2. NEUTRON SOURCES

I. THE IBR-2 PULSED REACTOR

In 2016, the activities on the research nuclear facility IBR-2 (RNF IBR-2) were carried out in accordance with the objectives of the theme "Development of the IBR-2 Facility with a Complex of Cryogenic Neutron Moderators"

At the RNF IBR-2 a cyclic mode of operation is adopted, in which the reactor is operated continuously at a power for 180÷400 hours in accordance with its schedule of operation for the current year.

In 2016, the IBR-2 research nuclear facility was operated in a nominal on-power mode under Rostekhnadzor license № valid until 30.09.2022.

Statistical data on the IBR-2 operation of IBR-2 for physics experiments are presented in **Table 2-I-1**.

Table 2-I-1. *presents data on the IBR-2 operation for physics experiments.*

№ cycle	Period	Reactor operation for physics experiments, hr	Moderator type
1	18.01-29.01	262	water
2	08.02-19.02	262	water
3	14.03-28.03	328	water
4	04.04-18.04	328	water
5	16.05-27.05	120	water
6	26.09-07.10	canceled due to technical reasons	
7	17.10-03.11	408	water
8	15.11-25.11	237	cryogenic
9	05.12-26.12	502	water
TOTAL		**2447**	

The reasons for the IBR-2 shutdowns in 2016 were:

- The emergency shutdown on 06.04.2016 at 16:32 was caused by a voltage drop in the 10-kV bus section I of the main step-down substation GPP-2 as a result of an outage of the power transmission line PTL-110 kV “Tempy-Dubna-2” (outside the area of responsibility of JINR).
- The safety shutdown system was activated on 20.05.2016 at 04:40 because of a short-term power outage of the RNF IBR-2 caused by a voltage drop in the 10-kV bus section I of GPP-2 as a result of a failure of the bushing insulators of line 11 of the feeder of the central power distribution station CRP-1 of GPP-2 (in the area of responsibility of JINR).
- The emergency shutdown on 26.05.2016 at 16:06 was caused by a voltage drop in the 10-kV bus section I of GPP-2 as a result of short circuits in the municipal electric power supply system (outside the area of responsibility of JINR).
- The safety shutdown system was triggered on 27.05.2016 at 10:49 because of a voltage drop in the 10-kV bus section I of GPP-2 as a result of actuation of ground-fault protection in box №3 “Atoll” at CRP-8 (outside the area of responsibility of JINR).

Due to multiple power supply failures in May 2016 caused by voltage drops, cycle №5 of IBR-2 operation for physical experiments was terminated before the scheduled date with a loss of about 130 hours of experimental beam time.

II. IREN FACILITY

At the end of 2015 the second accelerating section was installed instead of the drift gap at the LUE-200 accelerator. In the early 2016 the connection of technical systems for the second accelerating section was made and a complex check of all systems of the accelerator was done. The existing accelerator configuration: the first section is powered by an E3730A Toshiba klystron, the second one – by a 2129 Thomson klystron. The power supply of klystrons is provided by Dawonsys modulators.

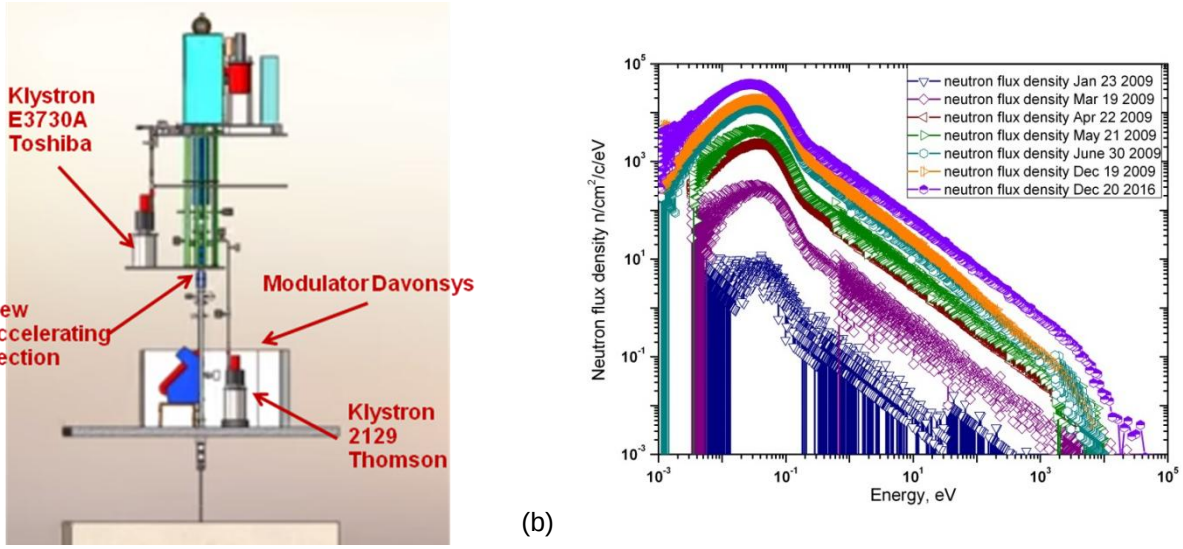

Fig. 2-II-1. *(a)Scheme of a new configuration of the accelerator;(b) Spectra of neutron flux density from IREN obtained during the development of the facility.*

During 2016 the training of the accelerating systems with the gradual achievement of nominal operating parameters was carried out. In December the facility operated within nominal parameters at a frequency of 50 Hz without any failures during one week. Preliminary measurements of the neutron flux were carried out. The estimation showed an increase of the neutron yield by at least 3 times in comparison with the operation with one section.

III. EG-5 ACCELERATOR

In 2016, the EG-5 accelerator operated for experiments for 620 hours. Experimental studies on charged particle beams using nuclear analytical methods of Rutherford backscattering (RBS) and elastic recoil detection (ERD) were conducted in cooperation with representatives of various institutes of the JINR Member States (Institute of Applied Physics of NAS, Sumy, Ukraine; Institute of Electrical Engineering of SAS, Bratislava, Slovakia; Maria Curie-Skłodowska-University, Lublin, Poland), Russian institutes (A.M.Prokhorov General Physics Institute of RAS, Moscow; B.P.Konstantinov Petersburg Nuclear Physics Institute, Gatchina; Voronezh State University), as well as of the JINR laboratories (DLNP, FLNR). Samples of different elemental composition and various preparation technologies were analyzed. The structure and properties of silicon and oxide films, the processes of accumulation and distribution of hydrogen and deuterium in the samples, the effect of proton irradiation on the characteristics of composite HTSC materials were investigated.