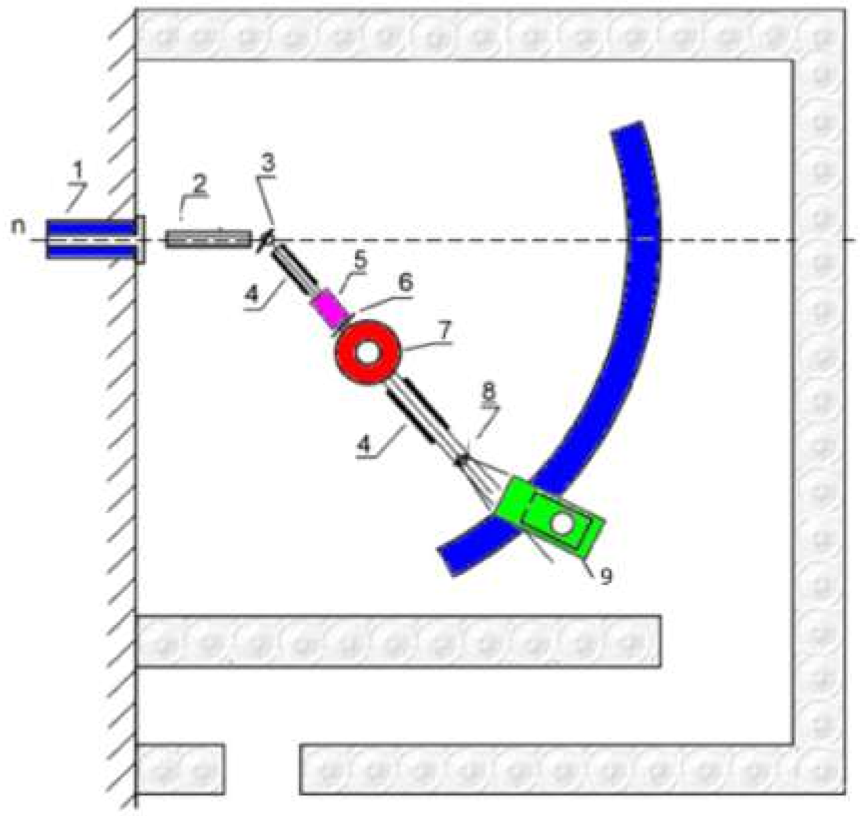
Introduction

To carry out the experiment we need

- Polarized neutrons
- Polarized nuclei
- System for study of the process



Polarized neutron spectrometer



1 – primary collimator; 2 – Soller collimator; 3 – polarizer crystal; 4 – guiding field electromagnets; 5 – Mezei flipper; 6 – shim; 7 – cryostat; 8 – analyzer crystal; 9 – detector.

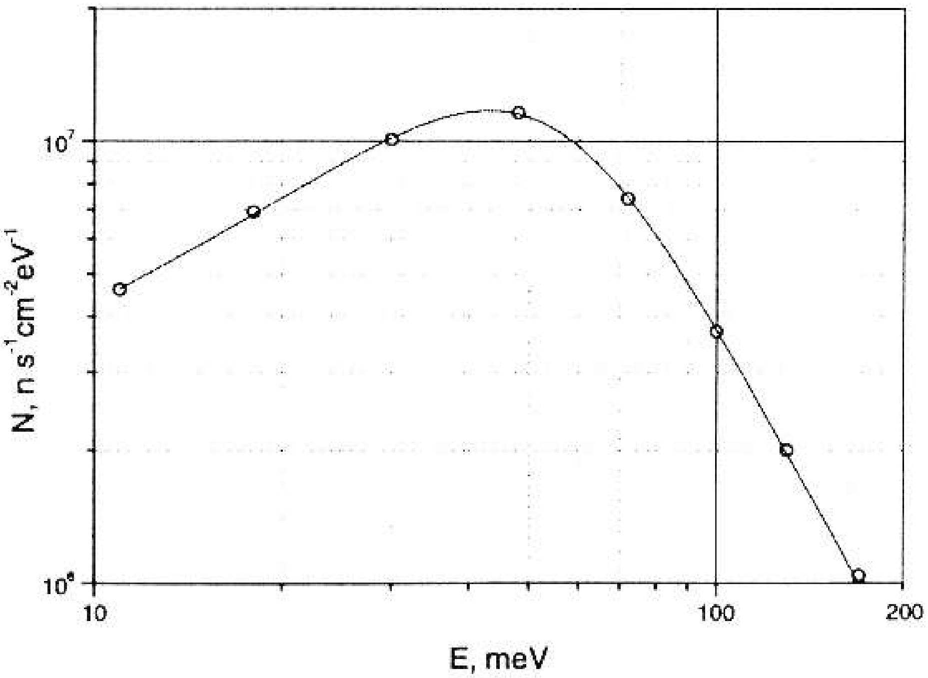
Control system

FL57STH76-1006B

OCD-SL00B-0016-C100-CRW

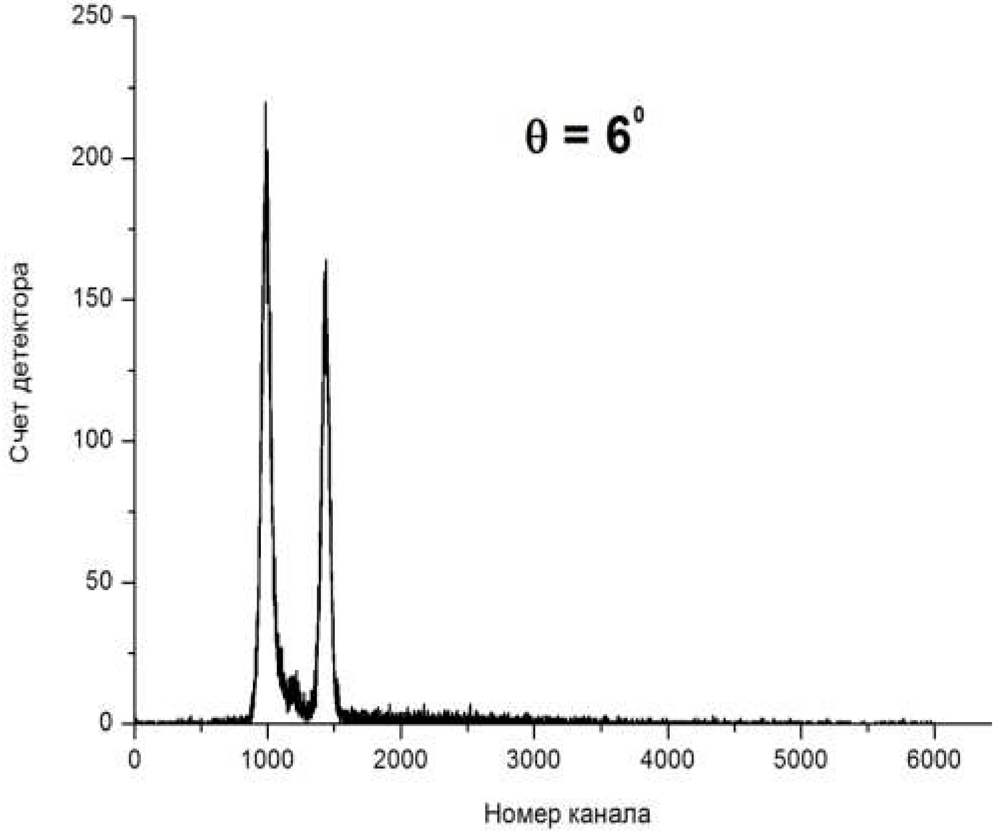
8SMC1-USBh

Energy spectrum of the primary neutron beam



The neutron flux in the specified energy range was 1.0 x 10^6 n/cm^{2}s.

The neutron diffraction



Bragg-Wolf condition

$$2d \sin\theta = n \cdot \lambda$$

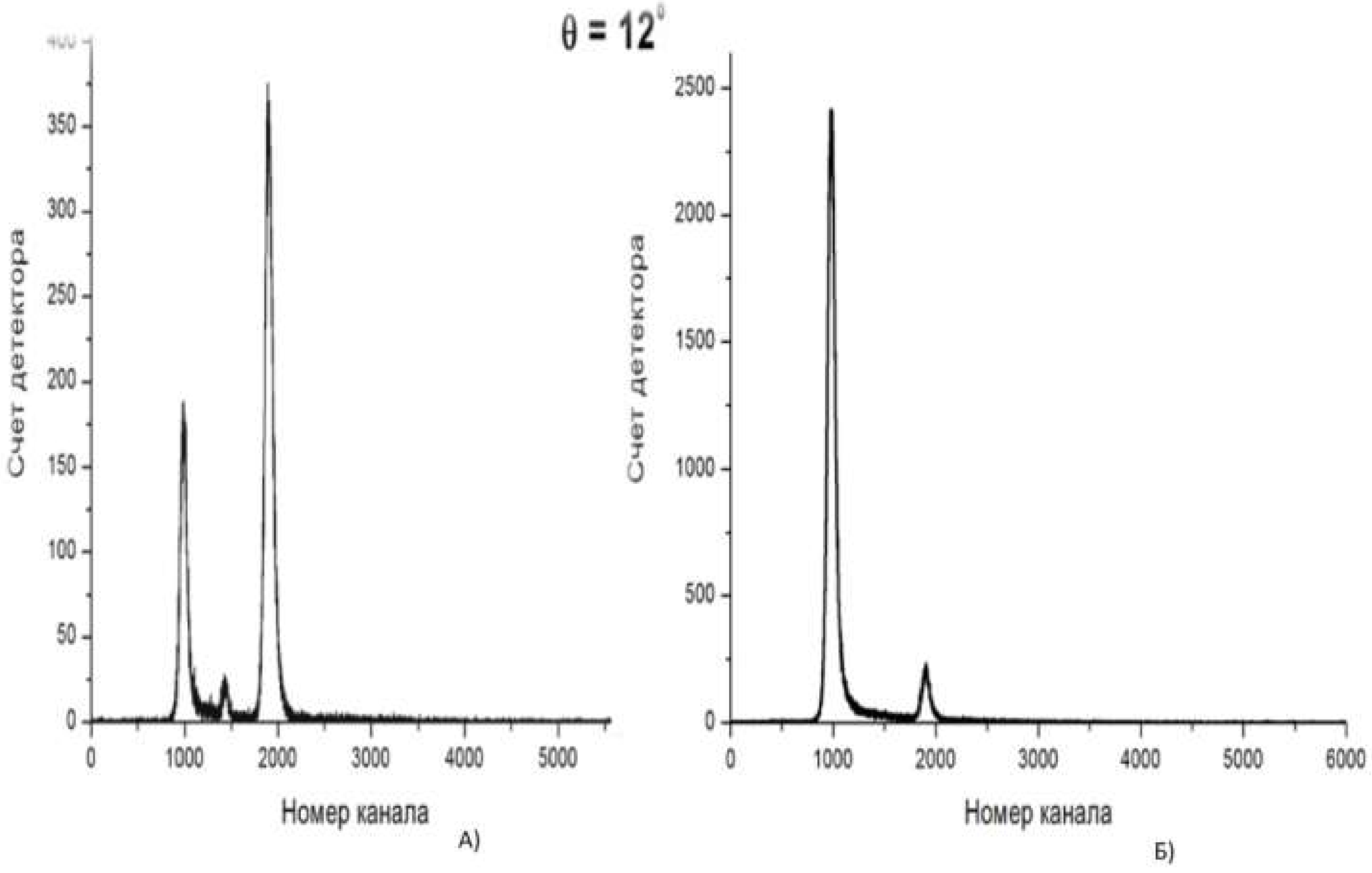
λ - is the neutron wavelength

d - the interplanar distance

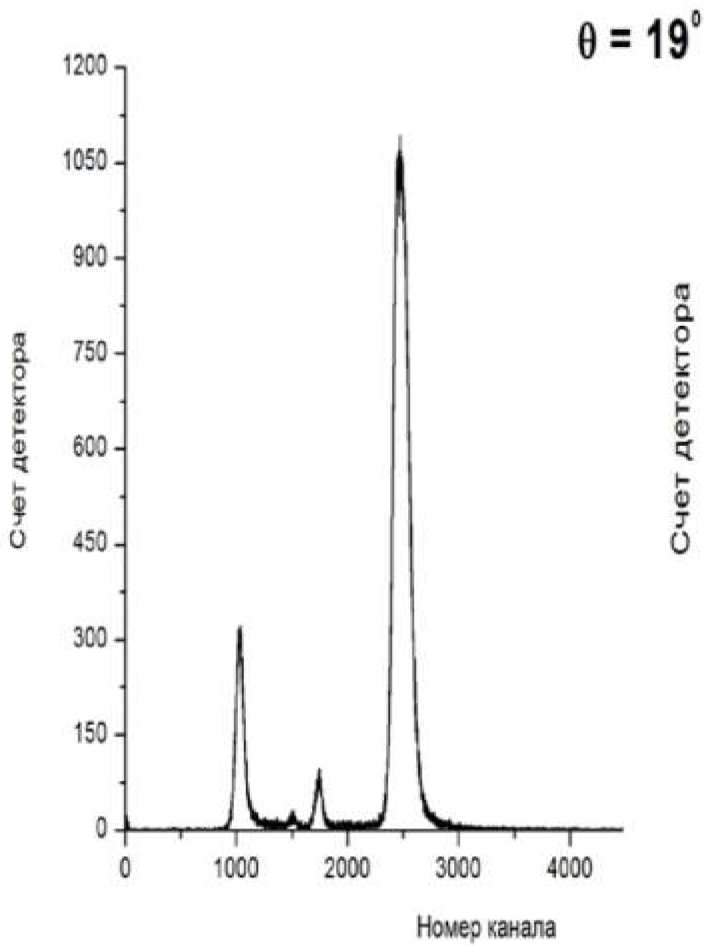
θ - the Bragg glancing angle

n - the order of reflection

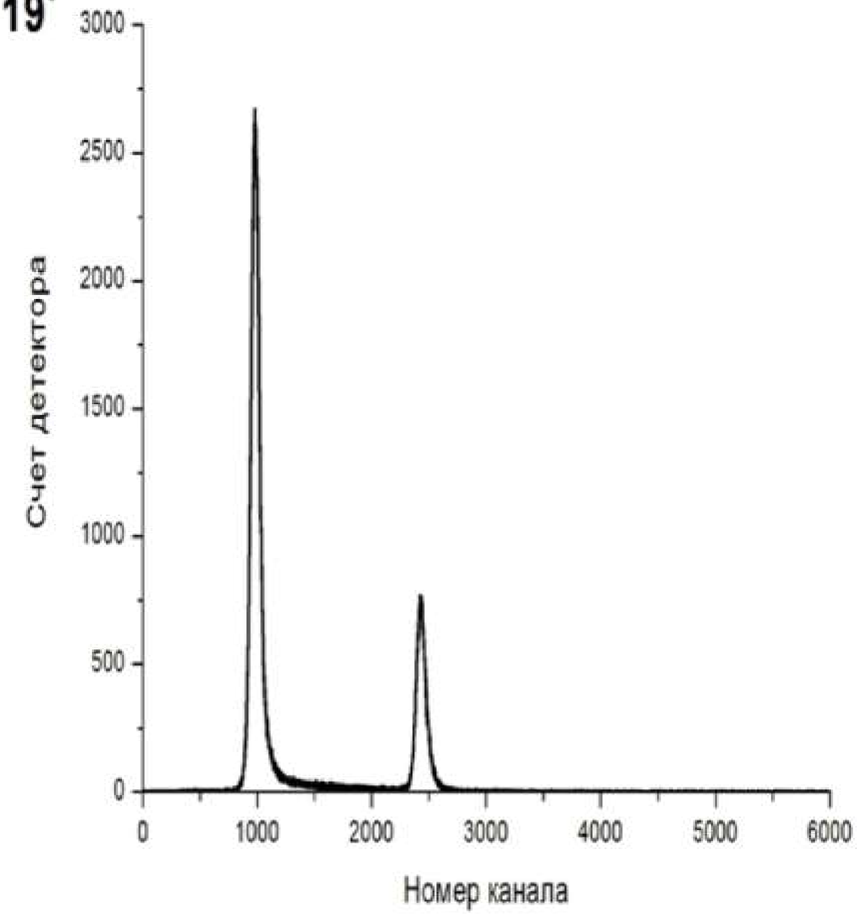
The neutron diffraction



The neutron diffraction



А)

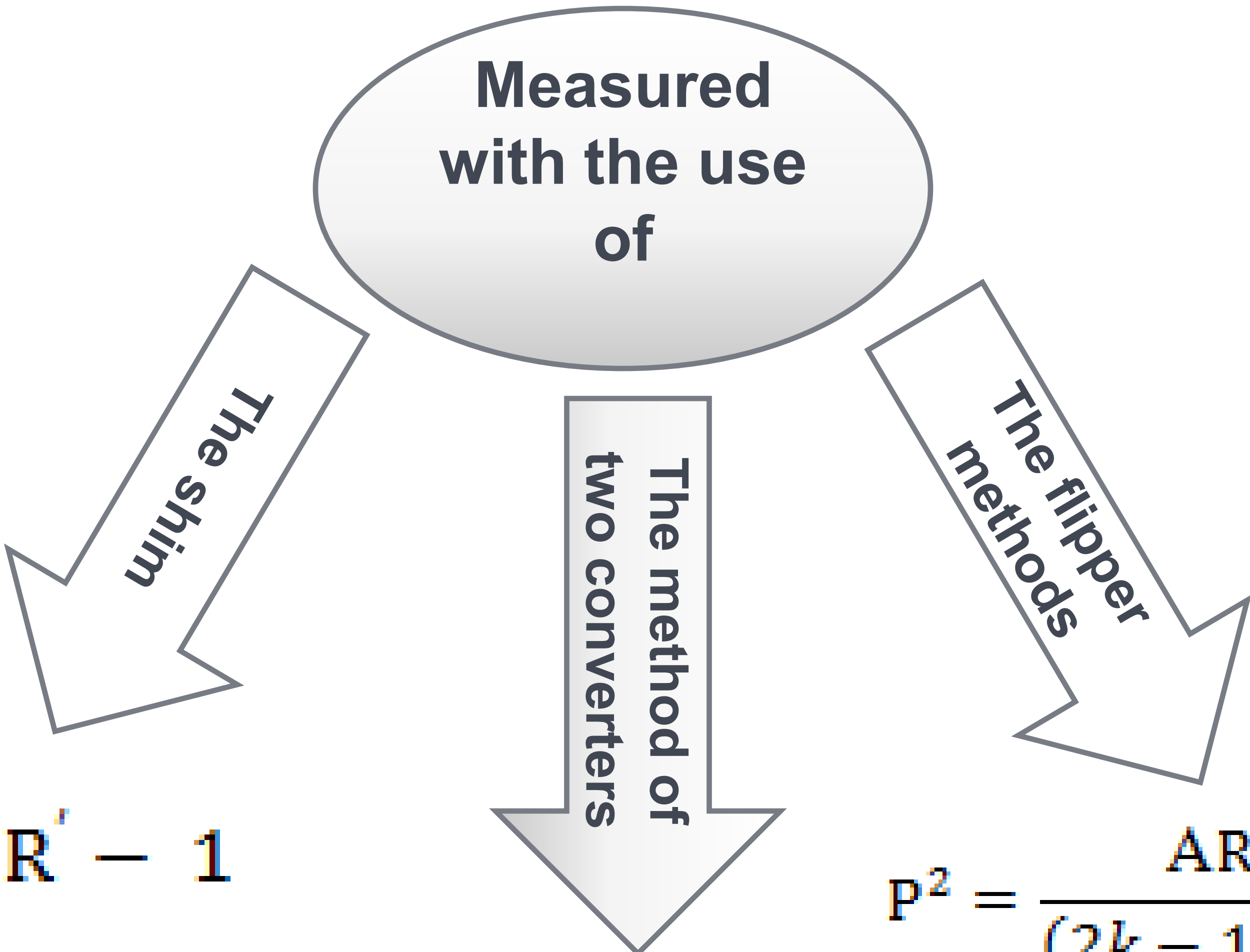


Б)

Parameters of the polarized neutron beam

Angle θ (deg)	19	12	6	4	3
Wavelength λ (Å)	1,15	0,74	0,37	0,25	0,19
Energy E_n (eV)	0,062	0,15	0,60	1,3	2,3
Detector counting rate after the polarizer n_1 (s^{-1})	800	270	65	33	22
Polarized beam intensity I_1 (n/s cm^2)	430	200	80	60	50
Detector counting rate after the analyzer n_2 (s^{-1})	70	23	3,1	0,6	0,2

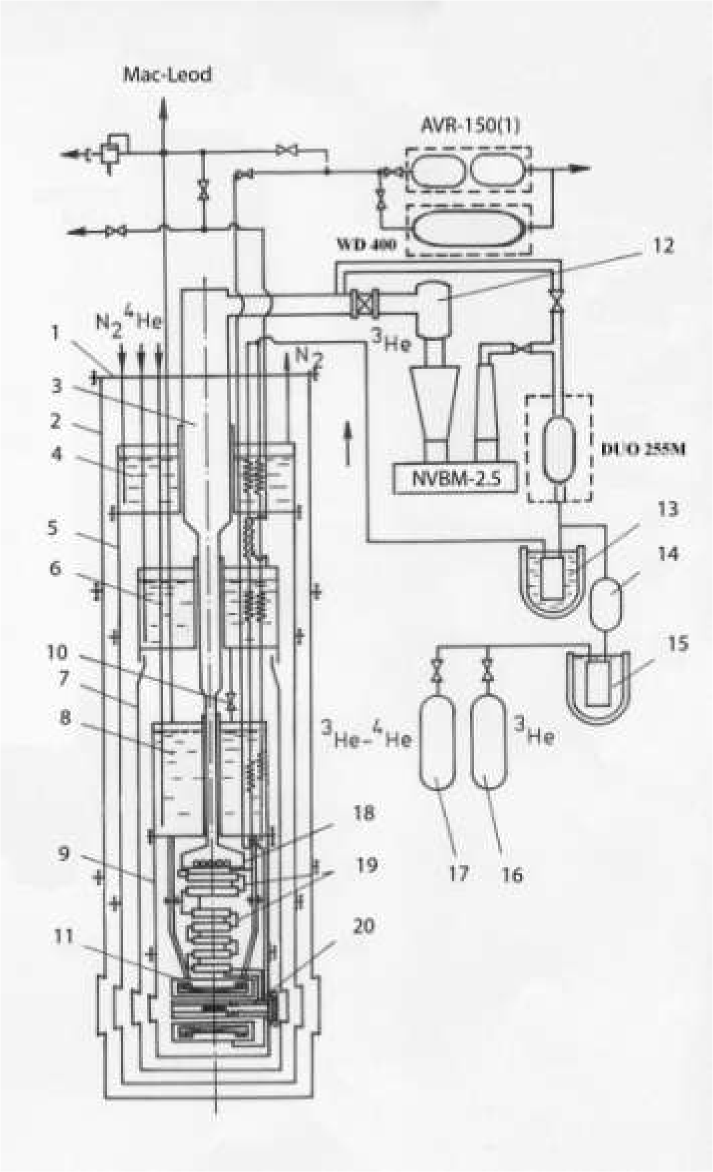
The neutron beam polarization



$$P^2 = R' - 1$$

$$P^2 = \frac{AR - 1}{(2k - 1)\,AR + 1}.$$

Polarized nuclear target



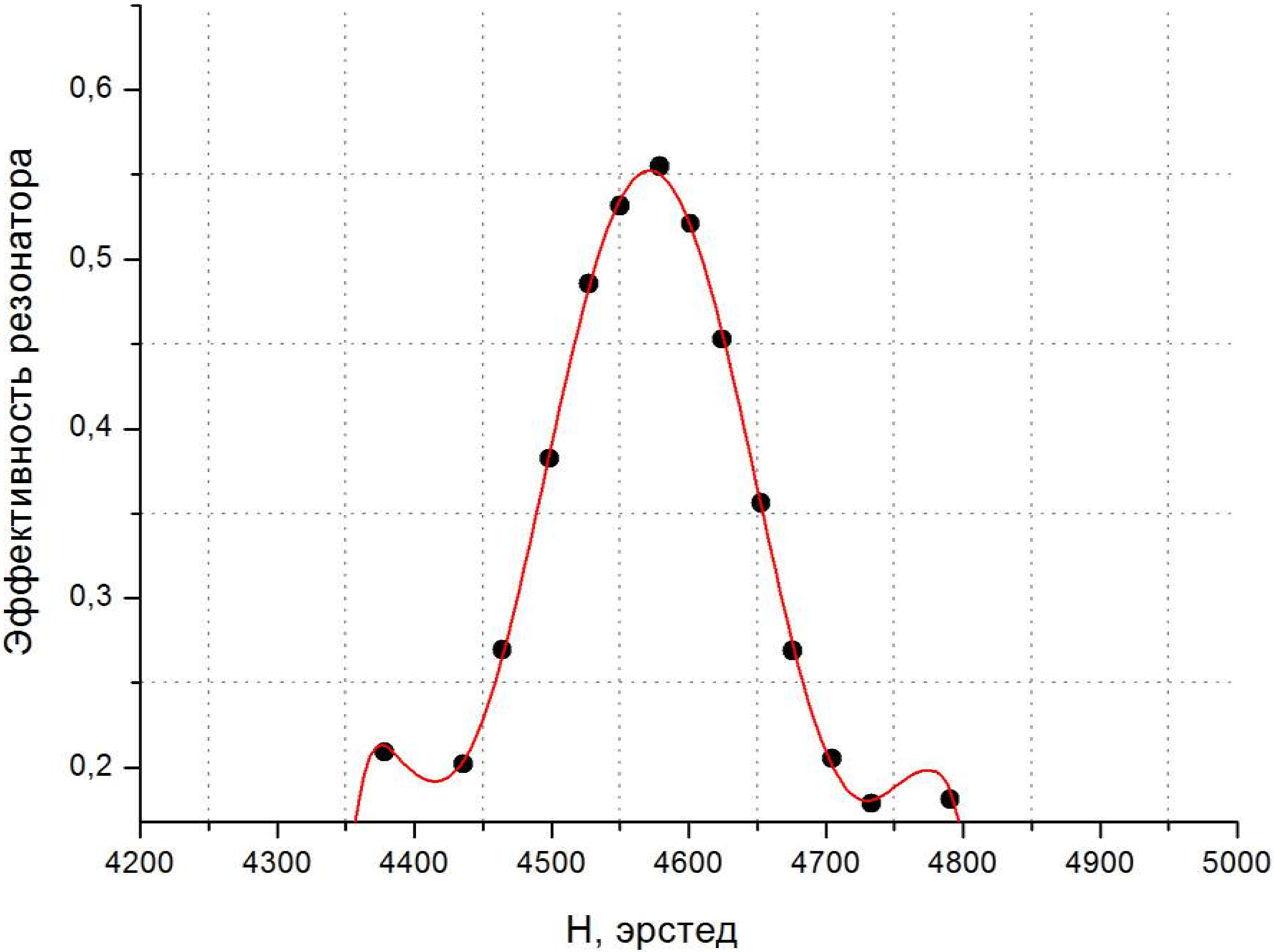
^3He - ^4He dilution cryostat diagram with a superconducting solenoid. 1 - main flange; 2 - vacuum housing; 3 - central ^3He pump-out pipe; 4 - nitrogen bath; 5 - nitrogen screen; 6 - helium bath; 7 - helium screen; 8 - helium bath to be evacuated; 9 - dilution stage helium screen; 10 - cryo-valve; 11 - superconducting solenoid; 12 - nitrogen trap of booster pump NVBM-2.5; 13 - oil filter; 14 - pump NVG-2; 15 - carbon trap; 16 - ^3He storage cylinder; 17 - ^3He - ^4He mixture storage cylinder; 18 - evaporation bath; 19 - heat exchangers; 20 - dilution bath.

Polarized nuclear target

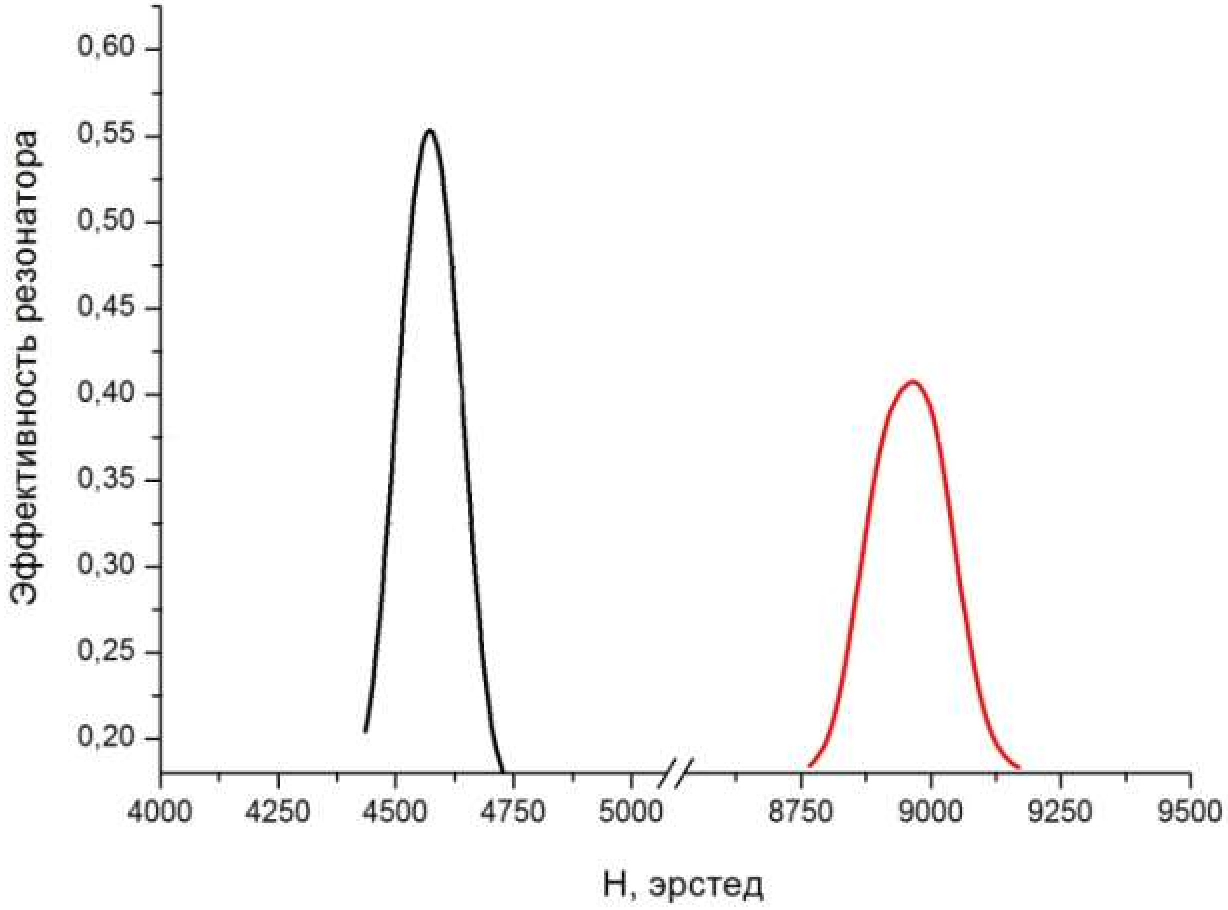
We have also upgraded the polarized nuclear target:

- ❖**We have updated the cryostat service infrastructure by replacing old vacuum devices with modern ones.**
- ❖**We have created a new, modern dilution bath for the cryostat.**
- ❖**We have created a new cryostat component for neutron Investigation of specimens in strong magnetic fields at room temperature (a “warm sluice”).**

Ferromagnetic neutron spin resonator


0,6
0,5
0,4
0,3
0,2
Эффективность резонатора
4200
4300
4400
4500
4600
4700
4800
4900
5000
H, эрстед

Ferromagnetic neutron spin resonator



A warm sluice

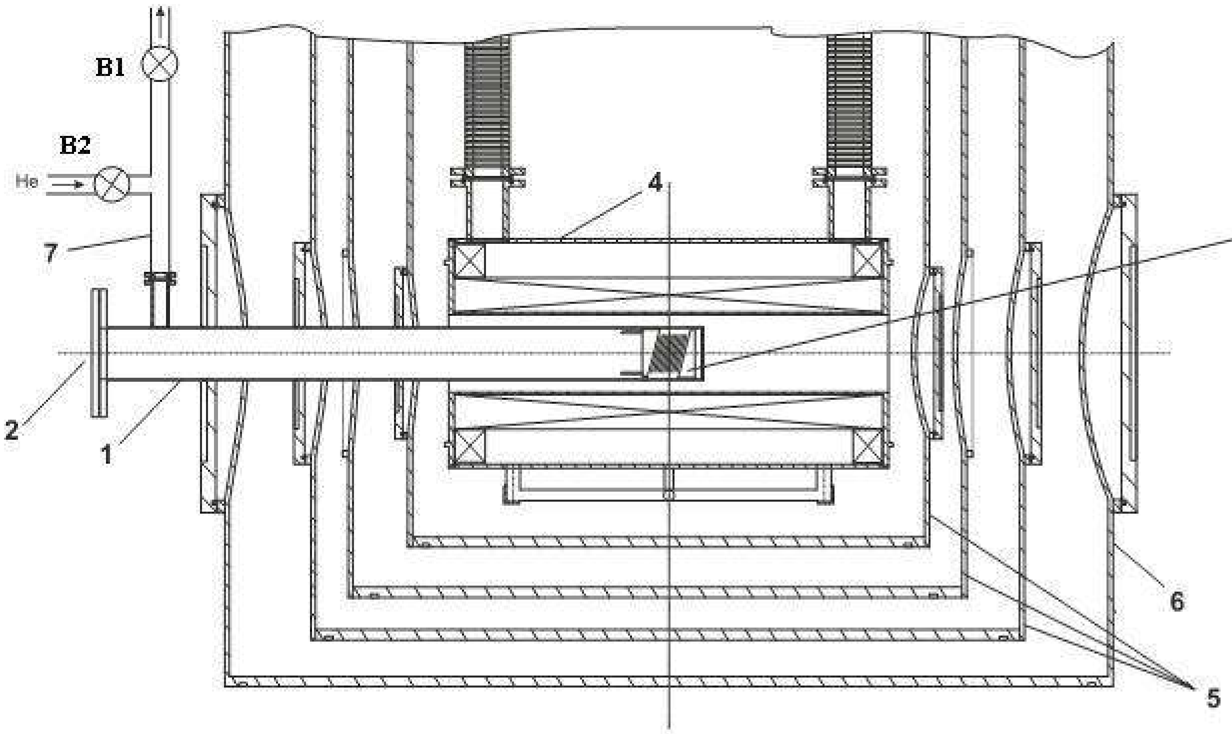


Diagram of the ‘warm sluice’

1 – sluice; 2 – vacuum flange; 3 – nuclear target; 4 - superconducting solenoid; 5 – cryostat’s baths; 6 - vacuum housing of cryostat; 7 - vacuum-valves;

Conclusion

We have completed the upgrade of the Kolkhida experimental setup. As a result of the modernization of the KOLKHIDA experimental setup we have upgraded the polarized neutron spectrometer control and monitoring system. We have completely updated fore-vacuum and high-vacuum pumps of the ^3He-^4He dilution cryostat. The cryostat has been equipped with a detachable system designed to study specimens placed in strong magnetic field at room temperature. We have developed new software for the KOLKHIDA setup.

Thank you for your attention!