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Introduction

The development of neutron imaging techniques as a tool for non-destructive analysis of the internal structure, defects and processes in industrial products, functional materials, objects of cultural heritage attracts considerable attention at the present time. The dedicated instruments are available at the many neutron sources. The IBR-2M high flux pulsed reactor is one of the most powerful pulsed neutron sources in the world with the average power 2 MW, power per neutron pulse 1850 MW and neutron flux in pulse of $5 \cdot 10^{15}$ n/cm²/s. During the period December 2006 – December 2010 the reactor was on modernization for replacement of the reactor vessel and fuel elements. During 2011, the successful physical and power start-up of IBR-2M were performed. Now reactor is operational and can be used for research and development activities using neutron scattering techniques in next 25 years prospective. However, no instruments dedicated for neutron imaging is installed at IBR-2M so far. Moreover, in Russian Federation there is no dedicated neutron imaging facility for cultural heritage research at the moment.

Experimental facilities

First activities for establishing prospects of neutron imaging development at IBR-2M were made in 2011. Using the experimental setup based on the CCD camera and beamline 12 with mirror neutron guide, it was shown that appropriate quality neutron images can be obtained in rather short time of 10 s with white neutron beam. The main goal of this project is to develop neutron imaging facility at the IBR-2M high flux pulsed reactor, which can be used for cultural heritage research purposes.

Table 1 - Technical parameters of the neutron imaging facility at the IBR-2M reactor

Neutron flux at the sample position	$\sim 10^6$ n/cm ² /s
Incoming beam apertures	50, 30, 20, 10 mm
L/D ratio for given apertures	240, 400, 600, 1200
Fields of view for given L/D	341, 298, 276, 255 mm
CCD-camera parameters	Active pixels: 4008×2672 Pixel size: 9×9 μm Image area 36×24 mm Digitization: 12 bit Cooling (Peltier) to -25 C

Cooperation:

- Helmholtz Zentrum Berlin (Germany),
- Paul Scherrer Institute (Switzerland),
- National Research Center “Kurchatov Institute” (Russia),
- Institute of Paleontology RAS (Russia).

Workplan year 1:

- The development of the neutron imaging facility with CCD camera-based detector at the one of available beamlines of the IBR-2 reactor. Design and fabrication of the main units - vacuumed collimator, box for CCD camera with larger field of view (15*15 cm) than presently available (1*5cm), purchasing of sample manipulator, material for X-ray filter.

- Nondestructive analysis of the Brachiopods and other objects from Institute of Paleontology (Moscow) by neutron imaging at IBR-2 reactor. It is planned to use white neutron beam and energy selection by polycrystalline filters.

Main objective	Sub objectives	Year 1				Year 2				Year 3			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development of Neutron Imaging Facility	Planning	X	X										
	Design and fabrication of main units, including vacuumed collimator parts, box for CCD camera		X	X	X	X	X	X	X				
	Purchase of the sample manipulator, material for X-ray filter			X	X								
Research cooperation	Promoting of contacts with neutron imaging and cultural heritage community		X	X	X	X	X						
Sample 1 - Brachiopods	Planning			X									
	Experimental measurements				X		X	X					
	Results								X				
	Report									X	X		